Original Research Article

"Core" Helps Double Carbon "Smart" Build the Future – "Ecotrash", an Internet of Things Ecological Protection Device Based on the Master Chip STM32

Xuanliang Chen [1,], Chunyu Nie[1], Luyao Shi[1], Yanan Zhao[1], Shengnan Zhao[2]*

1 Department of Cyber Security Academy, Qufu Normal University, Jining 273165, China

2 School of Statistics and Data Science, QuFu Normal University, Jining 273165, China

Abstract: In response to the national call for carbon neutrality, the GoClean team proposed the concept of "core helps double carbon, intelligent future" and innovatively designed the EcoTrash iot ecological protection device. Based on STM32 main control chip, cloud database, pattern recognition and Internet of Things, the ecological management platform integrating ecological protection, intelligent identification, human-computer interaction and cloud database is realized, and the concept of carbon neutrality is integrated into the design and function of the product. EcoTrash uses embedded hardware for human-machine interaction and environmental monitoring, including temperature, humidity and pollution levels. The data is transferred to the database through the cloud, and then transmitted to the visual analysis platform for data analysis. The six parts include power supply module, main control circuit, wechat mini program, visualization platform, visual identification module and environmental monitoring and purification system. The main working process is that the power supply module provides power to the main control chip, connects the small program through the ESP8266-WIFI module, and uses the visual recognition module of the EcoTrash device to input garbage information and transmit it to the big data platform. Through this system analysis of the local environment, we are committed to promoting carbon neutral development, contributing to the realization of the "dual carbon" goal and promoting green and low-carbon transition development.

Keywords: Carbon neutral; Internet of Things (IOT); Stm32 chip application

1. Introduction

With the rapid development of social economy and the acceleration of urbanization, the problem of garbage has become increasingly prominent. The accumulation of large amounts of garbage has brought serious sanitary problems to the urban environment. Garbage accumulation not only affects the beauty of the city, but also easily breeds harmful substances such as bacteria and viruses, which poses a potential threat to people's health. In addition, the accumulation of garbage can also cause the release of harmful gases such as malodor and formaldehyde, affecting air quality and causing problems for residents' living environment. On the other hand, the unreasonable disposal of garbage has caused serious pollution to the environment. Therefore, based on the practical application of information technology service industry, this paper puts forward the idea of "core" to help double carbon, "wisdom" to build the future ", and designs an Internet of things ecological protection device based on STM32 master chip -- EcoTrash. The project is based on cloud database, pattern recognition, integrated application of Internet of things. A data analysis and ecological management platform integrating ecological protection management, intelligent identification system, human-computer interaction system, cloud database and client has been realized. In order to realize the transformation and upgrading of sustainable development in

China, empower the smart development of cities and complete the "double carbon" goal at an early date. We will promote the deep integration of energy conservation, emission reduction and the Internet, and contribute to the national dual carbon cause[1-2].

2. Introduction to how EcoTrash works

EcoTrash is mainly composed of six parts: on-board power supply module, STM32F407 main control circuit, front-end wechat appletecotrash community management assistant, ecological management and data tracking visualization platform, K210 visual recognition module and intelligent lighting conversion system.

The main workflow is that the on-board power supply module supplies power to the main control chip STM32F407ZGT6, and the ESP8266-WIFI module is driven to connect with the EcoTrash community management assistant on the front end of the small program, and then through the mobile phone camera or the K210 visual recognition module of the EcoTrash Internet of things device. The spam information is input and then transmitted to the big data platform. In order to avoid the light problem of the night and the morning, the iot device will drive the lighting peripheral, and then through this way, improve the accuracy of identifying objects. The simple design is shown in FIG. 1.

