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Design of a Guest Face Detection Tool Using ESP32-CAM Based on Internet of Things (IoT)

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Abstract

In the digital era, technology continues to evolve in the field of security. One of the innovations is the use of Internet of Things (IoT) technology and face recognition. The background of this research problem is that there is no guest book documentation in digital form in companies or agencies, which is usually only in the form of manual writing. The proposed solution is to design and implement a guest face detection tool using ESP32-CAM that can distinguish between guests and employees. Employee face data is stored in a GitHub repository. When the tool detects an unknown face, a notification and photo will be sent to the Telegram bot. If an employee's face is detected, a notification of the employee's name is sent to the Telegram bot. The method used in this research is prototyping, including hardware design and software development to support the function of the tool. The test results show that this tool is effective in detecting and digitally archiving guest visits by distinguishing the faces of guests and employees and sending notifications to Telegram bots. In conclusion, this ESP32-CAM and IoT-based guest face detection tool successfully creates an effective digital guestbook archive.

Keywords: *ESP32-CAM, Face Recognition, IoT, Telegram bot, Face Detection*

1. Introduction

In today's digital era, technological developments are advancing along with the needs that aim to facilitate work in society. The use of facial recognition technology is increasingly innovating for business, security and research. Many community activities today are supported by technological developments that continue to grow rapidly. One of the developing technologies is the utilization of the Internet of Things (IoT) by combining technological devices that have been made and redeveloping existing devices. The concept of Internet of Things (IoT) is the development of a communication network between devices that are interconnected via the internet, which will send notifications and notifications. To support automated security by utilizing IoT, several sensors are used to detect signals from objects that guide security. One of the sensors that will be used is the ESP32-CAM which is able to detect a person's face[1].

ESP32-CAM is a series of camera module systems that work when given commands by the programmer through the arduino IDE editor. Both work well when given an ip address along with Wifi support to access via internet media. The ESP32-CAM module is used as a face recognition system that works as a microcontroller as well as a camera sensor where face images will be taken using a camera module and processed by the ESP32-CAM microcontroller [2]. This research will discuss the design of a guest face detector that is used to distinguish between guests who come and employees who work at a company. The ESP32-CAM camera will be used in this research as a tool to detect facial recognition while distinguishing between guest faces and employee faces, by utilizing GitHub to create a Repository as a place to store face recognition data and also utilizing the internet network and the telegram bot application as a result storage archive.

2. Literature Review

2.1. Design

Design is done to create a scheme for the plan to be made. By taking into account all aspects needed both hardware, software, network connections, storage repositories and the final result in the form of digital archives on telegram bots.

2.2. ESP32-CAM

ESP32-CAM is a microcontroller module with additional functions such as Bluetooth, Wifi, camera and micro SD card slot. This module can be used for Internet of Things projects that require camera capabilities. The ESP32-CAM has fewer I/O pins than the ESP32 Wroom module. ESP32-CAM is a variation of the ESP32 microcontroller to ESP32-CAM. The ESP32 is an integrated circuit that uses the ESP32-CAM microcontroller and is integrated with a camera module [3]. This module can be used for photography and can also be used as a Wifi

module for data transmission. ESP32-CAM specifications such as Wifi 802.11b/g/n, Bluetooth 4.2 with BLE, UART, SPI, I2C and PWM interfaces, clock frequency up to 160 MHz and computing power up to 600 DMIPS. The module also has 4 MB external PSRAM and 520 KB SRAM.

2.3. Internet of Things (IoT)

The Internet of Things, also known as IoT, is the idea that all objects in the real world can communicate with each other as part of one integrated system using the Internet network as the link. For example, a CCTV installed on a highway is connected to the Internet and installed in a control room ten kilometers away. Or a smart home that can be controlled using a smartphone and an Internet connection. Basically, IoT devices consist of sensors as data collection tools, internet connections as communication tools, and servers to collect and analyze information received from sensors. The first idea of the Internet of Things first appeared in one of Kevin Ashton's presentations in 1999. Since then, many large companies, including Intel, Microsoft, Oracle and others, have started to explore the Internet of Things. There are many indications that the impact of the Internet of Things will be “the next big thing” in the world of information technology. This is because IoT offers many opportunities to explore. A simple example of the advantages and applications of the Internet of Things is a refrigerator that can notify its owner via SMS or email that its food and drinks have run out and need to be refilled [4].

