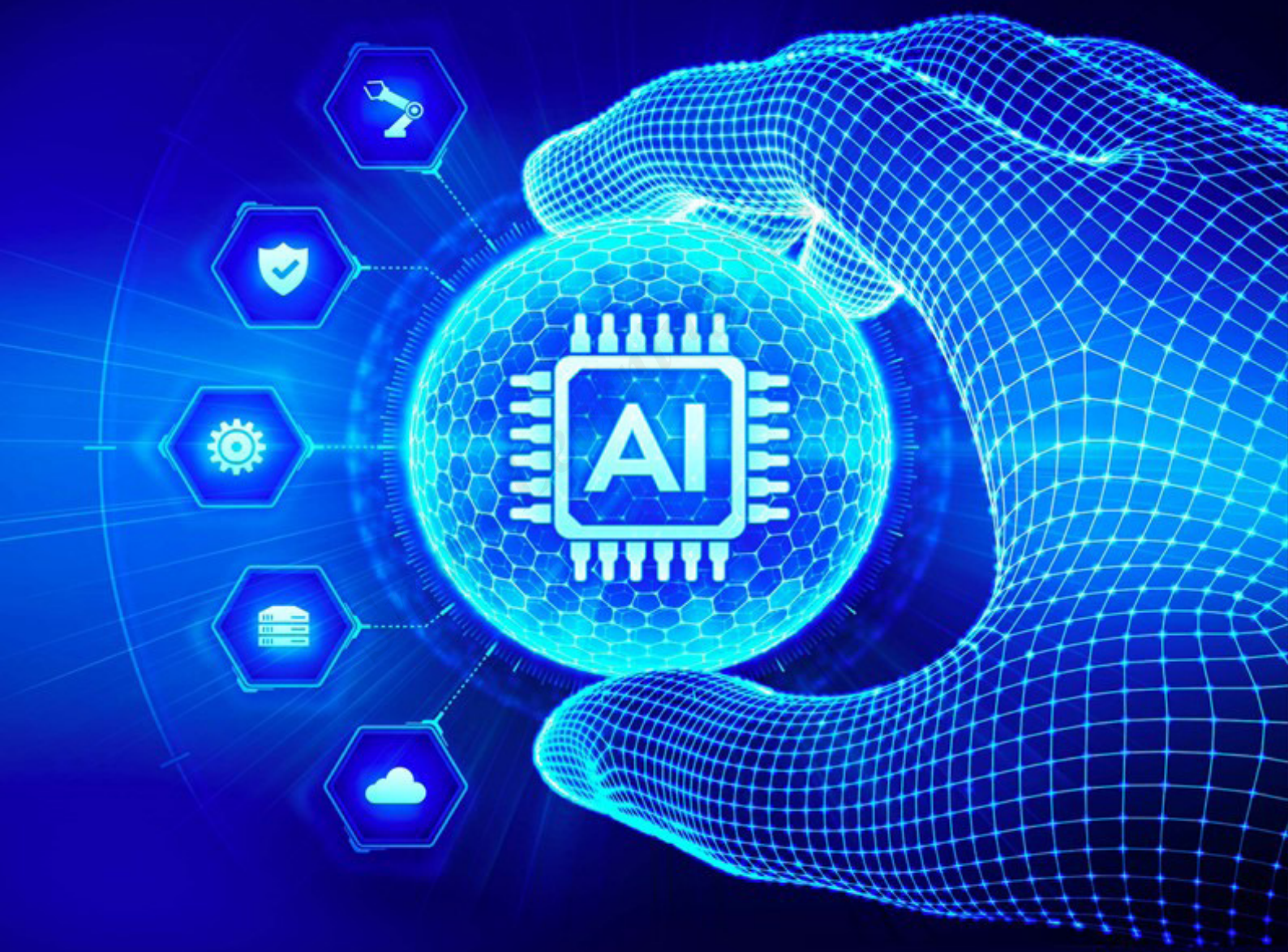
Youthful Ingenuity

A Collection of AI Innovations by Chinese Teenagers

Executive Summary



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青少年人工智能创新计划
Youth Artificial Intelligence Innovation Initiatives

Youthful Ingenuity: A Collection of AI Innovations by Chinese Teenagers

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Youth Artificial Intelligence Innovation Initiatives: the Yuanzhuo Initiatives for Chinese Teenagers

Background

Artificial Intelligence (AI) is driving the rapid development of ICT in Education, and AI in education has become a dynamic and diverse field with significant advancements. AI has been widely applied to various aspects of education, including personalized learning, adaptive assessment, intelligent tutoring, curriculum design, teacher training, and educational administration. AI has created value for students, teachers, schools, and regional education systems by improving teaching quality, efficiency, and equity.

According to UNESCO, AI presents multiple risks and challenges, such as ethical, legal, and social implications, necessitating policy debates and regulatory frameworks. Accordingly, UNESCO has been spearheading several initiatives to support Member States in harnessing the potential of AI for achieving the Education 2030 Agenda while ensuring that the core principles of human rights and human dignity guide its application in educational contexts. Some of these initiatives include:

- The Beijing Consensus on Artificial Intelligence and Education established a shared vision and action plan to promote AI in education (UNESCO 2019).

- The publication Artificial Intelligence and Education: Guidance for Policymakers provided practical recommendations and examples for developing and implementing AI policies in education (UNESCO 2021).

- In March 2023, the International Forum on Artificial Intelligence and Digital Education, together with the Establishment Ceremony of the UNESCO Chair on Artificial Intelligence in Education, takes place at Beijing Normal University, the objective is to facilitate a platform that enables the exchange of knowledge and experiences amongst professionals, educators, and policymakers who possess expertise in the domain of AI in education.

Throughout this process, governments and relevant organizations worldwide have implemented various policies and standards to encourage the integration and growth of artificial intelligence within education. For example, in April 2022, Information Technology Curriculum Standards for Chinese Compulsory Education were introduced, incorporating AI into the learning content of grades 7-9 in China's compulsory education system. Furthermore, in 2019, the National Science Foundation (NSF) of the United States initiated the National Artificial Intelligence Research Institutes Program to establish a network of interdisciplinary and collaborative institutes to advance AI research and education. Additionally, the European Union (EU) launched the Digital Education Action Plan 2021-2027, aimed at fostering digital skills and competencies for digital transformation while enhancing the digital capacity of education and training institutions.

The teenage years present the optimal opportunity to nurture interests and uncover potential, as this is when their thinking, cognition, and innovation abilities rapidly develop. Incorporating AI education during adolescence is vital for cultivating talents with an innovative spirit and the ability to adapt to future societal needs. Introducing AI education during this period aids in developing innovative, logical analysis skills and problem-solving abilities. Engaging with and learning about AI from a young age can inspire students' interest in technology and innovation, helping them to

better adapt to future societal demands and enhance their competitiveness. Moreover, AI education requires students to acquire interdisciplinary knowledge and skills, offering them opportunities to improve their comprehensive capabilities.

Establishment of Youth Artificial Intelligence Innovation Initiatives

Beijing Normal University (BNU), a leading university for teacher education in China, has pioneered advancing AI in education and research. With its rich academic excellence and innovation history, BNU acknowledges the significance of fostering future leaders in the AI domain. The university has established numerous research centers, laboratories, and interdisciplinary programs to offer comprehensive training and resources for students, teachers, and researchers interested in AI. In November 2022, UNESCO approved the establishment of a UNESCO Chair on Artificial Intelligence in Education at BNU, signifying enhanced connections between research, policy, and practice at country, regional and global levels.

BNU's commitment to fostering talent and driving innovation has resulted in the creation of the Youth Artificial Intelligence Innovation Initiatives, as known as Yuanzhuo Initiatives, a pioneering initiative in AI education for youth. In December 2019, BNU launched Yuanzhuo Initiatives in response to the call for implementing the Beijing Consensus on Artificial Intelligence and Education. This program seeks to advance AI education among youth by fostering collaboration between academia, research institutions, and industry. Our goal is to cultivate top-notch innovative youth talents with the ability to apply original and groundbreaking algorithms to address real-world challenges.

Origin of the Title YUANZHUO

Historical records indicate that LIU Hong, also known by the courtesy name Yuanzhuo, was the inventor of the Chinese abacus (Suan-Pan in Chinese). Living during the Liu Song Dynasty in the Southern and Northern Dynasties period of ancient China, around the 5th century AD, Liu was a distinguished mathematician, astronomer, and engineer. In his work 'Qian Xiang Li' (Uranic Manifestation Calendar System), he presented a comprehensive account of the primary irregularities in lunar motion. This account was based on a detailed analysis of the vast data collected by Han dynasty sky-watchers over the preceding centuries, enabling solar eclipses' prediction. Liu's contributions led to the abacus becoming the foremost calculating instrument in ancient China, greatly impacting the advancement of mathematics, commerce, and science.

Hence, the name YUANZHUO was chosen for the Youth Artificial Intelligence Innovation Initiatives (YAIII), drawing inspiration from LIU Hong's courtesy name to represent originality and excellence. This embodies the nurturing of innovative spirit and exceptional talents in youth, paving the path for the forthcoming era of artificial intelligence.

Major Projects of Yuanzhuo Initiatives

(1) Yuanzhuo Resource Platform of Algorithm, Datasets, Courses and Textbooks

Launched in 2019, the Yuanzhuo Resource Platform (https://yuanzhuo.bnu.edu.cn) now offers nearly ten thousand types of artificial intelligence resources. This includes renowned teachers' lectures, expert reports, thematic seminars, artificial intelligence datasets, open computing resources based on JupyterHub, Yuanzhuo Initiatives self-developed open-source courses, and various academic resources provided by the National Engineering Research Center for Cyberlearning and Intelligent Technology (https://cit.bnu.edu.cn) and the Smart Learning Institute of Beijing Normal University (http://sli.bnu.edu.cn). The platform has received millions of visits from over 70 countries and

regions worldwide.

(2) Yuanzhuo Community for ICT Teachers and Students

The Yuanzhuo community embraces open source and mutual support. Experts, teachers, and students participate in community activities online and offline, including the official website, WeChat groups, Tencent meetings, and public account live broadcasts. Among these, Yuanzhuo Academy serves as an online communication platform for the community and has successfully hosted over forty online exchange activities since 2022. In addition, over one hundred esteemed guests have shared valuable insights on various topics, including discussions on curriculum standards, presentations on cutting-edge innovations such as ChatGPT, and the metaverse, teaching methodologies, and regular reading undertakings, eliciting enthusiastic responses from community members.

(3) Global Youth Cooperation through AI-themed Summer or Winter Schools

To promote cross-border cooperation and communication among young talents from diverse countries, we organize global youth AI-themed summer camps that provide invaluable guidance from experts from China and abroad. These camps serve as a platform for fostering international collaboration and nurturing the next generation of global leaders in the field of artificial intelligence. In the summer of 2022, together with the Computational Thinking Research Center of Beijing Normal University, we held an academic forum on the theme of computational thinking education across the Taiwan Strait and a summer camp for students with more than 400 participants.

(4) Boosting case studies by call for youth contributors

The Yuanzhuo Initiatives actively identify and commend outstanding achievements of young talents who demonstrate exceptional prowess in utilizing original and innovative AI algorithms to solve real-world problems. As a result, selected projects will be given the opportunity to be showcased internationally, elevating the status of China as a prominent global innovation hub for artificial intelligence.

Youths participating in Yuanzhuo Initiatives who demonstrate promising achievements are encouraged to explore research-worthy problems in artificial intelligence with comprehensive guidance and support. We are committed to providing extensive assistance through a series of community activities. Online community platforms that offer access to algorithms, computing power, datasets, knowledge, and invaluable insights to foster excellence among young talents continuously. Information technology teachers play a crucial role as instructors in enhancing students' technical knowledge and helping throughout the project journey. Experts from research institutions guide students to appreciate the fascinating aspects of AI technology and algorithms from a scientific perspective. Engineers from technology companies contribute by sharing cutting-edge algorithm cases that address practical challenges faced by enterprises and help students overcome technical hurdles.

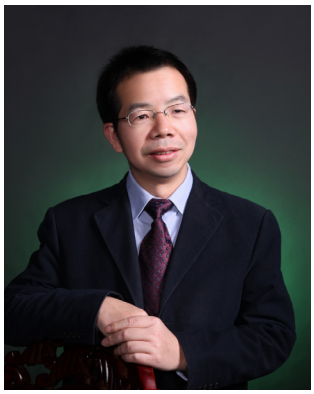
The Yuanzhuo Initiatives launched the first Solicitation of Outstanding Artificial Intelligence Cases of Chinese Youth in 2022. The project collected projects about real problems by using original and innovative algorithms of artificial intelligence by students in secondary schools in China. Hundreds of cases were received during the event, with 10 projects shortlisted after rigorous selection and defense at various levels. The projects originated from locations such as Beijing, Shanghai, Macau, Chengdu, and Fuzhou, covering diverse fields and topics, including industry, medicine, food security, express delivery, elderly assistance, waste sorting, smart homes, and smart classrooms.

Under the guidance and support of UNESCO and relevant organizations, we will initiate a campaign

to collect outstanding youth achievements in artificial intelligence across more than 10 countries worldwide. A compilation of these cases is set to be released in the summer of 2024, showcasing the accomplishments of youth worldwide in the field of artificial intelligence.

The Yuanzhuo Initiatives are committed to promoting AI education for youth through cooperative approaches, nurturing innovation, and supporting exceptional accomplishments. We are confident that by equipping young talents with essential knowledge, skills, and resources, we can contribute to the progress of artificial intelligence for all.

Preface

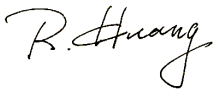


In the 21st century, an era full of challenges and opportunities, artificial intelligence has become an important driving force for developing science and technology. With the progress of technology and the widespread practical applications, artificial intelligence has gradually penetrated all aspects of our lives, thus shaping a whole new world. In this transformation, the youth generation is responsible for contributing to future innovation and development.

UNESCO issued the Beijing Consensus on Artificial Intelligence and Education in 2019. In order to response to the call and to show the outstanding achievements as well as the exploration spirit in the youth artificial intelligence field in China, therefore promoting the development of youth artificial intelligence education, Yuanzhuo Initiatives launched the first Solicitation of Outstanding Artificial Intelligence Cases in 2022. The solicitation collected projects focusing on real problems by using original and innovative algorithms of artificial intelligence by students in secondary schools in China. A total of hundreds of cases were received during the event, 10 of them were shortlisted after 3 rounds of selection and defense at various levels. The projects come from Beijing, Shanghai, Macau, Chengdu, Fuzhou and other places. The fields and topics involved are different, including industry, medicine, food security, express delivery, helping the elderly, smart home and other fields.

Behind these cases are a group of enthusiastic teenagers who pursue excellence. They have not only learned and applied artificial intelligence technology but also endeavor to solve practical problems in life, bringing real changes and progress to society. In these innovative cases, we can see the exploration spirit, innovation awareness, and technical strength of Chinese teenagers in the field of artificial intelligence, such as the project from Beijing Middle School: A Monitoring System for Migratory Bird Beijing Swift with Object Detection, which assisted Beijing Wildlife Rescue & Rehabilitation Center and solved the problem of low efficiency of volunteers' manual marking of swifts by using deep learning image processing technology, and achieved very good results in practice. Another example is A Rotor Fault Detection System Based on Nonlinear and Dynamic Response from Lou Hau High School, Macao, which focused on motor rotor fault detection. A detection rate of nearly 100% has been achieved through continuous improvement of algorithms and engineering practice.

We hope that the compilation and distribution of this casebook can provide more learning references and enlightenment for teenagers, stimulate their concern and passion for the field of artificial intelligence, increase interest in learning, and improve learning ability, therefore promoting the development of artificial intelligence education for teenagers. Meanwhile, this book also provides references and resources for artificial intelligence education and research institutions, contributing to China's scientific and technological innovation and development. Therefore, we expect these excellent cases to receive more attention and recognition in the field of artificial intelligence and jointly promote the development of artificial intelligence globally.



Ronghuai HUANG
Chair-holder, UNESCO Chair on AI in Education,
Professor, Beijing Normal University

Features of This Book

1. Youthful Perspective

As the title suggests, Youthful Ingenuity offers a unique perspective on AI from the younger generation. The book reflects the fresh and innovative mindset of teenagers growing up in the era of rapid technological advancements. Their unique approach, creativity, and out-of-the-box thinking bring a fresh perspective to the field of AI. This youthful perspective adds a dynamic and refreshing element to the book, making it an engaging read for experts and novices in AI.

2. Innovations by Chinese Teenagers

The most distinguishing feature of Youthful Ingenuity is that it presents innovations by Chinese teenagers, the driving force behind the book. These young minds have produced cutting-edge ideas, projects, and applications that demonstrate their creativity, curiosity, and determination to be effective in the field of AI. The book provides a platform for these teenagers to showcase their groundbreaking work, which is impressive and inspiring.

3. AI-focused Content

Youthful Ingenuity stands out for its exclusive focus on AI-related content. The book covers various topics, including machine learning, computer vision, natural language processing, robotics, and more. It delves into the technical details of the innovations, providing readers with a comprehensive understanding of the concepts and technologies involved. The book also discusses the challenges young innovators face and their approaches to overcoming them, making it a valuable resource for those interested in the practical applications of AI.

4. Diverse Topics Covered

Another distinctive feature of Youthful Ingenuity is the wide array of topics. The book showcases various AI projects and innovations, ranging from healthcare and education to agriculture and transportation. This diversity of topics demonstrates the versatility and applicability of AI in various domains and provides readers with a holistic view of the potential of AI in addressing real-world challenges.

5. Practical Applications of AI

Youthful Ingenuity emphasizes the practical applications of AI in solving real-world problems. The book focuses on how AI can address pressing issues such as disease diagnosis and environmental sustainability. The book provides practical insights, case studies, and examples of how these young innovators have leveraged AI to create meaningful impact and contribute to the betterment of society. This emphasis on real-world applications makes Youthful Ingenuity a relevant and valuable resource for those interested in the practical implications of AI.