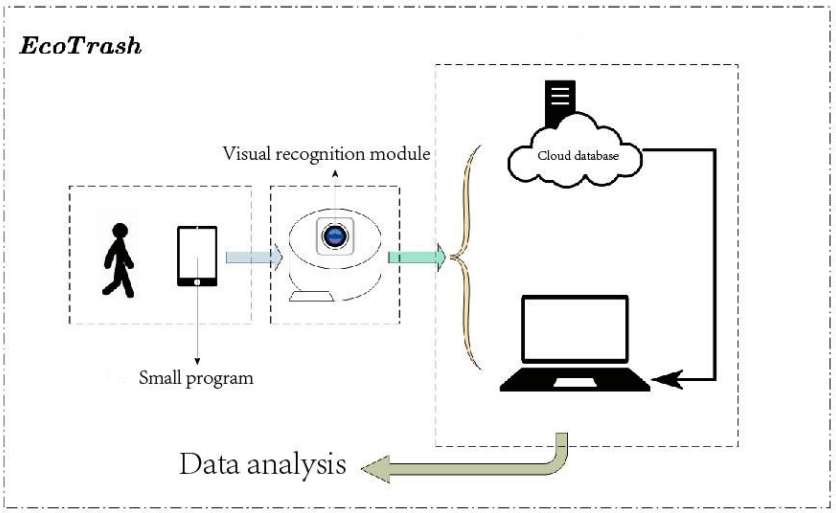

Fig 1. The EcoTrash process

The power supply mode of EcoTrash is the main photovoltaic matrix as the auxiliary power supply to the intelligent lighting system and the Internet of things. At the same time, the EcoTrash system can sample the data of air temperature, humidity and air pollution level through "cloud monitoring", which can be fed back to the ecological management and data tracking platform. In addition, EcoTrash can also be monitored by "cloud detection" to achieve the optimal air purification effect of HEPA electrostatic filter online filtering. Through "cloud monitoring", high-performance computing and deep learning are performed on environmental parameters at this time, so as to achieve ecological management system monitoring. At the same time, the "cloud exchange" of data is carried out on the basis of "cloud monitoring", and it can also work normally and efficiently in the scene of uncertain weather conditions and air quality, and switching between day and night.

For example, when detecting the working time of EcoTrash in the data tracking visualization platform, it is found that when it is in the evening or night, the power of EcoTrash increases, but it can still work normally.

3. Technical key point analysis

3.1. The driving system is based on the main control chip STM32F407ZGT6

The main control chip STM32F407ZGT6 is an ARM Cortex-M4 core microcontroller with high performance and low power consumption. It has rich peripheral equipment and powerful computing capabilities, which is suitable for various application fields, including ecological management and protection[3].

For STM32F407ZGT6 can be used as the core controller of the environmental monitoring system, by connecting sensors and acquisition modules, real-time monitoring and data acquisition of air quality, humidity, wind speed and other environmental parameters. At the same time, the chip has a variety of communication interfaces, which can carry out data interaction and remote control with the cloud platform or mobile terminal. And the mainstream of STM32 embedded devices provide more peripheral routines, for developers, the chip is easier to use.

For the power supply of STM32, we can add an on-board power supply. The on-board power supply has solar panels to supply power to STM32. Through the power storage device, energy is collected and supplied to the surrounding electric facilities. The system will reduce the power supply of the power supply system to EcoTash, thereby reducing the consumption of resources for power generation, realizing the self-sufficiency of the road to a certain extent, basically realizing zero pollution power generation, in line with the new concept of saving resources, low carbon and environmental protection in today's society.

3.2. The "Cloud-Hosted" monitors the smart terminal

The terminal uses K210 to obtain visual data and then transmits the monitored temperature, humidity and wind speed data to the platform through the MQTT platform, which includes K210 vision module, ecological management and data tracking visualization platform big data intelligent terminal control system[4].

For K210, the internal visual intelligence processing system is used. On the basis of preparing the data set, KNN is used as the classification network for ecological waste detection and recognition, and imagenet is used to pre-train the network. After positioning each type, the data set is identified through LPRNet, and the recognition results are stored in the data processing system. K210 camera recognition part uses three layers of convolutional neural network, makes its own data set, divides the garbage into multiple types and multiple identification, and then stores the recognition results in the data processing system. Finally, the identification data is obtained and sent to the EcoTrash background management platform to read the data, and then visual analysis.

3.3. EcoTrash detection system

The detection system of EcoTrash is roughly divided into four parts: environmental monitoring, parameter transmission, model training and data sent from the cloud.

The front-end obtains information or obtains relevant parameters through K210, sends the parameters to the platform for online model training, and then puts the 20% data set to test the accuracy. The flow chart is shown in FIG. 2.