2.4. Network Communication

Network communication is the process of collecting, processing, and transmitting information between multiple computers and computers connected through a computer network. These communication networks allow connected computers and computers to interact and share information. Network communication can be done using a variety of technologies, including local area networks (LANs), wide area networks (WANs), and the Internet. Network communications can be used for a variety of purposes, including sending and receiving data, collecting data, processing data, and sending data to other locations. Network communication can reduce the cost and time required for data collection and transmission and facilitate communication between individuals and organizations [5].

2.5. Face Recognition

Face recognition is a system that identifies and authenticates individuals using facial features. These facial recognition systems can recognize a person's face in various situations, including photos, videos, and in real time. Facial recognition is highly accurate, but not as good as iris or retina authentication. This facial recognition technology is considered more secure and cheaper than existing security methods. There are many complex variables in facial recognition including raw facial images, processed images, captured images, and personal data. The implementation of this system requires a device in the form of a camera sensor and a method to determine whether the image captured by the web camera is a human face. In addition, the system also works to identify the information corresponding to the detected facial expression. The human face recognition process begins with a face detection step based on several parameters such as eye distance, nose width and cheek shape [2].

2.6. Adapter FT232EL

Adapter FT232RL is a USB to TTL/UART signal converter module (USB-TTL converter) used to add USB functionality to electronic microcontroller devices such as Arduino and Raspberry Pi. This module uses a chip made by FTDI, the FT232RL, which functions as a converter of USB data into TTL/UART signals. The FT232RL is an industrial converter that can select the UART voltage between 3.3VDC or 5VDC. Other features include USB power supply with selectable 5V or 3.3V, overcurrent protection with 500mA fuse with pin definition of DTR, RXD, TX, VCC, CTS and GND.

2.7. GitHub

GitHub is a hosting service for Git repositories where users store, manage and track code changes in software projects. Two main systems have been developed namely Version Control and Git. While Version Control records all code changes, Git is a distributed Version Control system that allows project members to access the change history. GitHub repositories are where all the code, files and update history of the project has been stored. Each repository can have multiple collaborators and can be published publicly or privately. These repositories allow users to efficiently manage, track and collaborate on software development. Github uses the Git tool to host open source software, and Github is also classified as Webhosting. Git itself is a system control tool whose function is to manage various programming languages. Git was chosen because it is the most popular among many VCS [6].

2.8. Telegram

Telegram is a cloud-based application that allows users to easily access their Telegram account from multiple devices simultaneously. You can share unlimited files up to 1.5 GB. The Telegram app was created by two Russian brothers, Nikolai Durov and Pavel Durov. Through both collaborations, Nikolai focused on app development, creating the MTProto protocol that powers Telegram. Pavel is currently in charge of finance and infrastructure through Digital Fortress funding [7].

2.9. C Programming Language

C programming is an unquestionably reliable programming language that is widely used to create programs in various fields, including assembly and operating system development. Until now, C is still a popular and popular programming language. Meanwhile, C inspired the creation of new programming languages such as C++, Java and so on. Therefore, in terms of subject mastery grammar, these three languages can be said to be equivalent. The C programming language is very flexible and portable, and can be installed and run on various operating systems. In general, C is mainly used to interface between hardware devices so that they can communicate with each other. The current C++ programming language has evolved through the standardization process conducted by the American National Standards

Institute (ANSI) and the International Standards Organization (ISO), adding new features that are not yet supported by classic (original) C++. A unique feature of the C++ language is its support for object-oriented programming, also known as object-oriented programming (OOP). This makes C++ popular among programmers and students alike [8].

3. Analysis and Design

3.1. System Design

In designing a system entitled "Design of a Guest Face Detection Tool Using ES32-CAM Based on Internet of Things (IoT)" which in making the tool there are several problems that must be solved. The problems include:

1. How to design and implement a guest face detection tool using ESP32-CAM?
2. How to connect ESP32-CAM with the Internet of Things (IoT)?
3. How does the guest face detection tool work using ESP32-CAM and how to store archives on the use of guest face detection tools connected to the telegram bot application?