Contents

Executive Summary

01 A Monitoring System for Migratory Bird Beijing Swift with Object Detection

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Highlights

This project outlines the development of an intelligent assistant application that uses advanced data collection and processing techniques to accurately monitor and count swifts. With the use of Artificial Intelligence, this project represents a promising solution to challenges faced in swift monitoring and can potentially become a model for monitoring other bird species in the future.

Challenges: The expenses associated with tagging swallows significantly escalate the cost of acquiring extensive, effective training data. Current deep learning methods for target detection demonstrate limited accuracy when identifying small targets. Furthermore, the precision of these existing techniques continues to be inadequate for small target detection.

Solution: The project's dataset was primarily developed through a combination of manual tagging and pseudo-labeling generated by the model.

Outcome: The deliverables comprised a deep learning model and an integrated web system (inclusive of a website and a mini program).

What is the Beijing Swift Survey Project about and why is it important for biodiversity conservation efforts?

The Beijing Swift Survey Project is a project aimed at assessing the conservation status of swifts in Beijing. It is an essential component of the city's biodiversity conservation efforts. The use of Artificial Intelligence can significantly improve the efficiency and accuracy of data collection, which can have far-reaching implications for ecological research and conservation efforts.

How does the object detection algorithm improve the accuracy of swift counting processes?

The object detection algorithm employed by the system can better highlight the features of the tiny target, thereby enhancing the detection accuracy without significantly decreasing the detection speed. The improved CenterNet model has been tested and shown to have a significant performance and speed improvement compared with the pre-improvement, meeting the requirements of the target detection system in the project objectives.

How does the use of Artificial Intelligence in bird monitoring have far-reaching implications for ecological research and conservation efforts?

The use of Artificial Intelligence in bird monitoring can significantly improve the efficiency and accuracy of data collection, which can have far-reaching implications for ecological research and conservation efforts. By accurately monitoring and counting bird populations, researchers can better understand the ecological health of an area and make informed decisions about conservation efforts. The development of the intelligent assistant application for the Beijing Swift Survey Project represents a promising solution to challenges faced in swift monitoring, and it can potentially become a model for monitoring other bird species in the future.

Executive Summary

Abstract

This project outlines the development of an intelligent assistant application (APP) for the Beijing Swift Survey Project in 2022, which uses advanced data collection and processing techniques. The system employs an object detection algorithm to monitor and count swifts accurately, improving the accuracy of swift counting processes while streamlining data collection. Furthermore, the system utilizes the internet for increased publicity and aims to enhance the user experience through continuous optimization and innovative features. The Beijing Swift Survey Project is to assess the conservation status of swifts in Beijing and is an essential component of the city's biodiversity conservation efforts. The use of Artificial Intelligence can significantly improve the efficiency and accuracy of data collection, which can have far-reaching implications for ecological research and conservation efforts. The development of this APP represents a promising solution to challenges faced in swift monitoring, and it can potentially become a model for monitoring other bird species in the future.

Keywords: Swift (Bird), Object Detection, Mobile Application (APP).

1. Overview of Beijing Swift Survey Project

Background

Beijing Swift, also known as the hawk swallow, is a member of Caprimulgiformes, Apodidae. The bird, named after Beijing, has many unique biological characteristics. Still, due to urban development and the demolition of old buildings, the Beijing Swift, which used to nest under the eaves of ancient buildings, has been affected. To protect the Beijing Swift population, Beijing Wildlife Rescue Center launched the Beijing Swift Scientific survey Project in 2017 and recruited volunteers from the public in 2018.

During the survey, volunteers were asked to take multiple photos of the Swifts' flight and count each image. The Beijing Swift is small, fast, and prefers to fly in clusters, which caused some difficulties in the survey. At the same time, with the development of the project, more social volunteers have joined the study. The number of social volunteers in the project has reached nearly 500, and the number of active survey points has increased from a few in the early stage to almost 100 at present, so it has become a problem to summarize such a large amount of survey data.

To solve the above two problems, after communicating with the responsible personnel of the Beijing Swift Survey Project, the project received some support and started development.1.22 Project Objectives

The project aims to use artificial intelligence and network technology to solve the difficulties encountered in the Beijing Swift Survey project and to support further development. The specific objectives are:

(1) Using Deep Learning Image Processing Technology to Complete Photograph annotation quickly.

(2) Build a system to aggregate survey data and add more functionality.

(3) Build a portal website for the survey project to help promote it.

The project will fully use of the network and artificial intelligence technology to facilitate the Beijing Swift survey project volunteers. The project team should also fully understand the needs and opinions of volunteers and survey project leaders, continuously optimize the iterative system and introduce more functions.

Why to Monitor Beijing Swift

This project is to apply artificial intelligence and Internet technology to assist the Beijing Swift Survey Project. For the present situation, the system has received better feedback and can effectively improve the efficiency of the volunteer survey. At the same time, after a year of trial operation, the system's data collection and processing function has unified the data collection approach for the Beijing Swift Survey Project in 2022. In the follow-up development, the project will also help the survey project to use the Internet for publicity while continuously optimizing the experience and developing new functions. Furthermore, the project team will also actively look for opportunities to use artificial intelligence and network technology to investigate and conserve more species.

While achieving the project objectives, the team solved some difficulties. Some of these can be applied to similar issues. Specifically, the project proposes a way to deal with the inaccurate and slow detection of small targets. At the same time, the project also collects a relatively complete Swift target detection data set, which can be used to evaluate the performance of the micro-target detection model.

Overall, the value of the project is reflected in its support for Beijing Swift Survey Project and the solutions to relevant technical problems.

2. Technological Issues and Solutions for Beijing Swift Survey

The project's main technical problem is accurately detecting swifts in the pictures. The difficulty of this problem is that swifts are often densely distributed in the picture, and each swift occupies a very tiny area. For most existing target detection methods, detecting a tiny target in a high-resolution image can lead to significant result errors or a long calculation time.

This part talks about the technological challenges and solutions related to the Beijing Swift Survey. The main problem is how to develop a target detection system that can quickly and accurately detect Beijing Swifts in pictures. The second goal is to use network technology to fill in and report data uniformly.

Improving the Detection Accuracy

To improve detection accuracy, several strategies can be used. One is to add the capability of multi-scale input or multi-scale feature fusion to the model. Another is to apply data enhancement to the training data to provide multi-scale feature information. The third is to use an anchor-free solution. These strategies can help enhance the model's ability to detect small targets.

The document discusses the use of an image pyramid sampling method and a multi-scale feature

prediction fusion model. However, using multi-scale input can slow down the inference speed. An improved target detection scheme has a higher detection accuracy rate for the cluster of Beijing Swift.

Simplifying User Interaction and Stabilizing Network System

The second problem involves the user interaction part of the system. The solution is to simplify the interaction design by removing unwanted distractions and providing instructional elements. The user interface design of this project's network system follows a modern and concise style.

To ensure the stability of the network system, it's important to design the queue mechanism to prevent instability and even collapse caused by excessive detection tasks. The stability of the filling and uploading part of the system can be guaranteed by improving the back-end performance. Specific solutions include using languages with more optimized space and introducing asynchronous and multithreading in the IO operation part of the network.

3. Phases of Project Implementation

The following sections, 3.1 and 3.2, of the project implementation involve the development and iterative design of the monitoring system. In the 3.1 section, the team creates three components to develop the monitoring system. In the 3.2 section, iterative designs are implemented to continuously improve the monitoring system based on feedback and evolving project requirements. This combination ensures an adaptable and effective monitoring process throughout the project.

Development of the Monitoring System

The monitoring system was developed in three parts. The front-end part was designed to be user-friendly. The target detection part was made to identify and track the birds. The back-end part was created to handle data storage and processing. These parts work together to make a complete monitoring system.

The front-end part was built using a framework called Vue2 and a library called ElementUI. The system was designed to be simple and easy to use. The team plans to add more features to the system in the future.

Iterative Designs for the Monitoring System

The team used an iterative design process to improve the monitoring system. They started with an early version of the system, tested it, and then made an improved version based on the feedback they received. They plan to keep improving the system in the future.

The early version of the system was simple and had less than 1000 lines of code. It was launched in June 2021 and received positive feedback. However, there were some problems with the system, like low detection accuracy and speed, and poor system stability.

The improved version of the system was developed from September 2021 to April 2022. It had more features and improved user experience. It was launched in September 2022 and also received positive feedback.

The team is now planning the next version of the system. They want to improve the user experience and aesthetics even more. They also want to add more practical features and improve the accuracy of

the target detection system. They plan to use more server resources to make the system run smoothly and efficiently.

4. Summary and Future Plans

The improved project version has been running for half a year following the 2022 survey project and has received much positive feedback. The project objectives of this project are almost achieved. However, there is still much room for improvement, such as the detection speed and accuracy of the target detection system and the aesthetics and usability of the front-end system.

The project team is now actively communicating with the Beijing Swift Survey project team to facilitate the development of the next version. The project also has some output. During the project development process, the project team maintained effective communication with the responsible team of the Beijing Swift Survey Project and obtained the approval of platform volunteers and the team in charge.

In the past two years of development and operation, the project has undergone many iterations to ensure that the output can achieve the project objectives and meet the needs of volunteers. At present, the Beijing Swift Survey Project in 2022 has been completed with the help of this project. All filling data can be summarized and counted through the system. Nearly 5Gb attachments were collected during the survey, and almost 400 valid records were generated.

Subsequently, the project team will continue to communicate with the responsible team and volunteers of the Beijing Swift Survey Project and ensure that the project's output can assist the investigation project. The next release cycle of the project is currently under development.

The project team will try to find more problems and explore solutions in the subsequent development. At the same time, the project will continue to create more value based on ensuring the achievement of the project objectives.

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Brief introduction of school and instructors

Beijing Middle School was established in September 2013, approved by Beijing Municipal Government. Adhering to the orientation of internationalization, modernization and high quality, the school is committed to building a modern school with Beijing style, Chinese temperament and world mind, and gradually developing into a world-class Chinese famous school.

Manming ZHAO: Teacher at the Beijing Youth Activity Center in Chaoyang District. His team published a total of 13 textbooks and 3 internal materials, 10 of which were awarded as Beijing outstanding after-school tutoring materials. In 2022, he won the title of the Most Beautiful Scientist in Chaoyang District, Beijing.

Executive Summary

02 An Intelligent Detection System for Monitoring Food Waste in School Dining Rooms

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Highlights

This innovative project uses AI computer vision technology to identify whether students' meal plates are clear or not in real-time, encouraging them to participate in the Clear Plate campaign and reduce food waste.

Challenges: Food waste in the campus environment is compromised due to the lack of easy-to-implement and effective monitoring measures, thereby making it challenging to track and encourage sustainable food consumption practices.

Solution: Employing machine learning techniques to build a "Clean Plate" identification model. Incorporating AI computer vision technology in campus dining facilities to non-intrusively capture images of students' trays during tray return. This system analyzes the images in real-time, identifying those trays with minimal food waste ("Clean Plate") and subsequently rewarding students who consistently follow this practice with credits.

Outcome: An intelligent solution for recognizing "Clean Plates" post-meal, implemented data augmentation techniques, and created two classification models for dishware. A Python-based recognition system was also established.

What does the project entail and why is it significant in addressing the issue of food waste?

The Clear Plate campaign encourages people to eat all the food they order and to develop the habit of buying as much as they eat. The Clear Plate campaign lacks an effective supervision mechanism and technology, which is why AI computer vision technology is used to capture the image of the meal plate in students' hands while recycling the meal plate in campus canteens to identify whether the plate is clear or not in real-time. The Clear Plate recognition prototype system uses machine learning algorithms to analyze the image data and identify whether the plate is clear or not. The students of Clear Plate are rewarded with points, and the accumulated points can be exchanged for drinks, fruit, and other small gifts. The Clear Plate recognition prototype system has the potential to be a valuable tool for promoting sustainability and reducing waste in a wide range of settings.

What is the process for collecting and extracting feature data for the clear plate recognition model?

The object detection algorithm employed by the system can better highlight the features of the tiny target, thereby enhancing the detection accuracy without significantly decreasing the detection speed. The improved CenterNet model has been tested and shown to have a significant performance and speed improvement compared with the pre-improvement, meeting the requirements of the target detection system in the project objectives. According to , the process for collecting and extracting feature data for the clear plate recognition model involves the following stages:

(1) Collection and feature extraction of Clear Plate sample data: in this stage, the dining plate in the canteen is shot mainly through the shooting equipment.

(2) Clear the plate recognition model training: in this stage, the classification models for identifying the category of plates and whether dishes are clear are developed using machine learning methods.

(3) Recognition experiments and analysis: in this stage, the recognition model is tested and analyzed to ensure its objectivity, accuracy, and intelligence.

(4) Development of a Clear Plate recognition prototype system using Python: in this stage, the detection system based on the image acquired by the camera is developed.

Overall, this process involves collecting and analyzing image data of dining plates in the canteen, developing and training machine learning models to recognize clear plates, and implementing a prototype system for real-time detection using Python.

How does the Clear Plate recognition prototype system work, and what are its potential applications beyond school dining rooms?

The Clear Plate recognition prototype system works by using an intelligent detection system based on the image acquired by the camera. The system uses machine learning algorithms to analyze the image data and identify whether the plate is clear or not. The system can recognize the category of plates, whether a single plate is clear, and image recognition with multiple plates (combined with the division of bowls and plates and the recognition of whether the plate is clear).

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The potential applications of this system beyond school dining rooms could include any setting where food waste reduction is a priority, such as restaurants, hospitals, and other institutional dining facilities. The system could also be adapted to recognize other types of waste, such as plastic or paper waste, and could be used to monitor waste reduction efforts in a variety of contexts. Overall, the Clear Plate recognition prototype system has the potential to be a valuable tool for promoting sustainability and reducing waste in a wide range of settings.

Abstract

Food waste is a significant issue in China, with enough food wasted every year to feed 200 million people. To address this issue, the Clear Plate campaign was launched to encourage people to eat all the food ordered and develop the habit of buying as much as they eat. However, the campaign lacks an effective supervision mechanism and technology. To address this issue, AI computer vision technology is used to capture the image of the meal plate in students' hands while recycling the meal plate in campus canteens to identify whether the plate is clear or not in real-time. In addition, students who participate in the Clear Plate campaign are rewarded with points to exchange for drinks, fruit, and other small gifts. The project includes the collection and feature extraction of Clear Plate sample data, clear the plate recognition model training, recognition experiments, and analysis, and the development of a Clear Plate recognition prototype system using Python. The project's contributions include providing a comprehensive solution to Clear Plate intelligent recognition for canteen users, developing classification models for identifying the category of plates and whether dishes are clear, and developing a detection system based on the image acquired by the camera.

Keywords: Intelligent Detection System, Clear Plate Recognition, Food Waste Reduction.

1. Overview of the Project for Clear Plate Recognition

China has a large population and food country. However, food waste is prevalent in China. The food wasted every year is enough to feed 200 million people. According to the data analysis of relevant departments, China's food waste is serious. It is estimated that the total amount of food wasted in the country is equivalent to about 50 billion kilograms, equal to one-tenth of the whole grain output of China. Foreign media have also reported that China wastes enough food to feed 200 million people a year, which is staggering. According to a survey of leftovers after some students' meals in Beijing, the total amount of food thrown away is about one-third of the food they bought. College students throw away food yearly that can feed about 10 million people. To reduce and eliminate food waste, our country began to promote the Clear Plate campaign in recent years, encouraging people to try to eat all the food ordered and to buy as much as they eat. We combat extravagance and waste and

encourage everyone to cherish grain and eat all the food on their plates. It practices a strict economy supported by the central government and the people.

The Clear Plate campaign is not sustainable because of the lack of effective oversight mechanisms and technologies. The current identification of the Clear Plate campaign is not intelligent enough, and a mobile phone is required to take pictures and upload them. The AILab smart recognition system quickly identifies the uploaded photos to determine whether food IS left on the plate. Aiming at the problem that the Clear Plate campaign is not sustainable and lacks an effective supervision mechanism, and technology, AI computer vision technology is used in the campus canteen to capture the image of the meal plate in the hand of the students during the process of recycling the meal plate, to identify the meal plate is clear or not in real-time. The students of Clear Plate are rewarded with points, and the accumulated points can be exchanged for drinks, fruit, and other small gifts. We use the machine learning method to construct the Clear Plate recognition model to realize the objectivity, accuracy, and intelligence of Clear Plate recognition, which provides a feasible and new research method.

The contributions of the project include the following aspects:

(1) Put forward a comprehensive Clear Plate intelligent recognition solution for canteen users after dining.

(2) Solve the problem of fewer data acquisition using sample enhancement technology.

(3) Train the classification models for identifying the category of plates and whether the dishes are clear using the Master R-CNN model algorithm in the MMDetection framework and the Resnet50 in the MMC classification framework.

(4) Develop a intelligent detection system based on the image acquired by the camera using Python language.

2. Methods of Recognition and Classification

Target detection is an important problem in computer vision, but it is the theoretical basis of face recognition, vehicle detection, road network extraction, and other fields. The purpose of object detection can be divided into detecting the position of the interested object in the image and classifying the curious object.

In this project, we use the Fast R-CNN model algorithm to realize the recognition and classification of the dinner plate. The Master R-CNN algorithm has been implemented in the open-source project of MMDetection, so we can directly use the model training and recognition experiment by recalling MMDetection.

3. Overall Design of the Detection System for the Project

The process of the Clear Plate recognition system designed for this topic is shown in Figure 1. That is, when the user places the dinner plate on the recycling table in the process of recycling the dinner plate, the system captures the image of the dining plate by using the camera on the dining plate recycling table. First, it obtains the user information of the recycling dinner plate through face recognition. Then we use the trained dish and bowl detector model to identify the types of dishes (mainly to identify the shape and color of the dishes, and this topic defines eight kinds of dishes) and locate the

photos of the dishes. Next, the clear plate level classifier is used as a dichotomy identification method to judge whether the disc is clear. If the recognition result is clear, the user corresponding to the face recognition is rewarded with points.