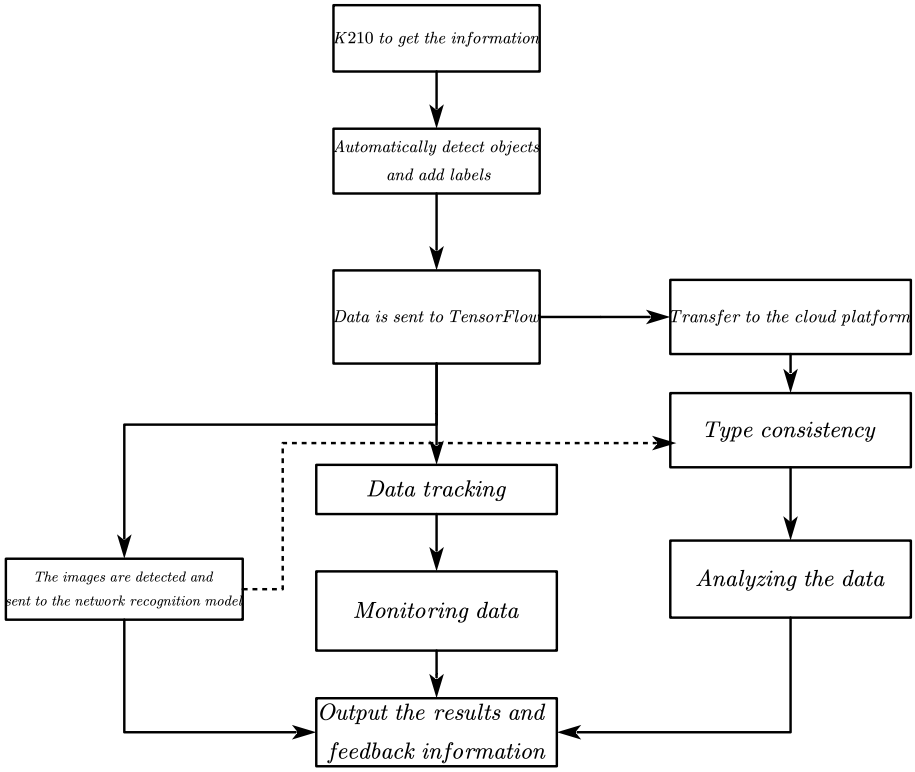

Fig2. The EcoTrash system detection process

The general process of the system is to obtain image information through K210, and then the image information is sent to the ESP8266-WiFi module, and the data is sent to the cloud host through the cloud platform terminal, and then 80% of the data is trained by the cloud host, KNN is intended to be used as the classification network, and then the garbage classification data is used for pattern tracking. It is planned to use the yolo model for identification, and then through the deepsort algorithm, the detection result is used as the input, and the Kalman filter is used for prediction and the Hungarian algorithm is used for target tracking. Due to the uncertainty of the transmission signal-to-noise ratio, there is some noise influence, so the Huffman coding is used to compress the channel, and the classification data is sent to the host under the condition of ensuring the maximum undistorted, and the unwanted part is filtered out by the Hilbert filter. The ecological waste is judged whether it is consistent with the label in the database through the yolo label detected by itself. If it is consistent, it is passed to the visualization platform for analysis.

4. Analysis of data results

For data testing, this paper uses the Yolov1 algorithm model[5]. First, the first few tens of layers of convolutional networks are pre-trained using the ImageNet dataset, and then the complete network is used to train and predict object recognition and localization on the PASCAL VOC dataset. The value of lrelu is set to 0.1, and the value of dropout is set to 0.5. The test results are shown in Table 1.

Table 1. Running the resulting tests

Number of running results	Accuracy
10	0.9613
20	0.9619
…	…
980	0.9659
990	0.9674

From the comparison between prediction data and actual data, the BP neural network has better prediction performance and relatively small error, which can meet the demand completely, and has fast prediction speed and convenient operation.

And the results are analyzed by clustering, where the data graph of clustering analysis is shown in FIG 3.

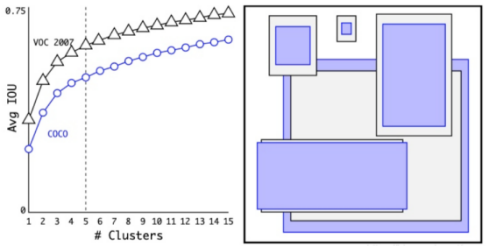

Fig 3. Cluster analysis results

It is found that the VOLOV1 algorithm for data testing can effectively classify the information, so it has a good adaptability to EcoTrash, and also meets all kinds of data in the project.

5. Conclusions

For "Core" to help double carbon and "smart" to build the future -- the iot ecological protection device "EcoTrash" based on the main control chip STM32. It provides a theoretical basis for the application of Internet of things and the development of double carbon. However, it still needs high-precision algorithm models and strong data support to truly apply this Internet of things device to practice. Through the Yolo algorithm model test, the algorithm analysis is added, which effectively improves the accuracy and precision of the EcoTrash project. The experimental results show that the introduction of Yolo algorithm and BP neural network model can make EcoTrash have good robustness, and has certain practical application value[6].

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