3.2. Block Diagram of the System

The designed system diagram can be seen in the following figure:

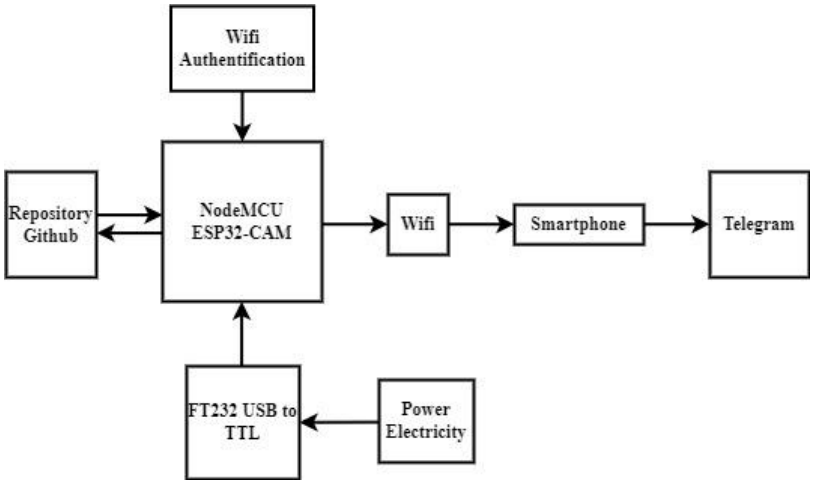

Fig. 1: Block Diagram of the System

The main component used in this system is NodeMCU ESP32-CAM as a microcontroller that manages this system. The way the tool works can be seen where the ESP32-CAM is powered by electricity with the connecting media using FT232 USB to TTL, after which the use of this tool is required to register the faces of employees who work at the company for employee identity recognition. Registered employee data will be stored on the Github Repository as a storage medium. Next we will authenticate the wifi settings so that the NodeMCU ESP32-CAM can connect to the internet network on the Smartphone which then connects it to the telegram bot to send photos of guests identified on the NodeMCU ESP-32 CAM. The stored photo data will become an archive in the digital guest book.

3.3. Device Circuit

In this tool circuit, it functions to run the tool system so that it can work according to the program instructions.

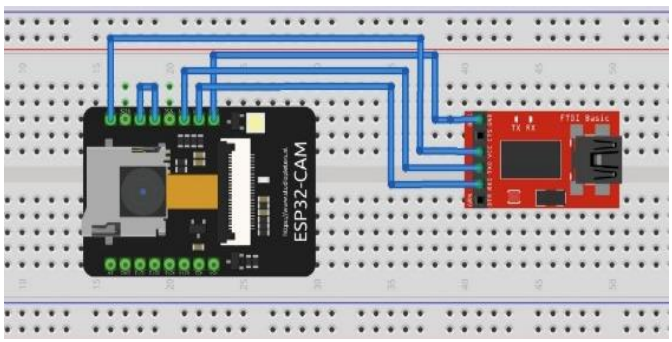

Fig. 2: Device Circuit

3.4. System Flowchart

In the system flowchart, you can see the flow from the start of the tool design to completion.

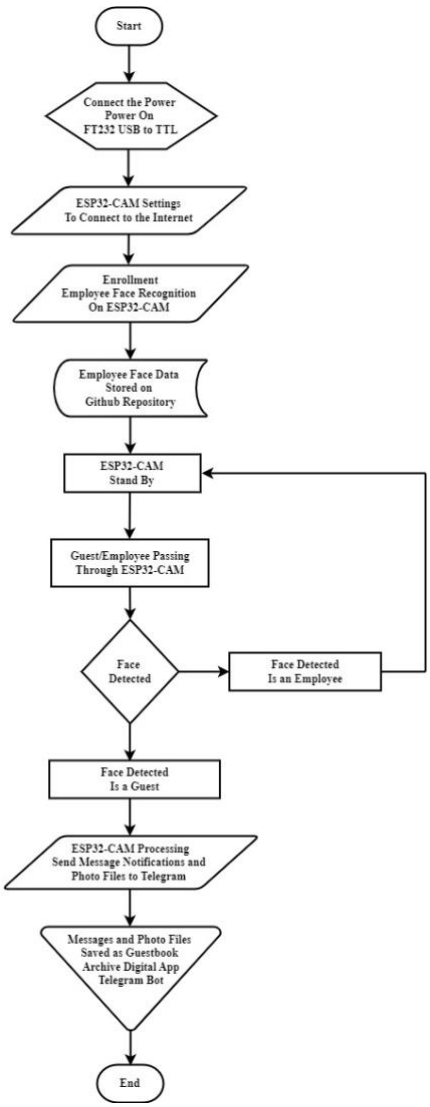

Fig. 3: Flowchart of working tool system

Description:

From the flowchart above, it can be explained where the process starts by connecting electrical power to the FT232 USB to TTL so that the ESP32-CAM can be run. Setting ESP32-CAM so that it can connect to the internet network. First register the faces of employees who work on the Github repository that was created, aiming to distinguish guests who attend. Employee data that has been registered will be stored in the Github Repository. NodeMCU ESP32-CAM will stand by in monitoring guests and employees who pass through it. Face detected, if the detected face is a working employee, the ESP32-CAM will return to the Stand By position and send a notification of the Employee message and the name of the working employee, because the employee data has been stored in the GitHub Repository. However, if the detected face is a guest, the ESP32-CAM will capture a photo of the guest's face and will send the photo file and Guest message notification to the telegram bot application. Files in the form of photos and Guest message text will be stored in telegram and archived in the digital guest book.

4. Discussion and Implementation

4.1. Discussion

This chapter will explain and also show how the results of testing the design of the tool made and its discussion. The results of the tests carried out are tools made, designed and programmed using the Arduino IDE application. This tool can later be used in digital guestbook archiving.

4.2. Component Testing

To find out whether the NodeMCU ESP32-CAM microcontroller circuit has worked properly, testing will be carried out by giving the command program to the microcontroller by inputting data from the computer into the microcontroller. In doing the installation, first connect the microcontroller between computers with a downloader via a micro USB cable to the microcontroller circuit. To test the tool with commands can be done with a few steps that must be considered, among others.

1. Instalasi Software Arduino IDE

Installing the arduino ide application as a program editor that will be created. Then create a guest face detection tool program using the c language.

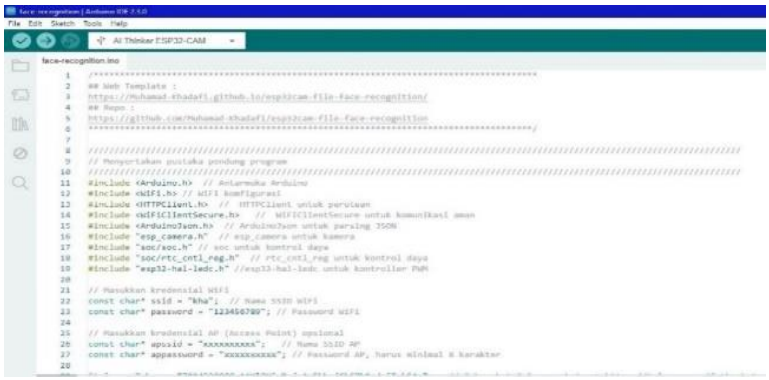

Fig. 4: Create a program

2. Creating a GitHub Repository

After the program is complete, then create a GitHub repository as a data storage medium that can be accessed online. The GitHub repository function for facial recognition access to employees connected to the c language program on the Arduino ide.

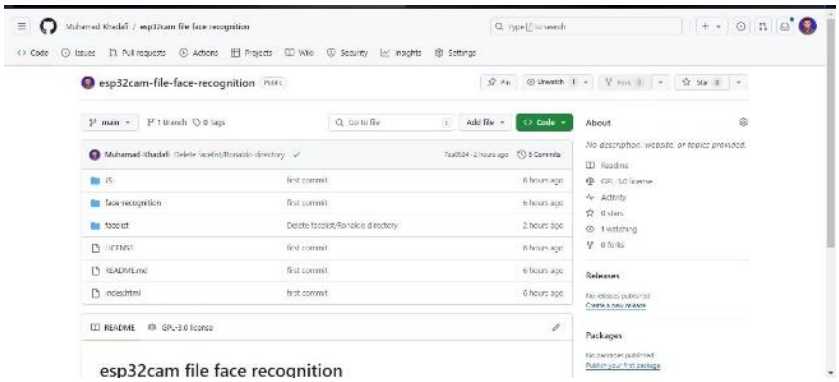

Fig. 5: Creating a GitHub Repository

3. Upload Program to ESP32-CAM

Please verify to see the correctness of the program made, upload the program to the ESP32-CAM microcontroller until it is finished until 100%.