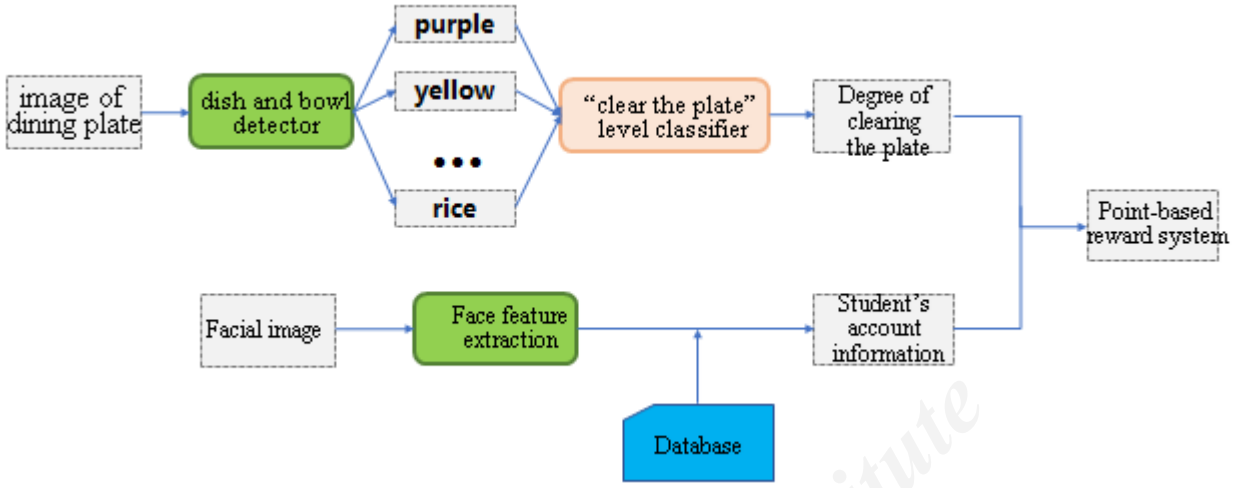

Figure 1 System Flow

In this project, we train two classification models using the Fast R-CNN algorithm in MMDetection: one is for the classification of dishes, and the other is the classification model for whether the plates are clear. We will introduce our work from data collection and annotation, data enhancement, and model training.

4. Development of the Intelligent Detection System

Based on Flask, we construct a prototype system of Clear Plate recognition for web services, which can be used for the comprehensive solution of Clear Plate detection in the campus canteen. The system is divided into front-end and back-end. System cameras are recalled through a front-end page to carry out real-time photographing and transmission. The back end is used to process the captured meal plate photos and display identification results on the front-end page. Finally, prompting is carried out at the front end according to the identification results. Figure 2 is an optical intelligent detection system architecture.

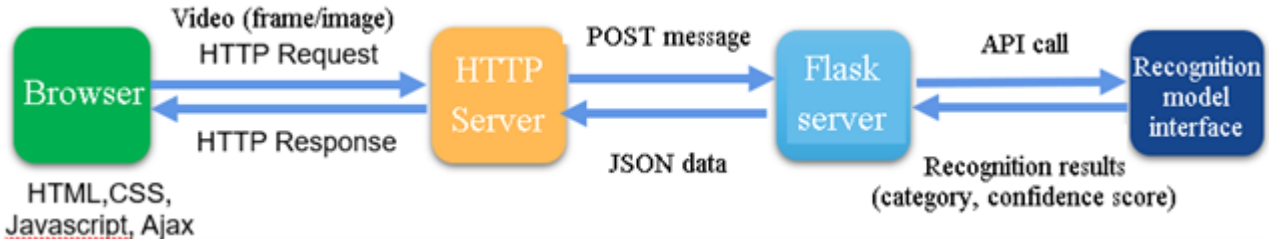

Figure 2 Architecture of Intelligent detection System for the Clear Plate Recognition

We set up cameras connected to the Clear Plate detection system in the public canteen of the campus. The teachers and students put the dining plate after the meal under the camera for an identification test. The operation interface of the system is shown in Figure 3.

5. Conclusion

This project proposes a comprehensive scheme of intelligent recognition of Clear Plate for canteen users. Many groups of dish data are collected as training and test samples according to the project targets. The sample data is expanded using a sample enhancement program, which solves the problem of less collected data. The classification models for detecting the types of dishes and judging whether the dishes are Clear Plate are trained using the Faster-RCNN model algorithm in the framework of MMDetection and the Resnet50 in the framework of MMC classification, respectively. The experimental results prove that the corresponding training algorithms and models have a good effect and verify the feasibility and innovation of the application scenario. However, due to the short duration of the project, there are still some areas for further progression and improvement in the project research, including:

(1) Combined with the face recognition of SDK, a complete reward and punishment system is formed. Alternatively, a system to judge how long a person can eat up or a canteen flow control system is developed combined with SDK.

(2) The model for improving Clear Plate recognition is not a simple binary classification but outputs a score representing the Clear Plate degree.

In this project, the latest achievements of artificial intelligence technology in the field of machine vision are applied to the intelligent recognition of dining plates after meals to automatically identify whether the diners are clear the plate, supervise the diners to eat in a civilized manner, save food, and provide beneficial exploration for the implementation of Clear Plate actions.

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Brief introduction of school and instructors

The High School Affiliated to Shanghai Jiao Tong University is a key boarding high school under the dual leadership of Shanghai Municipal Education Commission and Shanghai Jiao Tong University. It has been awarded the title of Civilized Unit in Shanghai for 18 consecutive years. The university highlights the characteristics of scientific and technological innovation and has jointly established the Top Innovative Talent Training Base with Shanghai Jiao Tong University.

Zhihong HU: Master of Education from East China Normal University, is currently a senior teacher of information technology in the affiliated Middle school of Shanghai Jiao Tong University. He was awarded as the National Excellent Advisor of Information Technology Innovation and Practice activities in primary and secondary schools.

Executive Summary

03 A Stroke Diagnosis System with CNN Algorithm trained by Open-Access Brain CT Datasets

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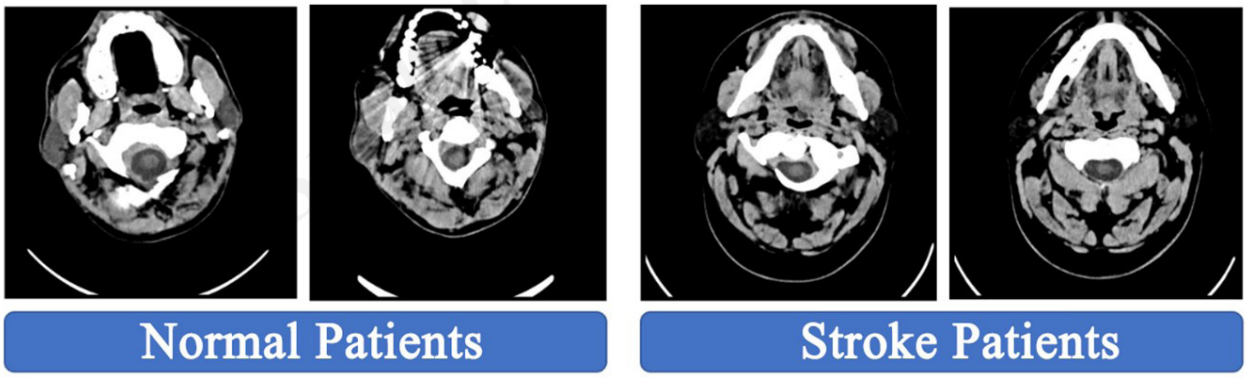
Highlights

This project explores how computer aided diagnosis technology can improve the accuracy and efficiency of stroke diagnosis using CT imaging.

Challenges: Stroke, being the second leading cause of death and a prime cause of disability globally, can lead to increased disability and death rates due to delayed treatment and high misdiagnosis chances.

Solution: We utilized Kaggle's CT brain image dataset and intelligent image recognition technology to help doctors identify strokes more accurately and swiftly.

Outcome: Owing to data limitations, the team normalized the dataset and manually adjusted the learning parameters to ensure model convergence and fitting. After training with relevant CT images using an existing convolutional neural network model, a high-speed model was developed to accurately diagnose strokes.



What are the main focus areas and technological implementations of this project?

The Beijing Swift Survey Project is a project aimed at assessing the conservation status of swifts in Beijing. It is an essential component of the city's biodiversity conservation efforts. The use of Artificial Intelligence can significantly improve the efficiency and accuracy of data collection, which can have far-reaching implications for ecological research and conservation efforts.

How does the Stroke Diagnosis System function?

The system uses a shallow neural network model to improve the portability of the equipment and the speed of the whole deployment while ensuring high accuracy. For specialized large medical diagnostic devices, deeper neural network models such as residual networks and GoogLeNet with larger datasets can be used to explore accuracy and multi-classification further.

The project discusses the implementation of the Stroke Diagnosis System based on experimental results. It chose AlexNet as the final network model for the assistant analysis of brain CT in this Stroke Diagnosis System because AlexNet is lightweight and still maintains high accuracy. Finally, code is written to read the picture.

How can the Stroke Diagnosis System potentially reduce the burden on clinical emergency doctors?

The Stroke Diagnosis System aims to improve the efficiency and accuracy of CT image diagnosis in stroke by applying CAD technology to classify different densities of brain CT images. By automating some aspects of the diagnosis process, the system may potentially reduce the burden on clinical emergency doctors.

Executive Summary

Abstract

Stroke is a major cause of disability and death worldwide, with the incidence increasing with age. In China, millions of people are affected by stroke every year. The golden treatment time for stroke is only four hours; missed diagnosis or misdiagnosis can lead to permanent brain injury or death. CT imaging is an essential tool in stroke diagnosis, with different densities of brain CT images corresponding to different brain diseases. However, diagnosis relies on doctors' experience and knowledge, leading to misdiagnosis and missed diagnoses. Computer Aided Diagnosis (CAD) technology, including neural network technology in machine learning and open-access brain CT datasets, has shown promise in improving the accuracy of diagnosis and reducing missed diagnoses. This project aims to improve the efficiency and accuracy of CT image diagnosis in stroke by applying CAD technology to classify different densities of brain CT images, potentially improving patient outcomes and reducing the burden on clinical emergency doctors.

Keywords: Stroke Diagnosis, Computed Tomography Scan, Computer Aided Diagnosis, Neural Network, Open-Access Brain CT Datasets.

1. Project Overview of the Stroke Diagnosis System

Stroke, commonly known as apoplexy, refers to a series of brain diseases in which cerebral blood vessel ruptures or block, causing impaired blood circulation to the brain. Stroke is expected in the middle-aged and elderly, and the incidence increases with age, which makes it the second leading cause of death in the world and one of the main causes of disability in the population. According to data published by the World Stroke Organization (WSO) in its 2022 Global Stroke Fact Sheet('Corrigendum to: World Stroke Organization (WSO): Global Stroke Fact Sheet 2022', 2022), more than 80% of the 12 million new stroke cases worldwide are from people over 49 years old. Moreover, the global stroke history shows that one in four people over 25 years old will have suffered a stroke in their lifetime. As a developing country with the largest population in the world, stroke is also severe in China. According to China National Stroke Center Report 2020(Greenberg et al., 2002), in 2020, about 17.8 million people in China aged or above 40 suffered from a stroke, with 3.4 million new cases and 2.3 million stroke-related deaths, which shows many people involved in stroke.

Diagnosis depends entirely on doctors' clinical experience and knowledge of medical image information, so misdiagnoses and missed diagnoses are inevitable. In recent years, Computer Aided Diagnosis (CAD) technology has gradually become one of the research hot spots in medical imaging. Many CAD technologies have appeared and developed rapidly, which has played an active role in improv-

ing the accuracy of doctors' diagnoses and reducing missed diagnoses. To improve the efficiency and accuracy of CT image diagnosis, we will use neural network technology in machine learning to judge the classification problems in the current diagnosis course of treatment.

2. Relevant Technologies for Diagnosing Stroke

In recent years, due to the prevalence of machine learning, especially computer vision, various diseases have been studied in the direction of applying machine learning. Stroke has been studied because of its death and disability rate. Many patients and attempts are made to increase the probability of a patient being successfully cured by giving expert-assisted diagnostic information. Many related research models have recently adopted the traditional machine learning SVM (Support Vector Machines) support vector machine as a classification tool for stroke prevention, diagnosis, treatment, and pre-screening(Bacchi et al., 2020). The classical support vector machine model is very good at bi-classification problems. Still, the accuracy and the number of samples are critical in the medical field of patient life safety. As for data, the data in the medical field is growing with technology development. More mature technologies are usually oriented to more people so that more data can be collected. Although SVM (Support Vector Machines) performs well on small samples, it is not easy to meet the demand when trying to improve the model's accuracy with a large amount of data. Its original algorithm does not support the solution of multi-classification problems. However, many diseases like stroke (most strokes are ischemic, but there are other categories like thrombotic stroke, embolic stroke, and transient ischemic attack), which can be divided into many small categories, and differentiating them is also critical to the physician's diagnosis and practice of treatment.

3. Comparison of Neural Network Algorithms in Stroke Diagnosis

We discusses the comparison of various neural network algorithms in stroke diagnosis using CT images in this part. The data was obtained from the stroke CT image dataset on the open data platform Kaggle, which contained a total of 2501 brain CT images, including 1551 non-stroke brain CT images and 950 CT images of the stroke's brain.

Several standard neural network models are used to analyze and learn CT images, including AlexNet, ResNet, GoogLeNet, DenseNet, and SqueezeNet. Each model has its unique architecture and approach to feature extraction and learning.

AlexNet, one of the classic CNN models, was a breakthrough in the ImageNet LSVRC-2010 competition. However, compared to newer models, its feature extraction is not as effective due to its large convolution kernel size and step size, and no padding operation before the convolution operation.

ResNet introduced the concept of residual structure to solve the degradation problem by allowing some layers to be skipped. This approach prevents the decrease in the accuracy rate, enabling the increase in depth to improve the accuracy rate stably.

GoogLeNet, the first classical model using a parallel network structure, proposed an Exception structure to solve the problem of overfitting parameters after the network was deepened. It uses convolution kernels of multiple sizes and concatenates their extracted feature maps together to improve the ability of multi-scale feature extraction.

DenseNet, based on ResNet, believes that feature reuse may be a better method than identity mapping to prevent model degradation. It allows features and gradients to be transferred more efficiently

between layers, mitigating the problem of gradient disappearance.

We calculated accuracy, recall, precision, F1-score, the area under the ROC curve (AUC), and training speed as model evaluation and comparison criteria. It's important to choose the right neural network model for specific tasks, such as stroke diagnosis using CT images.

4. Conclusion and Limitation

A comparison of the learning results in the Stroke Diagnosis System shows that diagnosing stroke with brain CT images does not require an overly complex model and a perfect optimization. Even a decade ago AlexNet did an excellent job, but some new models sometimes have more advantages than disadvantages in pursuing higher accuracy through higher complexity. First, overly complex models require longer training costs, that is, time and device performance (each model has a different training time for each epotch under the same environment, and the speed of convergence directly affects the number of epotch that need to be learned to achieve the same accuracy rate). Secondly, for simple classification problems, too complex models are more likely to have problems such as overfitting and convergence difficulties. Finally, in the future, smaller devices and chips, such as human-implanted chips, may require overall model size and ease of deployment. It is why SqueezeNet has emerged in recent years to deploy machine-learning models for small components.

However, different models were trained only in the same environment and parameters. The entire performance of some networks (such as VGG and DenseNet) focused on improving model performance through deep networks was not exploited. Compared to SqueezeNet, they are better suited for multi-classification problems such as the previous imagenet competition.

The purpose of this project is to discuss the application of different neural network models to the diagnosis of stroke patients to make some validation. A more extensive set of open data and a variety of neural network models are used to determine the problem's complexity and the model's performance requirements than some existing studies. As for the classification of stroke patients, under the condition of ensuring the model's accuracy (about 98%), a shallow neural network model can be adopted to improve the portability of the equipment and the speed of the whole deployment. For specialized large medical diagnostic devices, however, deeper neural network models such as residual networks and GoogLeNet with larger datasets can be used to explore accuracy and multi-classification further.

To sum up, this paper applies the gray level co-occurrence matrix and BP neural network technology to the brain CT image auxiliary diagnosis by using the computer-aided diagnosis technology, which not only can help the doctor to lighten the work burden but also provide the necessary auxiliary diagnosis information for the doctor and effectively reduces the occurrence of misdiagnosis and missed diagnosis. It has specific application prospects and value. Unfortunately, clinical data from hospitals are unavailable in this study, and the data sets published online generally do not fully fit the variability of real-world problems.

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Brief introduction of school and instructors

Beijing Royal Education (BRE) has been devoted to precollege, international education of the highest standard since its establishment in 1996. Integrating eastern and western pedagogical techniques and resources, it has created a nurturing, challenging and diverse learning environment. Open-mindedness, advanced educational philosophies, and alignment with international standards are the route of development that BRS has followed and embraced.

Ye XIA: Graduated from University of Electronic Science and Technology of China with a master's degree in software engineering. He received his master's degree in computer engineering from California State University in 2018. In 2019, he joined Beijing Royal Palace School as a computer science and AP Computer Principal teacher.

Executive Summary

04 Application of Face Detection for Learning Engagement in Classroom

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Highlights

This project explores the integration of artificial intelligence and education to improve the quality and efficiency of classroom teaching. Our proposed face detection system provides real-time feedback to teachers on students' facial expressions, enhancing learning engagement and teaching quality.

Challenges: Within the class-based teaching system, it's challenging for teachers to accurately assess each student's understanding and learning status in real-time during classroom instruction.

Solution: We utilized students' facial expression data during classes to build a comprehensive multi-person facial dataset. We employed techniques like deep learning CNNs, OpenCV, and Google's BlazeFace model to evaluate students' engagement and learning status.

Outcome: We curated a comprehensive dataset tailored for classroom teaching, investigated essential methodologies for classroom applications, designed a classroom state classification model focused on facial features and expressions, and developed a classroom application system based on facial recognition technology.

How does the face detection system work to evaluate students' classroom status?

The proposed face detection system provides real-time detection of students' facial expressions, which can be used to evaluate their classroom status. The system is designed to detect multiple faces in a classroom environment and can accurately detect faces even under interference conditions such as facial change, illumination condition, and face shift . The system uses critical technology and algorithm theory of classroom state monitoring systems based on expression analysis . The real-time detection of students' facial expressions provides teachers with timely feedback to enhance teaching quality and learning engagement in the classroom.

What methods were used to construct the face detection dataset based on the classroom environment?

To construct the face detection dataset based on the classroom environment, the project team collected data in a virtual classroom environment and used human face information to create a multi-face dataset under the classroom environment of face detection and face detection. The team reconstructed the 3D face model, obtained the face representation through the deep neural network, and then tried to obtain high accuracy by training on many datasets. However, the training data was limited during the implementation of this project. Therefore, the team built a batch of real classroom datasets and enhanced the data. The face datasets of different classes were constructed for the two processes of face detection and face detection and marked them, respectively. The existing public face datasets, such as FDDB and LFW, were not suitable for face detection research in a classroom environment, so the project needed to build a face dataset based on classroom teaching.

How does the integration of artificial intelligence and education improve classroom teaching?

The integration of artificial intelligence and education can improve classroom teaching in several ways. In this project, an artificial intelligence method is used to acquire the facial expression data of the students from the classroom. A deep-learning convolution neural network DCNN, an OpenCV computer vision database, and a Google Media Pipe Face Mesh are used to analyze and judge the classroom state of the students to form an effective classroom state evaluation mechanism to assist teachers in improving the quality and efficiency of classroom teaching. The proposed face detection system provides real-time feedback to teachers on students' facial expressions, enhancing learning engagement and teaching quality . By using artificial intelligence to monitor students' facial expressions, teachers can better understand their students' learning status and adjust their teaching methods accordingly. This can lead to more effective teaching time.

Executive Summary

Abstract

Integrating artificial intelligence (AI) and education has led to the widespread application of facial recognition technology in various fields, including classroom teaching. In this project, AI methods are used to acquire facial expression data of students to create an effective classroom state evaluation mechanism that assists teachers in improving the quality and efficiency of classroom teaching. The research involves analyzing the significance of the application of face detection technology in classroom teaching, constructing a face detection dataset based on the classroom environment, and identifying critical methods used in classroom teaching application systems. The proposed face detection system for teaching in the classroom improves traditional face detection algorithms by optimizing the network structure and implementing a lightweight classroom monitoring program to evaluate each student's classroom status. The real-time detection of students' facial expressions provides teachers with timely feedback to enhance teaching quality and learning engagement in the classroom.

Keywords: Dynamic Face Detection, , Real-time Control, Learning Engagement.

1. Project of Appling Face Detection Technology in Classroom

With the continuous development of artificial intelligence technology, the application of artificial intelligence & education is becoming increasingly extensive. Face detection technology, as an essential technology in computer vision of artificial intelligence technology, has been applied in various fields, such as face monitoring systems in the security field, the access control system in community management, face check-in and attendance system in daily office, and so on.

Since the formation of the class teaching system in education research, the classroom has always been an important place for teachers and students to learn and communicate. It has been widely concerned and valued by schools and society. Classroom teaching has also become essential for teacher teaching and student learning. In traditional classroom teaching, each student's grasp and absorption degree of knowledge in the learning process is different, so the teacher cannot pay attention to the learning state of each child in real-time and cannot accurately judge whether each student has mastered the relevant knowledge point in real-time. In addition to speaking and group discussion, students' facial expressions in class can also reflect the acceptance of classroom knowledge to a certain extent.

Classroom teaching is a complex process. Teachers need to constantly seek the integrating points between their teaching behavior and students' needs. In a one-to-many classroom teaching environment, the student's learning degree is inconsistent, the learning efficiency is not high, and when

they have questions or puzzles, they cannot ask the teacher in time, leading to a decline in teaching quality. In the project, an artificial intelligence method is used to acquire the facial expression data of the students from the classroom. A deep-learning convolution neural network DCNN, an OpenCV computer vision database, and a Google Media Pipe Face Mesh are used to analyze and judge the classroom state of the students to form an effective classroom state evaluation mechanism to assist teachers in improving the quality and efficiency of classroom teaching.

The problems to be solved in the Project include:

(1) To study the background and significance of the applications of face detection technology in classroom teaching.

(2) To understand the research progress of face detection at home and abroad, analyze the shortcomings of the face data set, such as LFW, and try to construct the data set of face detection research based on the classroom teaching environment.

(3) To study and identify the critical methods used in classroom teaching application systems based on face detection systems.

(4) For the problem of classroom state classification, a classification model of the system is designed based on facial features.

(5) To design a classroom teaching application system based on the research of face detection, recognition, and feature classification. Real-time detection of students' facial expressions will provide feedback to teachers timely when the students are found to be in a bad classroom state or have doubts about the classroom content to improve the teaching quality and classroom efficiency.

It is used the critical technology and algorithm theory of classroom state monitoring systems based on expression analysis. The traditional face detection algorithm can't meet the current application requirements because of its shortcomings, such as a large amount of computation and poor real-time performance, so a face detection system construction based on classroom teaching is proposed. The convolution operation in the traditional CNN model is improved, and the network structure of the model is optimized. Design and implement a lightweight classroom monitoring program to make each student's classroom status visible and evaluable.

2. Overall Project Design

To address the problems proposed in this project, the project team proposed to build an application system based on the dynamic face detection technology in the classroom and tried to enrich and improve the dataset, form expression model construction, conduct anomaly analysis on the collected data, do algorithm model construction by combining the big data platform, analyze the differences of various expressions, classify the characteristics of different facial expressions, summarize the algorithm of expression recognition, and put forward the potential application of expression recognition, challenges, and future research directions. The solutions to the core issues are part 2.1: Design of Multi-face Detection Scheme in Classroom Teaching and part 2.2: Applying Face Detection Technology for Engaging Classroom Students.

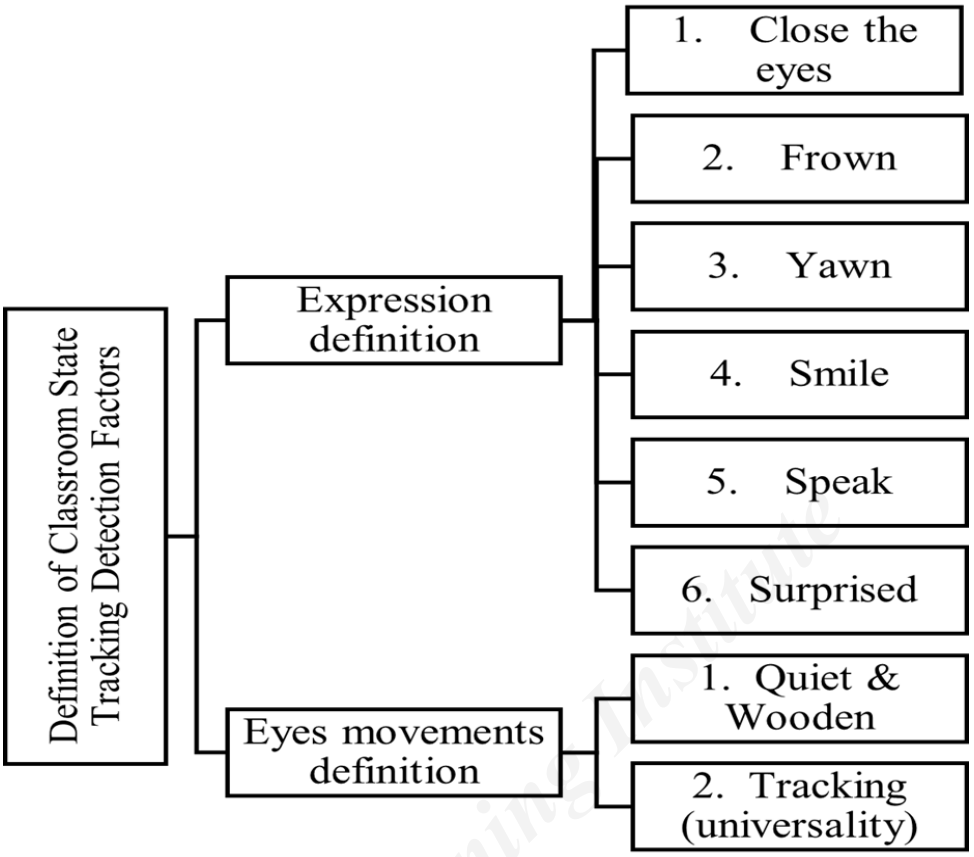

Figure 1 Definition of Classroom State Tracking Detection Factors

3. Conclusion and Future Plans

The project is based on the application research of dynamic face detection technology in the classroom. Based on reading and learning many relevant documents and application materials on face detection technology and classroom state analysis, combined with a classroom learning experience, the project members designed to achieve real-time control of the students' learning state in the classroom. By timely giving the students' learning status to teachers, parents, or school educational administration management personnel, the teachers can adjust the teaching strategies in time according to the feedback in and after the teaching and improve the efficiency of the teacher's classroom teaching content. The project's overall effect can provide reference and reference for solving the problems of class concentration and knowledge mastery of students in classroom teaching.

Through the project's research, the members constantly tap their potential, actively explore, and boldly innovate and practice in determining the project theme, analyzing the problems to be solved, code writing, testing, optimization, etc. For the issues in the project, the members can constantly put forward solutions and experience the problem-solving process. In this way, their information literacy has been significantly improved. In project cooperation, the members split the overall project content into responsibilities according to their knowledge base and specialized subject expertise. Zhao Jiaming was responsible for face detection, and Chen Jiaxuan was responsible for facial expression recognition and relevant details analysis after recognition. Deng Yuxuan was responsible for drawing the prototype of the project presentation effect. According to the project content to be studied,

the students learned while doing, which cultivated the learning ability and enhanced the teamwork ability among students.

The project is now in its final stage, but due to the limitation of time and space, the actual test data of some research contents are insufficient, and the research effect is still not convincing. In the following, we will try to add practical test classrooms in the school, further optimize the algorithm through the actual data sampling analysis and increase the practical demonstration of the accuracy of the learning state analysis. The subsequent research will focus on improving and optimizing the existing face detection algorithm and improving the system.

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Brief introduction of school and instructors

The Second Branch School of the High School Affiliated to Renmin University of China is a public school affiliated to the Haidian District Education Commission and a member school of the Joint General School of the High School Affiliated to Renmin University of China. It is a practitioner of the balanced quality education policy vigorously promoted by the Haidian District Education Commission. In 2020, the school won the first batch of new brand schools in Haidian District.

Lan WU: Information technology teaching and research team leader of the Second Branch School Attached to Renmin University of China, the academic leader of Haidian District, and the information technology teaching and research trainee. Wu was awarded as the national, Beijing and Haidian District excellent instructor of information technology.

Ye GAO: Information technology teacher of the Second Branch of Renmin University High School Affiliated to Renmin University of China. Gao is the backbone of information technology discipline in Haidian District and a trainee teaching and research member of IT discipline in Haidian District.

Executive Summary

05 A Smart Monitoring System on Refrigeration with Neural Network Models

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Highlights

This project presents an innovative solution to combat food waste and improve food safety through technology. The smart monitoring system on refrigeration with neural network models is a promising step towards a more sustainable future.

Challenges: The goal of this plan is to reduce household food waste and improve food safety using technological solutions.

Solution: Developed a refrigerator camera capable of detecting food items. Constructed a comprehensive database of food expiration dates, allowing the system to keep track of each item's storage date. Integrated the system with a website to provide users with timely reminders about approaching expiration dates, encouraging prompt consumption.

Outcome: Successfully developed and produced a prototype set of refrigerator products. Created a website system capable of reading and processing real-time camera data.

How does the smart monitoring system on refrigeration work?

The smart monitoring system on refrigeration utilizes technology to combat food waste and safety issues. It reminds users to consume the food before it expires, reducing household food waste. The system uses a Faster RCNN model to identify food and a front-end page for user interaction . Additionally, the required program is imported into the camera in advance and provided for a user to use the program at any time and anywhere. The camera can be used on multiple refrigerators, which means the user can use the intelligent refrigerator assistant to be applied to any refrigerator. A neural network deep learning hypertext language technology platform is connected to realize backend and front-end operations to provide help for a better visual effect for the user.

How does the neural network models trained and applied

The neural network model used in this project is a Faster RCNN model, which is a type of pre-trained image model. The model is trained using a large dataset of food images to identify different types of food. The training process involves several attempts to train different models, and the results are improved by adding more pictures to the dataset. During the training process, the computer sometimes confuses specific items with similar items, but this phenomenon is gradually reduced by taking pictures of designated items and similar items together and informing the computer of the differences between them. Finally, the stride size is reduced in the training to allow the computer to train more carefully and present a perfect result . Once the model is trained, it is applied to the smart monitoring system on the refrigerator. The system uses a camera to capture images of the food inside the refrigerator, and the images are processed by the pre-trained model to identify the food. The system then reminds the user to consume the food before it expires, reducing household food waste. The system also includes a front-end page for user interaction, allowing the user to view the status of the food in the refrigerator and receive reminders.

Can this technology be applied to other industries besides household refrigeration?

This technology can be optimized and extended to various industries besides household refrigeration, mentions that this technology can be applied to other industries such as social security and elderly services to enhance life quality and decrease food waste, which is a prominent global development issue. The technology can be used to monitor the freshness of food in various settings, such as restaurants, supermarkets, to reduce food waste and improve food safety.

Executive Summary

Abstract

This project utilizes technology to combat food waste and safety issues. We developed a smart monitoring system on the refrigerator that reminds users to consume the food before it expires, reducing household food waste. We trained a Faster RCNN model to identify food and developed a front-end page for user interaction. Although this smart system on refrigerators may not significantly reduce food waste, it aims to increase public awareness and inspire individuals to act. Furthermore, this technology can be optimized and extended to various industries, such as social security and elderly services, to enhance life quality and decrease food waste, a prominent global development issue. The project aims to reduce food waste and improve food safety through technology, promoting a more sustainable future.

Keywords: Food Waste, Pre-trained Image Model, Real-time Detection.

1. Project Overview of Smart Monitoring on Refrigeration

This project aims to reduce food waste and increase food safety. It is hoped that technology can be used to improve the phenomenon of food waste in the family. Do you find the sedimentation hundred years cans in the refrigerator at home? Do you often take rotten and smelly apples from the fridge? The spoiled food from the refrigerator is thrown into the garbage bin. Imagine that if everyone produces a rotten apple in the refrigerator, the world will waste about 7.7 billion good apples, likely to become every fresh apple that saves low-income people. That is the food waste phenomenon that teenagers want to change. In this era of technology, it can be learned to use technology to improve the problem.

Food safety is the key to maintaining life and improving health by obtaining enough safe food. Foodborne diseases are often infectious or toxic and are invisible to the naked eye because bacteria, viruses, parasites, or chemicals enter the body via contaminated food or water. That is why a food shelf life is the key. In addition, how food is produced, stored, handled, and eaten affects food safety. To ensure food safety, governments, international organizations, scientists, the private sector, and civil society can take the following methods: comply with global food standards; establish effective food regulatory systems, including emergency preparedness and response; provide clean water; apply good agricultural practices, including land, aquatic, livestock, and horticulture; and strengthen the application of food safety management systems by food operators; improve the ability of consumers to select healthy foods and the like.

This innovation provides solutions for household food waste and food safety.

2. Project Design for Modifying the Refrigerator

Schemes and Timetable

Scheme 1: Place a camera in the refrigerator. A miniature weighing instrument is arranged in the fridge, which is matched with the camera to detect the freshness of the food. And then, the mobile phone software is used to remind the expiration of the shelf life.

Scheme 2: Make a camera in the refrigerator that can detect food. Moreover, there is an extensive database of shelf life and will be classified food. When the shelf life is approaching, combine it with the website to remind users to eat as soon as possible. It is guaranteed to reduce unnecessary household food waste and ensure food safety.

Breakthrough in Difficulty

(1) How to Install the Camera on the Refrigerator

This problem arose at the beginning when the implementation of Scheme 2 was finished. After a long-time discussion, several ideas were discussed. Buy a cryogenic-resistant camera, but the refrigerator has many compartments, a cryogenic-resistant camera costs more than 1,000 RMB, and a few cryogenic-resistant cameras can make the price too high, so this solution is eliminated. The second idea is to put the camera out of the refrigerator. Make a box outside the refrigerator, with a camera above it, to detect items and enter a web address. Later, it was discovered that it was impossible to catch the entry and exit status of articles. This solution was eventually removed.

After two times discussions, we found that the solution was straightforward. Put a camera on top of the refrigerator to detect the food variety and the entry and exit status. Progress is beginning to take a new pace.

(2) How to Detect the Entry and Exit Status Items

At first, the idea was to use the hand as a key point to determine the trajectory. However, it is found that the amount of workload is heavy, and another neural network needs to be opened again for deep learning. Also, the recognition error of the object is increased due to the occlusion of the hand, so the object's center point is directly selected to judge the moving track.

If the camera is placed on top of the refrigerator, the movement of items in and out of the computer screen should also be adjusted. Next, we need to study the angle. Experiments show that if the camera is above the refrigerator, placing the objects into the refrigerator is from the bottom to the top. On the contrary, taking out the objects is from top to bottom. Therefore, the relationship between the entry and exit status judgment and the distinction is derived. Then the match with the key point of the center point of the article, we can judge its moving track can detect the entry and exit state of the objects.

3. Implementation of Smart Monitoring System on Refrigeration

The primary function of the intelligent refrigerator assistant is to recognize the classification of the items and judge whether to put or take out the goods when the user puts them in front of the camera

and records them on the website.

The function of distinguishing access is achieved by recording the current time, judging, judging the items' motion track, and using the motion track of the center to deduce the user's action.