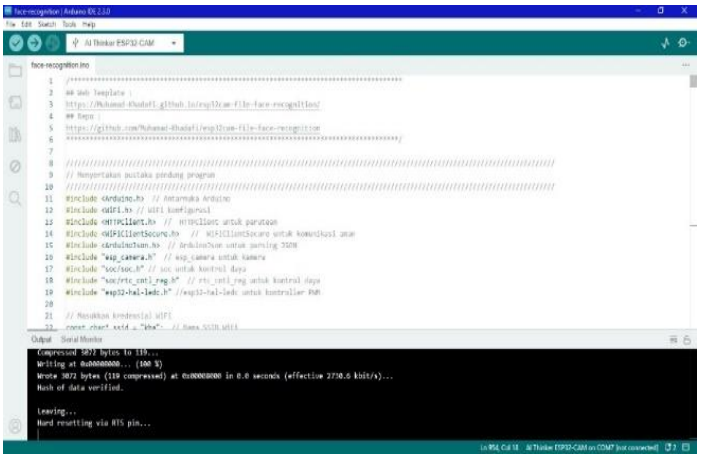

Fig. 6: Program uploaded successfully

4. Web Access Trial

After the program has been uploaded, please reset the ESP32-CAM on the reset button and open the serial monitor on the arduino ide to get an ip address link for web access trials on the device to be tried. Next, do a trial of detecting an unrecognized face. If the face is not recognized, the device will give a description of “unknown” and send a message notification and send a photo file of the unrecognized face to the telegram bot application. The message and photo file will be stored in the telegram bot as a digital guestbook archive.

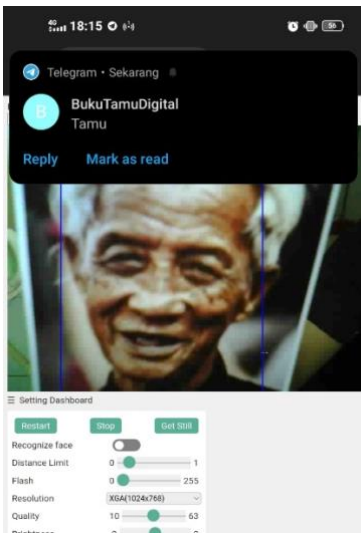

Fig. 7: Guest face detection notification

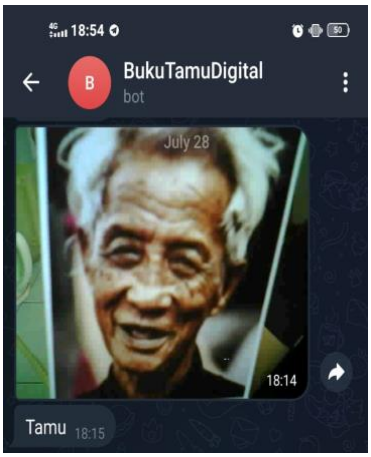

Fig. 8: Guest face detection result in telegram bot

5. Hardware Circuit of Tools

After the software trial runs well, then make a prototype design as a simulation of the guest face detection tool.

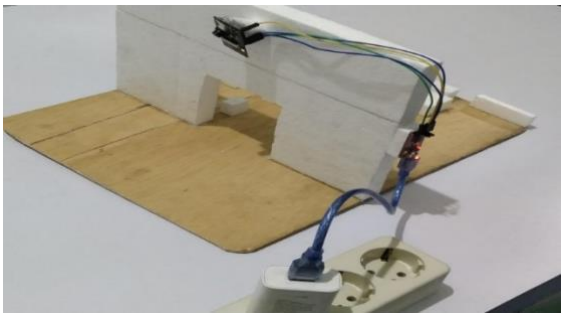

Fig. 9: Hardware circuit of the tool

5. Conclusion

Based on the results in the discussion, we have completed the design and manufacture stages of the system, the process continues to the Testing and analysis stages of all these stages, the following conclusions can be drawn:

1. In designing and implementing a guest face detection tool using ESP32-CAM as the main control, which manages guest face detection and employee face recognition which will become a digital guest book archive. Programming ESP32-CAM to be connected to the internet of things (IoT) in accordance with the concept of guest face detection devices that can be connected to each other after connecting to the internet network.
2. The way this guest face detection tool works is that it can distinguish employees and guests who are detected. First, employee data in the form of photo files is registered and stored on the GitHub repository as a data storage medium that will be used. Employee data that has been stored becomes employee face recognition data, after the tool has detected the employee's face, a text message notification will appear in the form of “Employee! Employee name” and sent to the telegram bot. Furthermore, for

the detection of unknown face recognition will be considered a guest. Where this guest face detection tool will detect and detect unknown faces with the "unknown" condition, after that the tool will send a text message notification "Guest" and "Photo". Then the message notification can be seen in the telegram bot as a Digital Guest Book storage archive media.

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