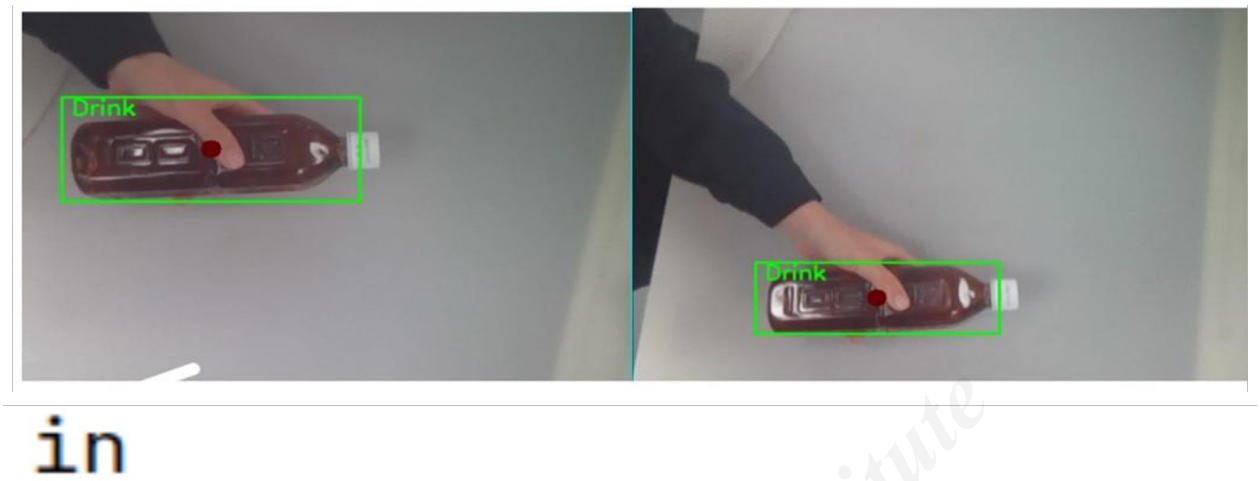

Figure 1 Identifying User Actions as Putting in or Taking out

When an object is detected, and the entry and exit direction of the article is judged to be put in storage, the user is indicated to put the item in the right direction. Otherwise, the user takes the item out of the refrigerator.

When the entry time of any goods is collected, the time point will be stored on the website. The intelligent refrigerator assistant can take out the food which reaches the shelf life at the fastest time, judge the best use time of it, and remind the user when the user does not take out the article by the time. If the goods have expired, a display will inform the user that the item has expired.

This scheme provides an accessory device for the refrigerator. Considering that the project is not entirely improved at present, the camera of the accessory equipment is still connected to the computer and performs the operation. However, after the solution is perfected, the program and database stored in the computer will be held on the GPU to achieve the effect of portability and easy installation.

4. Conclusions

This project is a successful completion and over-fulfilled within the planned time, which is the greatest gift to the producer. In this meaningful project, we learned much new knowledge and realized the importance of teamwork. On our study trip, we were deeply attracted to the power of science and technology. We found that technology can make our life more convenient and help us solve social problems as much as possible. Although this technology cannot ultimately reduce the huge amount of food waste, through our trial, it is really to form the double convenience of our life. We remind ourselves every day to protect the environment and reduce food waste.

Nearly one billion tons of food is wasted every year, about twice the best estimate in the past, according to the Food Waste Index Report, published by the United Nations Environment Programme (UNEP) On the fourth day of this month. This report is the most comprehensive to date, which points out that the world's household food waste amounts to 74 kilograms per person per year. Un-

fortunately, food waste has continuously been rising, and this scheme does not claim to reduce food waste significantly. Still, hopefully, it can be used to remind the public that it is necessary to start taking action to reduce food waste.

This scheme can also be optimized. For example, it can also be widely used in industrial activities, social security, elderly services, etc. It is believed that after the popularization of the intelligent refrigerator assistant in the future, the food waste caused by improper storage methods can be significantly reduced, food safety can be guaranteed for the user, and the goal of improving life intelligence can be achieved.

Food waste has become a significant problem in the development of the world. We believe the proposal can greatly reduce this situation, and the world will improve with the cooperation of human beings and machines.

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Brief introduction of school and instructors

Pui Ching Middle School, Macao is a school that combines the traditional rigorous academic attitude with the spirit of free and open inquiry. Pui Ching is dedicated to innovations in education and the holistic development of students. Through constantly improving our school facilities and devoting resources to teacher development, the school aims to help students develop intellectually, mentally, physically, emotionally, and socially.

Jianyuan LIN: Teacher at Pui Ching Middle School, Macau. He has been working in software engineering for more than ten years. He enjoys the value and significance of making progress together with his classmates.

Executive Summary

06 A Rotor Fault Detection System Based on Nonlinear and Dynamic Response Models

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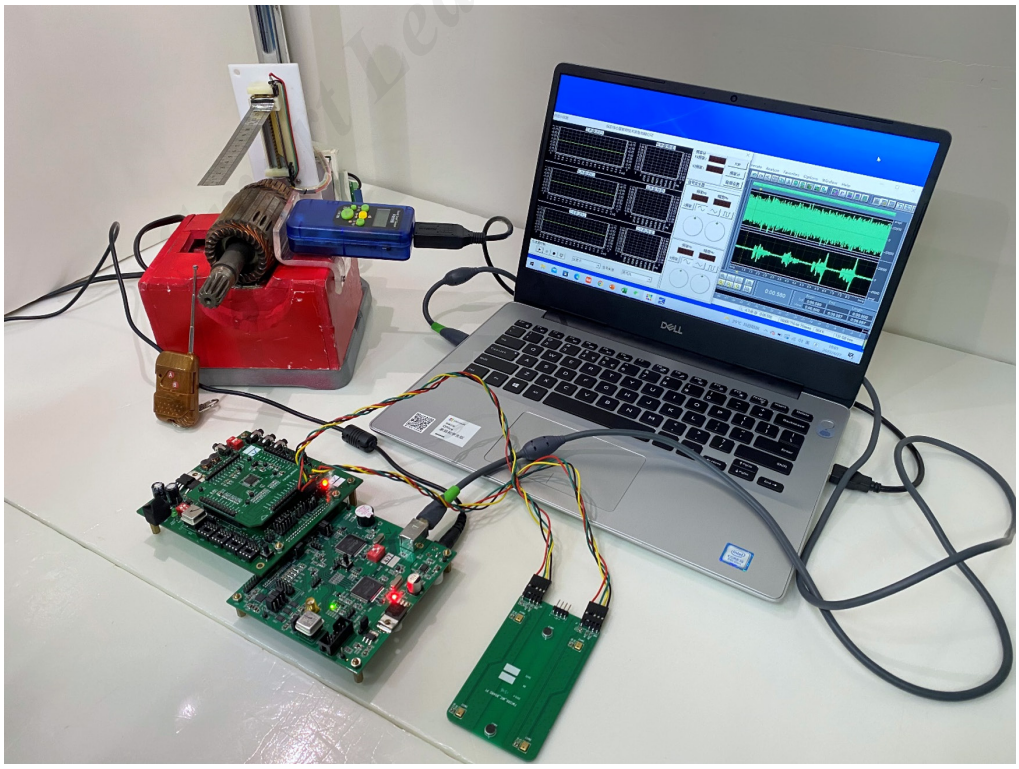
Highlights

This research proposes a comprehensive solution for accurately detecting rotor faults and enhancing the overall quality of motor production. By utilizing electromagnetic induction and acoustic signal processing, this system offers a reliable and efficient solution for fault detection, which is crucial for ensuring safe and reliable motor operation in various industrial settings.

Challenges: The aim is to enhance the operation of factory inspection lines to prevent catastrophic motor failures, thereby ensuring user safety and improve efficiency.

Solution: A comprehensive inspection system was developed based on electromagnetic induction, which is capable of accurately diagnosing rotor faults and quality in motors/generators in both production and maintenance environments.

Outcome: The system could diagnose motor rotor faults with near 100% detection rate after workmanship modifications. The FM1388 core and the EEMD algorithm aided in analysis, effectively reducing noise or interferences, and providing a high-fidelity extracted vibration signal.



How does the proposed system detect rotor faults in motors?

The system works by utilizing a magnetic testing platform to observe the magnetic physical vibration phenomenon of the rotor. The rotor is excited by a time-varying magnetic field, which generates an electromagnetic response associated with rotor failure or quality issues. The response is then converted into an acoustic signal processing for fault detection. The acoustic signals of rotor vibration are sampled and processed by a DSP chip, and the background noises are removed. The original vibration signals from the electromagnetic probe are extracted. By analyzing the amplitude of spectrum data, the degree of the faultiness of the inter-turn short circuit of the rotor is further derived by referencing. The system employs a comprehensive detection system based on electromagnetic induction to minimize noise interference in production and maintenance environments, which ensures accurate fault diagnosis and analysis.

How does the neural network models trained and applied?

The system utilizes a DSP chip to sample and process the acoustic signals of rotor vibration, which effectively eliminates high-frequency noise interference while retaining more fault details. Additionally, the system employs a comprehensive detection system based on electromagnetic induction to minimize noise interference in production and maintenance environments, which ensures accurate fault diagnosis and analysis.

Can this technology be applied to other industries besides household refrigeration?

The system can be utilized in various industrial applications, including machinery manufacturing, power generation, and transportation. It can be used for Motor Production Inspection (Large-Sized Rotors for Power Generation), electric vehicles, and power generation. The system offers a reliable and efficient solution for fault detection, which is crucial for ensuring safe and reliable motor operation in various industrial settings.

Executive Summary

Abstract

This research proposes a detection system that utilizes electromagnetic induction to accurately diagnose rotor faults in motor and quality while minimizing noise interference in production and maintenance environments. The system is designed to improve the efficiency of factory inspection lines and prevent catastrophic motor failure accidents, thereby ensuring personal safety. The system employs a time-varying magnetic field to excite the rotor under test, which generates an electromagnetic response associated with rotor failure or quality issues. The response is then converted into an acoustic signal processing for fault detection. This approach offers a comprehensive solution for accurately detecting rotor faults and enhancing the overall quality of motor production. Additionally, the system can be utilized in various industrial applications, including machinery manufacturing, power generation, and transportation. Overall, the proposed system offers a reliable and efficient solution for fault detection, which is crucial for ensuring safe and reliable motor operation in various industrial settings.

Keywords: Rotor Fault Diagnosis, EEMD (Ensemble Empirical Mode Decomposition), Noise Reduction.

1. Project Overview for Detecting Rotor Faults in Motor

Electric motors and generators are essential to modern-day life, and their safe operation is vital to the operators. Therefore, studies on the fault of the electric rotor, diagnosis accurately, and maintenance of all kinds of faults have high practical values, especially with the proliferation of electric vehicles and wind power. The winding rotor is the core component of the motor, and its short-circuit fault is one of the primary modes of failure that seriously affects the performance and safety of these electric machines. But, more importantly, the safety of the users is the biggest concern.

This research aims to develop a comprehensive detection system based on electromagnetic induction, which can accurately diagnose faults and the quality of motor/generator rotors in production and maintenance environments. In the process, based on the principle of the EEMD algorithm, a noise reduction chip is proposed to decompose the original vibration signals of the rotor. Furthermore, it is hoped that the signal segmentation can be reduced to the maximum extent by resolving the limitation of wavelet transformation(Gaeid & Ping, 2011).

2. Project Design of Detecting Rotor Faults System

Structure of this System

This project consists of as following part: motor rotor (type, size, power, and the number of turns are not restricted); electromagnetic probe (thin sheets of ferro magnetic material); electromagnetic generator (230VAC, to excite the inter-turn of the rotor windings); test control pillar stand (to hold the stationary controller in place); stationary controller (a hold that fits the electromagnetic probe); miniature stepper motor (for controlling electromagnetic probe to complete vertical detection); dual controller (to ensure the working stability of the stepper motor and reduce the delay of remote control launching); wireless remote control (a transmitting antenna can be fitted, for stepping motor to control the vertical operation of electromagnetic probe); sound level sensor (Bluetooth connection is available, function as data collection); virtual oscilloscope (i-Seekwhy, convenient data processing and waveform transmission); electrical control panel (which housed the test control pillar stand's wireless remote controller and stepper motor driver to controls the electromagnetic probe's movement to provide up, down, and stop movement); computer (Served as terminal output to process and display i-Seekwhy and sound level sensor); Noise reduction chip (Speech IC size: 7x7mm, demo board, recording board. Model: FM1388. Number of package outlines: TQFP-48pin. Integrated ForteMedia technology 2 stereo digital microphone ports).

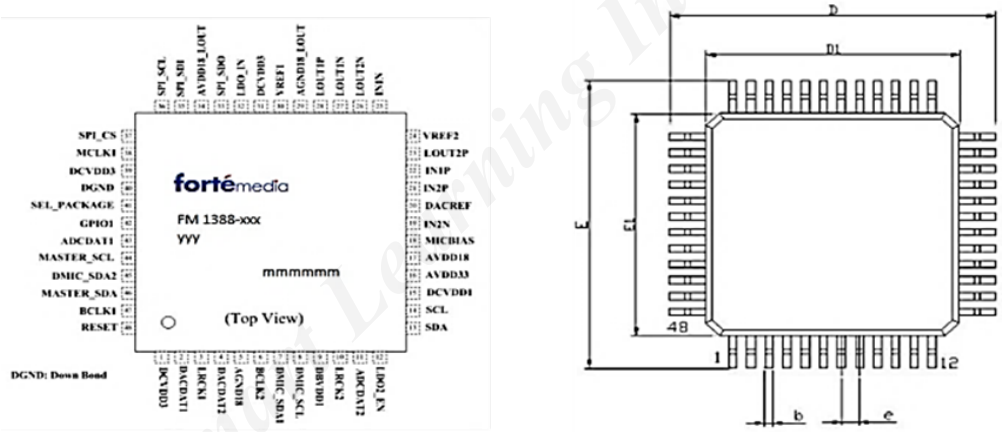


Figure 1 TQFP-48pin configuration

Research Methods of this System

The research experiment is divided into two stages: Stage 1- Automated Quality Inspection System for Rotor Coils of Commutator Motor; Stage 2 - Motor Rotor Fault Detection and its Signal Processing & Analysis Using EEMD.

By establishing a magnetic testing platform to observe the magnetic physical vibration phenomenon of the rotor, and further, with the help of sound sensors and virtual oscilloscopes, rotor fault signals can be collected and analyzed from the sound vibration spectrum.

The experiment steps are as follows:

(1) Assemble the electromagnetic generator and probe on the test control pillar stand with the manu-

al probe control mechanism.

(2) Install a small stepping electric unit at the connection of the handle of the test control pillar stand. A remote lifting control for the probe is used in place of the manual lifting handle. This improved the robustness of the device and allowed for more consistent measurement.

(3) Optimize the placement of the testing rotor between the grooves of the electromagnetic generator.

(4) Employ the use of remote control to decide the moving of the electromagnetic probe.

(5) We are utilizing a sound level sensor and oscilloscope i-Seekwhy to collect the rotor vibration spectrum data reflected by the electromagnetic probe.

7 steps of using the sound level sensor:

(1) Operate the control panel to start the detection system.

(2) Select the signal generator at the signal source.

(3) The signal generator has two sound channels. Select the sine wave.

(4) Open two soundtracks in the oscilloscope window.

(5) Display the two-sound track waveform and the synthesized waveform.

(6) Display the real-time frequency of the signal in the FFT window and frequency meter.

(7) Store data in the control panel.

By analyzing the amplitude of spectrum data, the degree of the faultiness of the inter-turn short circuit of the rotor is further derived by referencing(Fireteanu et al., 2014).

3. Experimental Results

The intuitive detection method involves a hierarchical rating system to judge the current quality of the rotor. The rotors are divided into six categories (A-F) based on the amplitude intensity of the electromagnetic probe. The categories range from “Breakdown” (requiring immediate replacement and repair) to “Off Size” (stable and not requiring any immediate attention). However, this method is noted to lack sufficient accuracy.

The automated method, on the other hand, uses a sound level sensor to collect the sound signal of the rotor vibration. The short-circuit condition of the rotor is then determined by analyzing this data. This method is reported to have higher accuracy and a greater degree of automation compared to the intuitive method. However, it is also noted that the sound level sensor can be affected by environmental noise, which may introduce errors in the detection results.

This part also discusses an improvement to the automated method using a sound level sensor and an oscilloscope to collect the rotor vibration spectrum. This method is said to have higher accuracy and automation. The experiment was divided into eight groups, with a total of 96 slots detected, 31 of which were short-circuited.

This part concludes by acknowledging the limitations of the intuitive detection methods and the need for more accurate methods. It also provides a table of data from a hundred experiments, detailing the amplitude of the electromagnetic probe across different experimental groups and slots of each rotor.

4. Conclusion and Future Plans

Through experimental design, continuous project evaluation, project data analysis, innovative iterative research summarizing engineering methods, and the analysis of the rotor short-circuit vibration signal amplitude, this project has achieved its primary goal of accurately determining the rotor fault severity. The research started with the detection of alternating electromagnetic fields. The experiment was repeated to refine the detection process, and the results obtained reached the expectation in the end. The collected data are conducive to further research.

The experimental method proposed in this project can effectively improve the IMF (Intrinsic Mode Function) variable component caused by the suppression of wavelet transform on signal segmentation. Based on the principle of the EEMD algorithm, a noise reduction chip is proposed to decompose the original vibration signals of the rotor. It is not limited by time and can reduce the delay limit of signal segmentation by wavelet transform to the maximum extent, and then the original vibration signal of the rotors can be obtained. By removing the delay, the geometric characteristics of the original vibration signal can be well preserved. It is more effective than the general wavelet domain filtering method.

In this study, a comprehensive detection system based on electromagnetic induction is developed to minimize noise interference in production and maintenance environments and thus accurately diagnose motor rotor faults and quality. This research can improve the operation of factory inspection lines, prevent catastrophic motor failure accidents, and ensure the personal safety of users, which has great significance and value.

The automatic rotor fault inspection device developed in this project can be used for Motor Production Inspection (Large-Sized Rotors for Power Generation). Large rotors, such as those used in electric vehicles and power generation, are expensive, and their failures can cause massive safety and cost issues. In addition, one of the world's large numbers of moto/generator rotor waste problems results in heavy metal pollution. This research provides a valuable and satisfactory response to the problem. Moreover, it is used to improve the production efficiency of the factory assembly line. Electric power tools have countless manufacturing, construction, and facility maintenance applications. Also, it can be used to repair motor loss and prevent mechanical metal contamination.

The future engineering goal of this project will focus on researching and developing a set of comprehensive quality inspection systems for electric vehicle starting commutators. It is known that this can be done from the current extension principle. By extracting and analyzing the original vibration signal of the rotor, we aim to maximize the application of functional modules of the noise reduction chip. Optimize the storage layer of signal data and improve the standard connection for automatically managing changing data structures.

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Brief introduction of school and instructors

Lou Hau High School, Macao was founded by a labor union in the 1950s. The school adheres to the teaching reform for a long time and seeks progress in the reform. In recent years, the Teaching Reform Committee has been set up to carry out diversified intelligent evaluation, and constantly study and analyze the theoretical viewpoints, concepts and measures of education at home and abroad, so as to achieve the results of creative thinking teaching and quality education.

Yixing LIANG: Vice teaching director of The Macau Workers' Children High School since 2003 and he also serves as a member of the Secondary School Committee of the Chinese Physical Society, president of the Macau Physics and Education Research Society, president of the Macau Technicians Association, president of the Macau Youth Sailing Model Association, and vice president of the Greater Bay Area Innovation and Invention Association.

Executive Summary

07 A Detection System for Choosing Ripe Strawberry with Machine Learning

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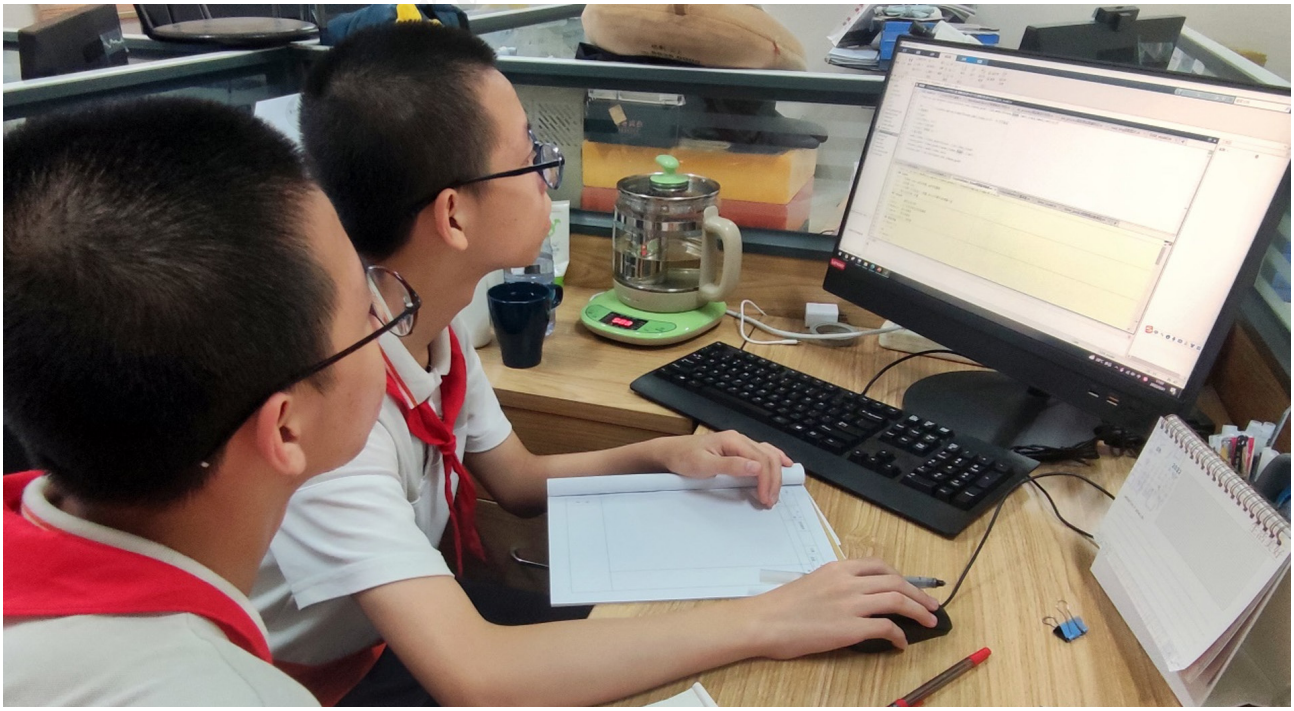
Highlights

This project aims to improve the efficiency and accuracy of fruit classification, resulting in better quality control and a reduction in food waste. By utilizing computer vision analysis and machine learning algorithms, this project can aid in the timely harvesting, processing, and distribution of strawberries, ultimately benefiting the agricultural industry and consumers alike.

Challenges: The food industry has been challenged by "low detection efficiency" and "food adulteration" in recent years. This study uses strawberries to focus on improving detection speed and accuracy through computer vision and machine learning, facilitating fruit farmers during harvest and broadening machine learning applications in the food sector.

Solution: Experienced fruit farmers sorted harvested strawberries into four ripeness categories, with 150 images captured for each. We utilized Support Vector Machine (SVM) for classification and compared the results with those from a Convolutional Neural Network (CNN).

Outcome: A set of strawberry imaging equipment was developed. An advanced strawberry ripeness detection model was created.



What machine learning algorithms are used in this project?

This project utilizes two machine learning algorithms: traditional machine learning and deep learning. The traditional machine learning model used is SVM, which achieved an accuracy of 97.50%. The deep learning model used the method of transfer learning of convolutional neural network (CNN), and the classification accuracy of the final model is 94.28%.

How does this project benefit the agricultural industry and consumers?

This project benefits the agricultural industry and consumers by improving the efficiency and accuracy of fruit classification, resulting in better quality control and a reduction in food waste. By utilizing computer vision analysis and machine learning algorithms, the project aids in the timely harvesting, processing, and distribution of strawberries. This ultimately benefits the agricultural industry by increasing productivity and reducing costs, while also benefiting consumers by providing them with fresher and safer fruits.

Can this detection system be applied to other types of fruits?

While this project focuses on enhancing the detection and accuracy rate of strawberries, the methodology and techniques used in this project can be applied to other types of fruits as well. The project employs machine learning algorithms and computer vision analysis to prompt recognition of the ripeness stages of strawberries. The project analyzes images of strawberries and uses mathematical models to categorize the fruit into their respective ripeness stages. Therefore, with appropriate modifications, this detection system can be applied to other types of fruits as well.

Executive Summary

Abstract

The timely and accurate detection of fruit ripeness is critical in preserving food safety and maintaining market order. The project focuses on enhancing the detection and accuracy rate of strawberries: a popular fruit with a short shelf life and is highly perishable. The project employs machine learning algorithms and computer vision analysis to prompt recognition of the ripeness stages of strawberries. The project analyzes images of strawberries and uses mathematical models to categorize the fruit into their respective ripeness stages. Through the use of machine learning, the project aims to improve the efficiency and accuracy of fruit classification, resulting in better quality control and a reduction in food waste. Furthermore, by utilizing computer vision analysis and machine learning algorithms, the project can aid in the timely harvesting, processing, and distribution of strawberries, ultimately benefiting the agricultural industry and consumers alike. The project presents a promising solution for the future of the fruit industry and food safety.

Keywords: Strawberry Ripeness, Machine Learning, Support Vector Machine(SVM) model, Rapid Detection Method.

1. Overview of Choosing Ripe Strawberry Project

The document discusses a project focused on improving the detection and accuracy rate of strawberry maturity, a critical task in the fruit industry. The project uses machine learning and computer vision analysis to recognize strawberry maturity, expanding the application of machine learning in the food industry.

Strawberries are delicate fruits that are easy to spoil and challenging to store. Therefore, the timing of picking strawberries is crucial to avoid spoilage during transportation or delivering an unsatisfactory taste to customers due to early picking. The document highlights that the differentiation of strawberry maturity is an essential task in the fruit industry. The industry standard divides the ripening of strawberries into four stages according to the coloring area: green ripe stage (25%), white ripe stage (50%), color transformation stage (75%), and red ripe stage (full coloring).

The document discusses various research works on predicting the ripeness of different fruits. It mentions the use of color complete local binary patterns to extract image texture features and color histograms to extract image color features. It also discusses the use of shape and color of fruits for image feature identification and the use of algorithms like k-nearest neighbor classification and Sup-

port Vector Machine (SVM) for fruit species identification.

However, the document acknowledges that most fruit classification and recognition algorithms often use images in a strictly limited environment, eliminating the influence of the external environment on the pictures. But the actual environment is complex, and the color and texture characteristics of the fruit image become complicated along with the different growth cycles of the fruits. Therefore, better classification and recognition methods are needed to solve these problems.

The document proposes a simple, fast, and effective recognition strategy to classify strawberry maturity states using traditional machine learning and deep learning algorithms. This method provides a new direction for expanding the application of machine learning in the field of food.

2. Design and Implementation of Experiments

This part discusses the design and implementation of experiments aimed at improving the detection and accuracy rate of strawberry maturity using machine learning and deep learning. The experiment is divided into four parts: strawberry image acquisition, collection of original images of strawberries, feature extraction on the strawberry image sample, and maturity matching.

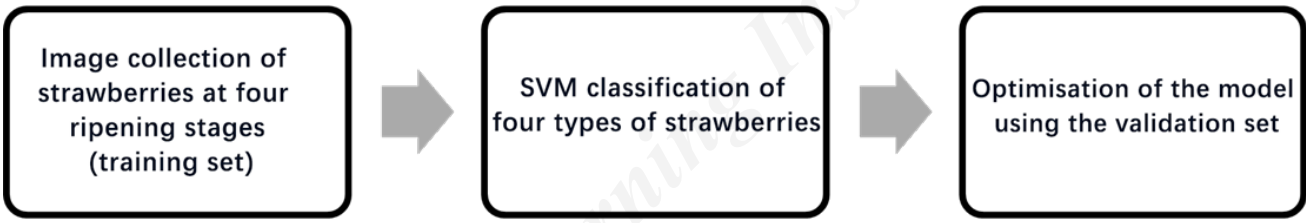


Figure 1 Experimental Procedure Design

The image acquisition process involves setting up a stable shooting environment with a portable LED light-supplementing studio, a mobile phone bracket, and a computer. The original images of strawberries are collected in four stages of ripeness: green ripe stage, white ripe stage, color transformation stage, and red ripe stage. A total of 600 images are saved in JPG format, with an image resolution set to 224*224.

This part then discusses the processing of strawberry digital images. The color in the strawberry image is quantitatively represented using an RGB color model. The background in the original strawberry image is segmented, and the mean value and standard deviation of the R, G, and B components of the strawberry image in the RGB color model are extracted.

This part also discusses the construction steps of the machine learning model. The data set of strawberries is divided by the method of Hold-out with the ratio of 8:2 into a training set (80%) and a test set (20%). The training set is used to generate the model, and the testing set is used to evaluate the model's correctness and error to verify the model's validity.

The results show that the rapid recognition of strawberry maturity recognition based on machine learning adopts two algorithm models: traditional machine learning and deep learning. The SVM

model results show that the model can accurately identify the maturity stage of strawberries with a few misjudgments.

There are still some technical difficulties to be solved in this project. However, it also highlights that the project provides a new solution for the automatic grading of fruits, reduces the burden of fruit growers, and promotes the excellent development of the fruit industry.

3. Conclusion and Future Plans

In this paper, a simple and rapid method of strawberry maturity recognition was proposed, i.e., a machine learning model was built to intelligently identify the ripeness of strawberries. First, a traditional machine learning model, SVM, is built with an accuracy of 97.50%. In the second part, a deep learning model is established, which adopts the method of transfer learning of convolutional neural network (CNN), and the classification accuracy of the final model is 94.28%. Both of the two models have achieved good performance at last, which proves the feasibility of this method. At the same time, it provides a new idea for further expanding the application of machine learning in automatic fruit classification.

The project aims at avoiding the loss caused by strawberry corrosion in the transportation process, reducing the risk to food safety and the cost and error of manual strawberry grading. A fast and accurate strawberry grading model is trained by building a model and training with a data set.

A computer vision system comprises an LED light-supplementing studio, an object stage, a fixed bracket, a mobile phone, and a computer. The experimental equipment is low in price and cost, convenient to use, simple in operation, and capable of collecting strawberry images well.

When constructing the traditional machine learning model, we conduct the digital processing for the strawberry image in the data set using the RGB color model and get the representation in R, G, and B components in the strawberry image. It is convenient for us to transform the RGB color model into the HSV model and Lab model to extract the color feature of the strawberry.

We needed to analyze the strawberry images when building the traditional machine model. We finally adopted the SVM model through online searches and various channels.

Next, we built a deep learning model and prepared to evaluate the accuracy of the deep learning model and compare it with the accuracy of the traditional machine learning model. The Convolutional Neural Networks (CNN) used in this work include the convolution, nonlinear, pooling, and up-sampling layers. Firstly, the RGB color model was used to segment the strawberry image in the data set. And then, we performed convolutional operations based on the convolutional kernel in the CNN (Convolutional Neural Networks) system to realize the extraction of the strawberry image characteristics. This method differed from the traditional machine learning method, which covered all the features of the strawberry image, not only the color features. The acquired strawberry images were preprocessed accordingly, and modified the image resolution modified to 224×224.

When dividing the data set, we discussed each other and expanded it to 11,340 pieces by image enhancement. The strawberry images were randomly divided into the training set, the test set, and the verification set according to the ratio of 6: 2: 2. Finally, the VGG16 network model was trained in advance on the ImageNet data set for testing.

The following is a schematic diagram of the confusion matrix of deep learning. The horizontal coordinate is the prediction category, and the vertical coordinate is the actual category. We randomly

select 594 pictures from each category to evaluate the model's accuracy. It is concluded that the total classification accuracy of this test set is 94.28%.

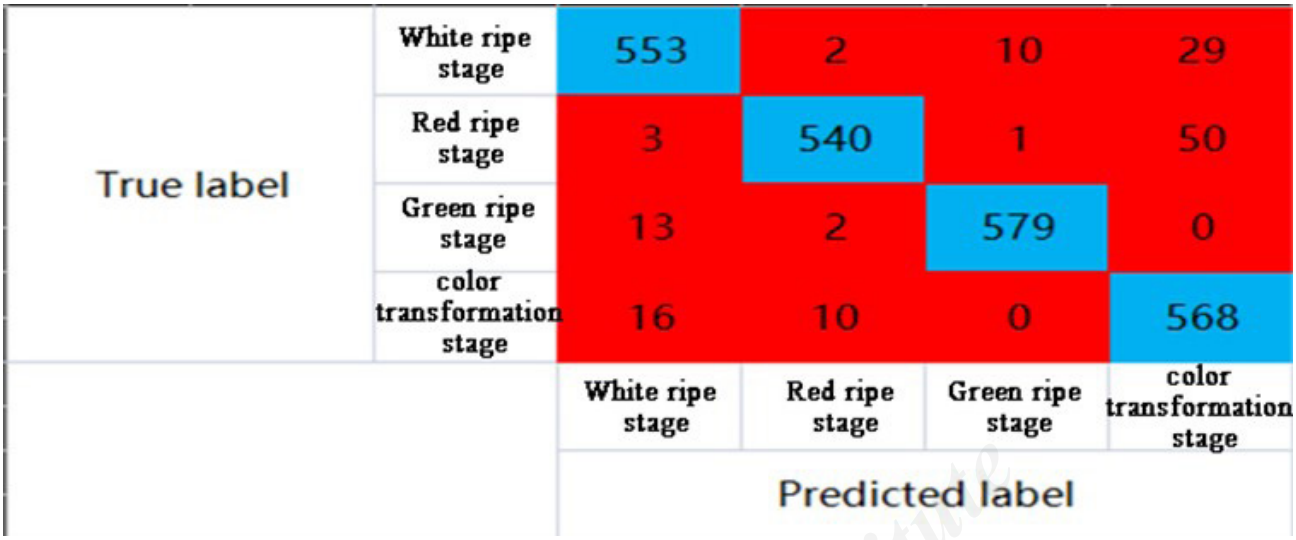


Figure 2 Schematic Diagram of Deep Learning Confusion Matrix

In the traditional machine learning model, SVM's classification effect is good, with an accuracy of 97.50%. In the deep learning model, we used the learning method of convolutional neural network migration, and the classification precision was 94.28%. In summary, the two models achieved good performance and provided a new idea to expand further the application of machine learning in fruit grading. This project not only adopted the method of building the traditional machine learning model but also tried to use different methods to solve the problem of strawberry grading by building a deep learning model, and the effect was excellent.

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Brief introduction of school and instructors

Jin'an Campus of Fuzhou No. 3 High School was opened in September 2019. It is a public junior high school in Fuzhou City with the same legal person and the same set of leadership. The school upholders the three school motto of 'encouragement, devotion to learning and practice', and forms the campus spirit rhyme of 'deep roots, far knowledge and practice in unity'.

Yuxia LIN: Graduated from Fuzhou University with a master's degree and is now a junior high school labor technology teacher. Guide students to participate in various scientific and technological innovation competitions and achieve certain results.

Siming HUANG: Graduated from Shaanxi Normal University and now works as a junior high school information technology teacher.

Executive Summary

08 Developing an Interactive Show-Wall with Smart Home Technology for STEM Learning

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Highlights

This project is a collaborative effort between students, teachers, and enterprises to introduce artificial intelligence elements into the decoration design of the lab. With this project, students can experiment with AI technology and create a sense of achievement and inspiration.

Challenges: Traditional IT labs are generally filled with various instruments but lack sufficient showcasing and exhibition aspects.

Solution: We integrated and presented computer vision and Internet of Things (IoT) technologies. With education as the foundation, we prioritized the use of open-source hardware and software, keeping scalability and affordability in mind.

Outcome: We developed an interactive AI smart wall that engages users in the Wenzhou dialect and includes intelligent home control terminals and sensors. This allows for facial-controlled lighting, posture-controlled curtains, voice-controlled air conditioning, and pattern-controlled lighting.

What is the purpose of the Interactive Show-Wall project?

This project utilizes two machine learning algorithms: traditional machine learning and deep learning. The traditional machine learning model used is SVM, which achieved an accuracy of 97.50%. The deep learning model used the method of transfer learning of convolutional neural network (CNN), and the classification accuracy of the final model is 94.28%.

How does the project incorporate smart home technology?

The Interactive Show-Wall project incorporates smart home technology by creating an AI interaction wall, which is a collection of intelligent home controllers with human-computer interaction. The data acquisition mainly includes cameras, microphones, lights, acceleration sensors, etc. The lab's home is whole-home smart, and an open-source smart home gateway, HASS, integrates intelligent lights of different brands.

What are the benefits of using an interactive show-wall for STEM learning?

The benefits of using an interactive show-wall for STEM learning are that it allows students to experiment with AI technology, creating a sense of achievement and inspiration for students who participated in the design. Additionally, the interactive show-wall with smart home technology reflects the people-oriented characteristics of AI and is closer to daily life.

Executive Summary

Abstract

This project is a STEM project jointly built by students, teachers, and enterprises that aim to introduce artificial intelligence elements combining culture and teaching into the decoration design of the lab. The project has great value in inspiring students and serves as a specific reference for other schools to build artificial intelligence laboratories. Due to insufficient ability, traditional AI labs lack personalization and cannot display students' achievements. However, the interactive show-wall with smart home technology reflects the people-oriented characteristics of AI and is closer to daily life. Moreover, the show-wall is a dynamic construction that allows students to use the latest creative works to experiment with AI technology, allowing students to experiment with AI technology, creating a sense of achievement and inspiration for students who participated in the design.

Keywords: Interactive Show-Wall, Smart Home, Internet of Thing, Open-source Hardware.

1. Overview of the Interactive Show-Wall Project

Background

Traditional information technology laboratories often place various instruments and equipment and pay little attention to the cultural display. In our opinion, artificial intelligence is a mysterious subject for most students. If there is no cultural display in the laboratory, giving students or other visitors direct feelings is difficult: Where is the AI in the AI lab? What is the difference between this and an ordinary computer room? Therefore, we have specially considered how to display AI works in building an artificial intelligence laboratory. In order not to take up space, we think that we can use the wall space, with the wall as the medium, so that the user can directly communicate and interact with AI, so we have this interactive AI background wall project.

Project Objectives

After investigation, there are still very few AI laboratories in primary and secondary schools. AI laboratories in colleges and universities are white walls & wall paintings. On a white wall are images of AI scientists such as Alan Turing, John McCarthy, Calvin Minsky, and Arthur Samuel, which remain unchanged year-round. Such a laboratory is too ordinary to attract students. So how does AI Lab attract students to learn and practice AI? In our opinion, this AI background wall is the core of the whole AI laboratory and should have three functions:

(1) Static function: The background wall shall have AI-related patterns, such as the words representing the laboratory AI culture and some AI professional terms. These patterns, words, laboratory tables, chairs, and other equipment together form the overall cultural atmosphere of the laboratory.

(2) Dynamic function: The background wall should be variable along with the different applications, teaching scenes, and different cultures. Because there are many unique terms for artificial intelligence, it is not easy to display all of them on a wall, so this wall should be able to be changed and decorated at any time. For example, when you take an intelligent online course, you can change it into keywords related to intelligent online; when you take a computer vision course, you can change it into keywords related to image detection.

(3) Interaction function: AI works can be fixed on the background wall, or AI perception devices can be fixed and then interact with the smart home of the laboratory through these devices. The standard smart home uses a central control screen to control the entire home's smart home, and we can use an entire wall. The display must be fantastic if it is easy to fix. Imagine that every time students enter the laboratory, they cannot help interacting with artificial intelligence, so their learning and entertainment will be thoroughly combined.

For ease of presentation, the interactive AI background wall item will be called interactive wall from now on.

2. Implementation with Smart Home Technology

This part discusses the design and implementation of an AI interactive wall in a laboratory setting, integrating smart home technology. The AI interaction wall is a collection of intelligent home controllers with human-computer interaction, and it includes data acquisition, intelligent processing, and control output.

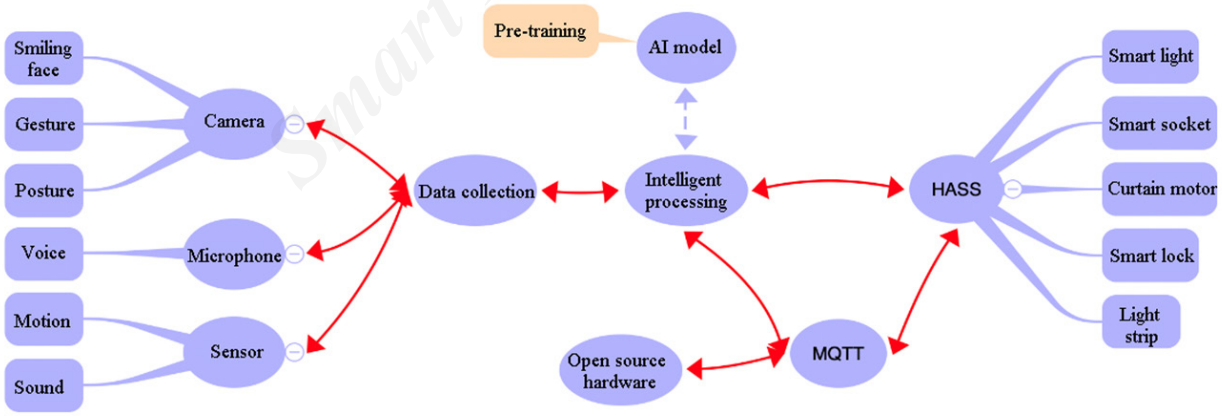

Figure 1 Workflow of AI Interactive Wall

The data acquisition involves cameras, microphones, lights, acceleration sensors, etc. The lab's home is a whole-home smart setup, integrating intelligent lights of different brands using an open-source smart home gateway, HASS. Some operations may involve remote control, so the MQTT protocol is

used, setting up an MQTT intranet server with SIoT software.

The AI interactive wall is designed to be static, dynamic, and interactive. The static function involves hand-painting the walls with acrylic paint, highlighting the characteristics of the laboratory. The dynamic function allows for the quick and dynamic adjustment of patterns or texts on the Knowledge Map node according to different courses. The interaction function is the core of the wall, completed by open source hardware and camera for perception (input), smart home devices for execution (output), and AI calculation (processing) part is flexibly deployed according to the complexity of the algorithm.

In this part, we also discusses the design of a control mechanism, similar to Mi AI, Siri, and Tmall Elf's wake-up words. The user first makes a specific gesture, and the controller sends a warning tone (voice) to indicate that the user has entered the recognition state.

The implementation with smart home technology provides a new direction for the application of AI in the field of human-computer interaction. It also highlights that the project provides a new solution for the automatic grading of fruits, reduces the burden of fruit growers, and promotes the excellent development of the fruit industry.

3. Conclusion

AI is originally an introverted intelligence, making it difficult to be explicit and display. Therefore, the traditional artificial intelligence laboratory is the same as the ordinary computer room without any characteristics. Although some schools also consider work displays, they can only buy AI works developed by major companies because of insufficient ability. As a result, they lack personalization and give people a feeling of ordinary; not only cannot do attraction but become an obstacle.

Although not the top in AI capability, the show-wall we designed reflects the artificial intelligence people-oriented characteristics and is closer to daily life because of the close connection with the smart home devices. What is more interesting is that the interactive wall is a dynamic construction. When students learn new artificial intelligence technology, they can use the latest creative works to replace the old works on the interactive wall. This interactive wall is a field for students to experiment with AI technology.

This project provides a good idea for constructing AI laboratories in many schools. According to the teacher's introduction, many school laboratory construction is entirely outsourced. Teachers and students have no opportunity to participate in the construction and are just users. If each school can add similar interactive walls in AI labs, the construction of AI labs will become a collaborative project between teachers, students, and enterprises. It is based entirely on real questions and situations and is project-based learning.

In addition, the works deployed on the interactive wall already have the function of products closely related to the real world. These works are also the tasks of the Entering the World of Intelligent Networks course, which will play an essential role in promoting artificial intelligence.

Project team members will continue learning AI-related technologies and enriching AI interaction walls. At the same time of optimization, we will also pay attention to the scheme arrangement and the writing of explanatory documents, including the scheme and technical realization path of the project, and strive to build the project into an open-source high-quality artificial intelligence education project for teenagers.

We hope that through the continuous improvement of this project, more students will feel the charm of AI and attract them to participate in the production of AI works. At the same time, we expect that the AI interactive wall can enter schools nationwide and the communities of various schools.

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Brief introduction of school and instructors

Wenzhou High School was founded in 1902. In 1953 it was confirmed as one of the 14 key middle schools in Zhejiang Province. In 1981 it was approved as one of the first 18 key middle schools in Zhejiang Province. In 2014, it was awarded the first batch of Zhejiang first-class ordinary high school characteristic demonstration School.

Zuoru XIE: Professor of information Technology. Director of AI Lab at Wenzhou High School in Zhejiang Province, China. Xie has a diverse range of research interests in Interdisciplinary Learning, Maker Education, STEM Education, and AI Education.

Dongsheng ZHU: Graduated from Fudan University majoring in computer science and technology. He has won the first prize of programming competition such as NOIP and the first prize of Information technology subject proposition competition of Zhejiang Wenzhou High School.

Executive Summary

09 An Intelligent Sensible System on Door Locker for Notification of Older People Lock-Forgetting

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Highlights

This project aims to provide a safe, practical, and affordable solution for older people who tend to forget to lock their doors. With the use of intelligent sensors, this device can detect and remind the elderly to close their doors in time, ensuring their personal and property safety.

Challenges: The aging population often struggles to adapt to new technologies, presenting various daily life challenges. This study seeks to assist the elderly by incorporating door alarm systems that detect open doors and uncollected keys without altering existing door lock structures.

Solution: A door magnetic switch was used for door status recognition. An infrared sensor was implemented to identify forgotten keys. A microswitch was used to set off a timeout alarm for unclosed doors.

Outcome: We developed a prototype set of smart door locks using open source hardware.

How does the Intelligent Sensible System for Door Locker work?

The Intelligent Sensible System for Door Locker is designed to have detection and alarm functions to remind the elderly to close the door in time. The system has two functional modules: one for judging whether the key is inserted into the door, and the other for judging whether the door is closed. The appropriate sensors and electronic modules are combined to realize these functions. When the system detects that the key is not removed or the door is not closed, it will sound an alarm to remind the elderly to take action.

What are the benefits of using this system for older people?

The Intelligent Sensible System for Door Locker provides several benefits for older people. Firstly, it helps to ensure their personal and property safety by reminding them to close the door in time. Secondly, it is safe, intelligent, economical, practical, and simple to install, making it a convenient solution for the elderly. Thirdly, it does not require changing the existing door lock structure, which reduces the cost and complexity of installation. Finally, it brings a sense of security to the minds of the elderly and has a specific deterrent effect on wrongdoers.

Can this system be easily installed on existing door locks?

Yes, the Intelligent Sensible System for Door Locker is designed to be practical, simple to install, and convenient for the operation of the elderly without changing the existing door lock structure. This means that it can be easily installed on existing door locks without the need for any major modifications. The purpose of the invention is to manufacture an intelligent door lock device that is simple to operate, low in cost, and strong in practicability, which can bring a sense of security to the mind of the elderly and have a specific deterrent effect on wrongdoers.

Executive Summary

Abstract

The project is to develop an intelligent sensible system for door lockers to notify older people of lock-forgetting, which is safe, intelligent, economical, practical, simple to install, and convenient to guarantee older people's personal and property safety. The device is designed to have detection and alarm functions to remind the elderly to close the door in time. The project focuses on finding the most suitable components through the detection test of different sensors to reduce costs and make the product affordable. The project aims to help the elderly around us to improve their personal and property home safety without changing the existing door lock structure and to bring a sense of security to the elderly's minds.

Keywords: Smart Door Lock, Older People, Home Safety, Intelligent Sensors.

1. Notficying the Lock Forgetting for Older People Project

In modern society, the aging problem is becoming more serious. According to statistics, in 2022, the population over 65 years old in China accounts for 14% of the total population. With the increasing aging population, our country is entering the aging era. As a result of the early family planning policies, many elders live separately from their children and live alone. The older person's physical condition worsens, body function gradually weakens, and memory and judgment ability both declines. Many older people often forget to pull out the key when entering the door or lock it because of their age and memory decline, so cases of stalking, burglary, and even robbery sometimes occur. Among the classmates in our team, there have been family members of them who suffer such a situation. We all think that there is a great possibility of a safety accident. Moreover, as China's aging becomes increasingly severe, a group of people gradually become old age. The number of elders will increase, so this kind of social problem will become more and more serious.

Developing a safe, intelligent, and economical sensible system on door locker is significant to the elderly. It can provide the first layer of guarantee for the life safety and property safety of the elderly.

According to our survey on the needs of the elderly around us, we believe that the safety of the elderly can be our research direction. After discussion and consultation, we decided to develop an intelligent door lock device that is safe, intelligent, economical, practical, simple to install, and conve-

nient for the operation of the elderly without changing the existing door lock structure to effectively guarantee the personal safety and property safety of the elderly.

The purpose of this research is to help the older people around us realize the alarm of not closing the door or not taking the key based on not changing the existing door lock structure at the lowest price to remind the older people to take off the key to the door in time and close the door, and protect the personal and property safety of the older people as much as possible. Therefore, the purpose of the invention is to manufacture an intelligent door lock device that is simple to operate, low in cost, and strong in practicability, which can bring a sense of security to the mind of the elderly and have a specific deterrent effect on wrongdoers. Therefore, we mainly focus on the following two research objectives:

(1) Manufacture a product with detection and alarm functions. For example, after the door is opened for some time, whether the door is closed or not is detected, and if the door is open, an alarm is given to remind the older people to close the door in time.

(2) The detection test of different sensors will find the most suitable components. In this way, the cost is reduced, the quality and the price are low, and more older people can accept the products. Therefore, let the product help more people.

2. Prototyping an Intelligent Sensible System on Door Locker

This part discusses the prototyping of an intelligent sensible system on a door locker. The project was carried out from January to August 2022 and involved various research methods, including investigation, experiment, and literature research methods.

The team surveyed at least 10 older people in their respective communities about their views on traditional door locks. The main concerns were that they often forgot to remove the key and close the door, which threatened their personal and property safety. Based on this survey, the team decided to focus their study around these two points. The team then embarked on the design and implementation of the intelligent door lock system. They considered how the door is opened and closed when making the model, the variation of each action, the measurement range of each component, and the voltage required for each element and the main control board. They also had to consider various complications, such as the need for a simple installation and issues with the sensor after rewiring.

The prototype of the door lock device was completed after many modifications. However, the team acknowledged that it still had many shortcomings. Some members gradually lost their enthusiasm for the project due to various factors such as too many assignments and time constraints, which negatively impacted the project's completion. The team participated in a summer camp for students on cross-strait computational thinking, which broadened their horizons and taught them how to do projects. They learned more about artificial intelligence and where to seek more professional knowledge in related areas.

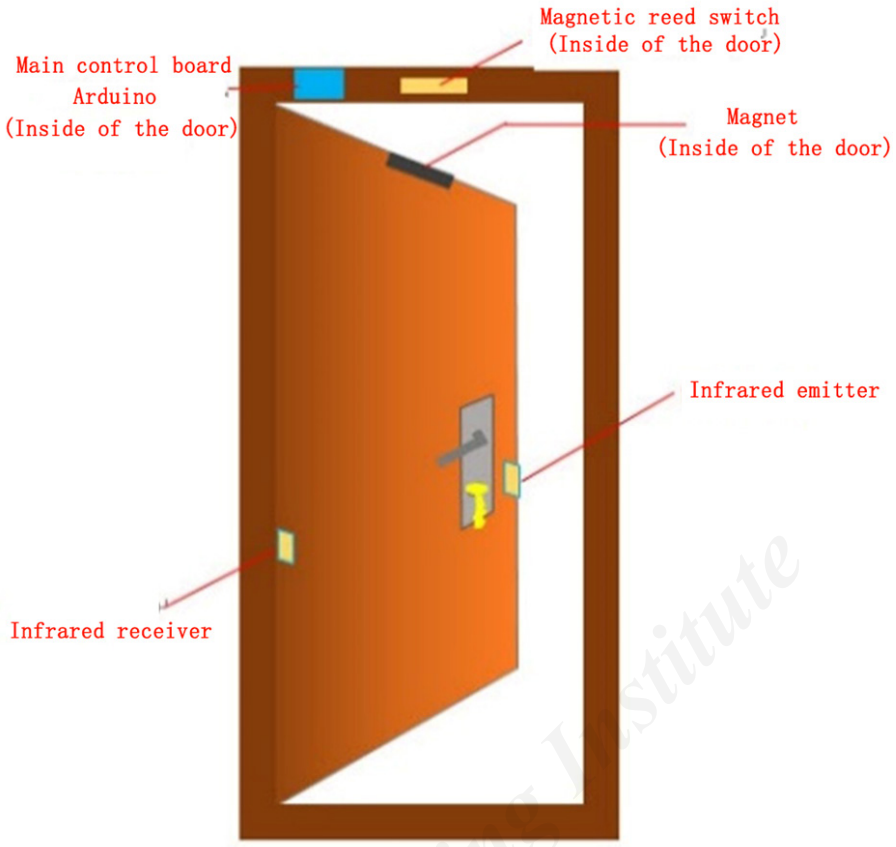

Figure 1 Schematic Diagram of Detection When the Key is forgotten to be Pulled Out

The challenges faced during the project and the lessons learned. It also highlights the importance of continuous learning and improvement in the field of artificial intelligence.

3. Conclusions and Future Plans

Through this project, we deeply realized that we have many shortcomings compared with others. We opened our eyes wider through this project. By seeking and reading the relevant literature, we know that a product is priced so high but still can be accepted and purchased because it can significantly facilitate people's life and provide convenient services for them. Although our products are not high in technology content, if we can add the service function of our products, they will be accepted by more people.

While doing the project, although we did not have the opportunity and time to learn the standardized programming language, we learned the mode of thinking. This activity made our logical thinking stricter and our thinking manner more diversified. At the same time, it also improved our part of the discipline accomplishment. For example, when comparing different sensors, we can only see the knowledge of sensor-related sensors in books, but we have no chance to practice it. Through this activity, we directly contact the sensor and understand its application method. Real knowledge comes from practice, and not all written books remain unchanged. We feel the gap between experimental and theoretical data.

Although the event is ending, our innovation is still not over. According to our phased discussion, our Smart Door Lock Device product can also dig deep into its capabilities by adding electronic modules to:

(1) Communication between the intelligent door lock device and the mobile phone can be added. By adding the WIFI module, the alarm signal that the door is not closed or the key is not taken off will be linked to the smart phone of the older person. The older person is better reminded to close the door and take the key through the secondary reminding function of the mobile phone.

(2) The automatic door-closing function of an intelligent door-lock device can be added. Now there are relatively mature door-closing products on Taobao. We can combine this product with our intelligent door lock device to make the door-closing operation more intelligent.

(3) The function of the doorbell can be added to expand the function of the intelligent door lock device.

All in all, through this project, we sweat and grow. Soon, we will apply the methods and skills learned in the project research process, keep the consciousness of innovation, and adhere to a rigorous work style to grow up better and faster.

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Brief introduction of school and instructors

Chengdu No. 17 High School, established in 1941, is an old public full high school with a moderate scale. It is an urban quality school with high reputation both inside and outside the industry, fine management, and excellent education, and can help students achieve diverse success.

Yunfeng ZHOU: Teacher at Chengdu No.17 High School. He has won Ye Deyuan Fund award, 2021 Jinjiang District Teaching Rookie, and 2020 Jinjiang District Teacher Teaching Skills Competition first prize.

Jia LAI: Graduated from the School of Computer Science of Sichuan Normal University and has been engaged in high school computer education for 17 years.

Executive Summary

10 Designing a Smart Car for Connecting Home and Community Delivery Pick-up Point

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Highlights

This project explores the feasibility and application demands of using a smart car for community express delivery, and propose a solution that can improve delivery efficiency and reduce costs.

Challenges: With the rise in online shopping and express delivery services, many packages are delivered daily. This project aims to solve the "last 500 meters" delivery problem within residential areas using mobile delivery lockers that can autonomously move to the resident's doorstep.

Solution: Used line following and ultrasonic obstacle avoidance simulation for navigation in complex environments, and AI technology for road sign recognition. Implemented voice commands and IoT technology to manage the delivery, retrieval, and user acknowledgment of packages.

Outcome: A product prototype set was developed, capable of full functionality in a simple environment.

What are the features of the proposed smart car system for community express delivery?

The proposed smart car system for community express delivery includes features such as route planning and optimization, automatic obstacle avoidance, and ultraviolet disinfection. Additionally, mentions that before delivery, the system confirms with residents whether they are at home and whether it is convenient for the car to deliver the goods to their homes, and notifies the customer to pick up the goods and inform them of the password for taking them to prevent the incorrect goods from being taken and to confirm that the goods have been received .

How can the use of a smart car improve delivery efficiency and reduce costs?

The system for community express delivery can improve delivery efficiency, reduce workforce, material, and time costs, and meet the needs of residents for timely express delivery. This is achieved through features such as route planning and optimization, automatic obstacle avoidance, and ultraviolet disinfection. By automating the delivery process, the system can reduce the need for human labor and increase the speed and accuracy of deliveries. Additionally, the system can optimize delivery routes to reduce travel time and fuel costs, and disinfect packages using ultraviolet light to reduce the risk of contamination

How is this smart car prototype designed, and what specific technologies are utilized in its development?

The smart car prototype was designed based on the ideas of automating the delivery process, optimizing delivery routes, and disinfecting packages using ultraviolet light. The prototype mainly includes a general control module, an execution module, a navigation module, an information communication module, a sense module, a man-machine interaction module, and an autonomous learning module. The smart car prototype integrates a variety of technologies, including a control unit, a driving unit, a road identification and avoidance module, an information communication module, a human-computer interaction module, and more. Additionally, mentions that the smart car prototype uses a solar panel to charge the car during driving and shutdown automatically, and that the car's components are made of environmentally friendly materials.

Executive Summary

Abstract

The growth of online shopping and express delivery has resulted in an increased demand for last-mile delivery services, which is still being done through door-to-door delivery in many communities. This mode of delivery is costly in terms of time and resources. The unmanned trolley proposed by Smart Logistics is an intelligent device that can navigate autonomously and recognize its environment, making it a promising solution for express community delivery. This study analyzes the feasibility and application demands of the smart car in community express delivery and develops a solution that includes features such as path planning, automatic obstacle avoidance, and ultraviolet disinfection. The proposed system can improve delivery efficiency, reduce workforce, material, and time costs, and meet the needs of residents for timely express delivery.

Keywords: Smart Car, Community Express Delivery, Open Source Hardware.

1. Overview of the Smart Car Project

With the popularity of online shopping and the development of express business, many express enter various communities daily. Express delivery has become a closely related part of our lives. However, it is found through community field observation that the delivery mode of the last kilometer of express community delivery is still door-to-door delivery. The daily delivery volume of couriers is enormous. If they catch up with the promotion of merchants, the number of expresses delivered to residents in a limited time every day is extremely limited. The cost of manpower, material resources, and time is very high, and the delivery efficiency is low. In addition, many communities do not allow couriers to enter the community for door-to-door delivery to prevent close contact and reduce the probability of transmission and infection during the epidemic. The express can only be put at the community's door or a fixed station waiting for the owner to collect. However, the office workers in the city are busy in the daytime and often do not have time to pick up the express. The older people who live on high floors and are inconvenient to move are not convenient to go downstairs to collect the express. Some express may be lost or damaged if not picked up in time.

Delivery Problems between Home and Community Pick-up Point

Based on the above background, the community's express delivery has become an urgent problem to be solved nowadays. The unmanned trolley proposed by Smart Logistics is an intelligent device with various functions such as environment recognition, autonomous decision-making, and active driving, which relates to the technical fields of mechanical structure, information technology, artificial

intelligence, and so on. According to the preset mode, the unmanned trolley can complete corresponding actions in a specific environment with the advantages of automatic navigation, obstacle avoidance functions, strong stability, real-time performance, etc. It can be well applied to logistics transportation if a courier vehicle can automatically deliver goods to the designated households at the appointed time according to the express demand of the community. It can ensure that the community residents can get the express in time and improve the delivery efficiency of the express, meet the needs of epidemic prevention and epidemic prevention, and reduce contact with external personnel. In this way, great convenience can be brought to the lives of the residents.

2. Issues and Solutions of Automatic Community Delivery

This part discusses the issues and solutions of automatic community delivery using smart cars. The study was conducted through literature investigation, field investigation, and comparative analysis. The team identified three main problems that needed to be addressed: precise navigation and obstacle avoidance, access control and elevator access, and user interaction.

The precise navigation and obstacle avoidance problem is due to the complex community environment. The current accuracy of commonly used navigation software can navigate to the community's entrance, but the specific building in the community is seldom identified on the map. The team proposed marking the details of the community's roads and buildings on the car's built-in map.

The access control and elevator access problem is due to the variety of buildings in the district. Some doors need to be authorized, and some elevators are old and without a local area network. The team proposed using smart cards in place of robotic arms and combining them with a dispensing bin to solve the problem of getting on and off the elevators.

The user interaction problem involves confirming with the residents whether they are at home and whether it is convenient for the car to deliver the goods to their homes. The team proposed notifying the customer to pick up the goods and informing them of the password for taking them to prevent the incorrect goods from being taken and to confirm that the goods have been received.

The core features of the community smart car, includes route planning and obstacle avoidance, access control and elevator access, item access, and environment-friendly effort. The team proposed using a solar panel at one side of the car body to charge the car during driving and shutdown automatically, reducing power consumption and signal radiation.

3. Design and Simulation of Smart Car Prototype

The design and simulation of a smart car prototype for express delivery are the issues ot this part. The smart car includes several modules: the general control module, the execution module, the navigation module, the information communication module, the sense module, the man-machine interaction module, and the autonomous learning module.

The general control module acts as the central information processor. The execution module sends commands to each module. The navigation module has a built-in accurate map for path planning. The information communication module realizes the information transmission to the outside world and interaction with the control center. The sense module senses changes in the external environ-

ment and provides real-time information. The human-machine interaction module communicates with people around. The autonomous learning module, with the help of artificial intelligence, improves the ability to receive and analyze data so that the car can react more quickly and reasonably.

The smart car also has a built-in ultraviolet disinfection lamp placed at the top inside of each goods cabinet. When goods are detected, automatic disinfection is carried out to ensure the cabinet door is closed.

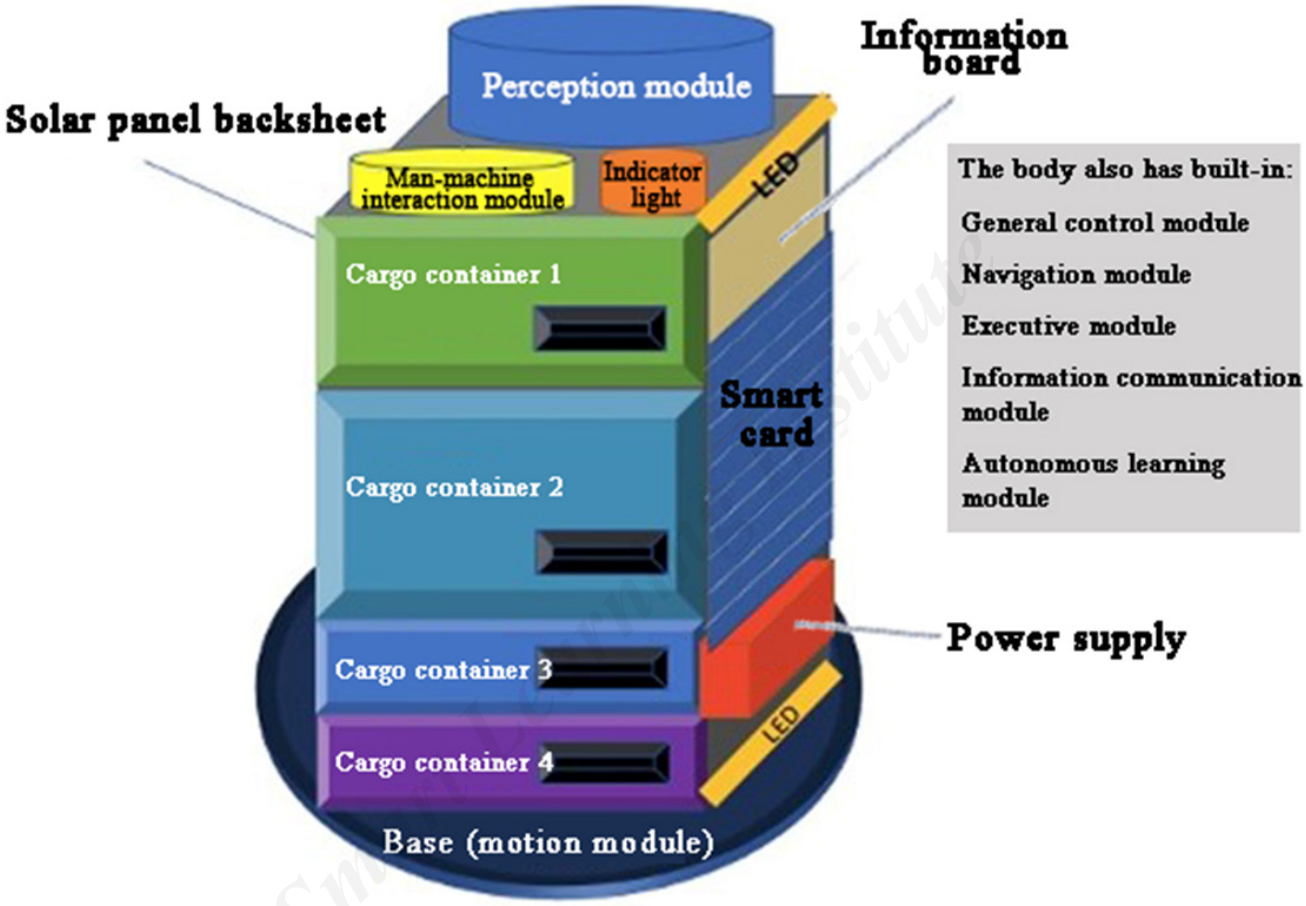

Figure 1 Schematic Diagram of the Smart Express Car

The operational simulation design involves the express delivery being put into the express cabinet of the smart car, generating a pickup code. The smart car, loaded with goods, begins to plan and optimize the delivery route and automatically detects whether the electric quantity is sufficient according to the total route length and the delivery time. The car starts from the starting point if the electric amount is predicted to be no less than 30% after it delivers goods.

4. Implementation of Smart Car Prototype

Based on the above research, we assembled an intelligent car under the teacher's guidance and debugged and ran it, and it realized most of the functions in our conception. The smart express car integrates a plurality of technologies. There is a general control module, which is the car's general control system. As the center of the control, with the help of a computer system, all the units need to integrate and interact with the available control module. The controller processes the data sent by the sensor module and then sends it to the drive module, thus controlling the movement of the whole

car and finally completing the automatic operation and control process. This trolley mainly comprises a control unit, an execution unit, a navigation module, a driving unit, a road identification and avoidance module, an information communication module, a human-computer interaction module, etc. The flow chart of the smart car's control system is shown in Figure 1.

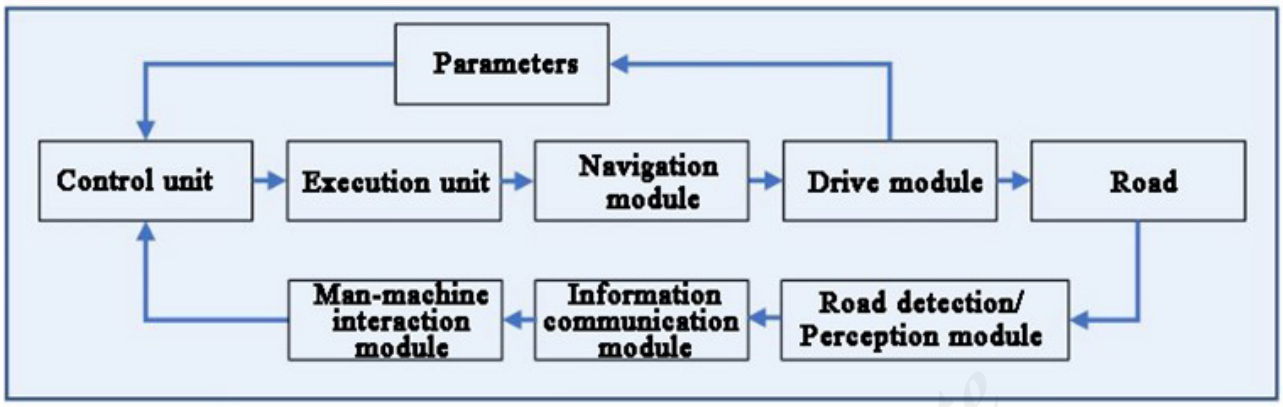

Figure 2 Flow Chart of Control System

The general control module acts as the central information processor. The execution module sends commands to each module. The navigation module has a built-in accurate map for path planning. The information communication module realizes the information transmission to the outside world and interaction with the control center. The sense module senses changes in the external environment and provides real-time information. The human-machine interaction module communicates with people around. The autonomous learning module, with the help of artificial intelligence, improves the ability to receive and analyze data so that the car can react more quickly and reasonably.

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5. Conclusion and Future Plans

The application value of the smart car has been demonstrated in some fields. This research uses literature inquiry, field investigation, and comparative analysis to analyze the application demands and feasibility of the smart car in community express delivery. The application development research is carried out according to the smart car's technical characteristics and operation scheme. According to the relevant technologies, the smart car is innovated and improved. The functions of information interaction, path planning, automatic obstacle avoidance, self-learning, ultraviolet disinfection, etc., are mainly realized, which can meet the needs of residents in the community to pick up the express, facilitate the courier, and the requirements of epidemic prevention. In practice, the smart car also needs to be perfected and improved. It will enhance the express mode to a certain extent, reduce the cost of workforce, material resources, and time, improve express efficien-

cy, and has good social and economic value. From the investigation of the project to the determination of the research scheme and then to the design and operation of the smart car, we have not only devoted to the project, expecting that the research can serve the practice, but also followed the clear research idea, adopted the appropriate research method, and solved the problem with the relevant knowledge of the smart car. In the research process, we are also constantly growing, gradually improving our essential character and critical ability to meet the needs of personal and social development.

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Brief introduction of school and instructors

Beijing Sanfan Middle School is the middle school of the Second High School affiliated to Beijing Normal University. The school implements all-round quality education to develop students' core qualities. Establish a diversified curriculum system, adhere to the student-oriented, and actively meet the needs of different students. The school actively explores interdisciplinary courses and other courses to cultivate new people who can adapt to future social development.

Lihuan WANG: Senior physics teacher in Sanfan Middle School and a backbone physics teacher in Beijing. In teaching with their own personality, behavior to infect the students, concerned about the overall growth of students. She advocates that students focus on the practical connections between life and the classroom.

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