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Design of Door Security System Based on Face Recognition with Arduino

Januardi Nasir[#], Azizul Azhar Ramli[*], Michael[#]

[#] *Department of.Technique, Universiti Putera Batam, Batam, Indonesia*
[*] *Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia, Malaysia*
E-mail: januardinasir@gmail.com, azizulr@uthm.edu.my, michael.kosuke@yahoo.com

***Abstract*— Robotics technology is very useful for the lives of many people today. Almost all aspects of his life utilize robotics technology according to the required field. The development of robotics technology has become a higher quality of human life. Perhaps robotics are still less popular among the general public who still thinks robotics are humanoid robots (robots or human machines). Robotics has been widely implemented in the real world ranging from the fields of industry, medicine, entertainment, security, to household appliances. In the field of security, robotics has an important role. As the robot principle itself is tireless and has little tolerance, the product in robotics in the security field can be a very useful tool. In addition to facilitate human insecurity, robotics products can also facilitate human in various jobs, such as in the locking doors or walls of anyone who already exists. The development of robotics is in line with the development of computer vision which is increasing its application in everyday life. With this research, is expected to improve security and comfort in the security room. The design of this system using electronic door locks, open source OpenCV and webcam as a unit component.**

***Keywords*— Robot, Microcontroller, Arduino, OpenCV, Electronic Door.**

I. INTRODUCTION

Current technological developments are so fast and useful. Digital technology is now able to replace traditional technology in the presence of a computer system. The many uses of digital cameras as a supporting tool in everyday human matters are supported by the many research and development of digital image processing technology in various fields such as robotics, medical, entertainment, and security. As technologies develop nowadays, digital image processing techniques and artificial intelligence can be used for analysis of the object on digital image such as for motorcycle detection [1], renal tumor detection [2], virtual reality robot [3], blood typing [4], rice variety identification [5], ship detection [6], and analysis of road damage [7].fruit planting time.

II. LITERATURE REVIEW

In various places such as banks, gold shops and pawnshops, security has become something that cannot be considered trivial. These places have spaces that need special monitoring such as document storage space. Securing these spaces using two or more keys and even using combination keys cannot prevent unauthorized people from entering the room. The risk of losing keys, duplicating keys by irresponsible people, and the leakage of secret numeric combinations to open these doors into things that cannot be fully controlled. Easy access to storage space can cause loss of important documents and/or other valuables, the spread of company confidential documents to the public. In general, the document storage space has a log book to record the history of opening the storage room where the log book is still manually recorded by humans. Therefore, these doors must have a security system that is not easily penetrated easily and clear recording. This can be prevented by using robotic technology and computer vision.

The design of a door security system using a microcontroller and computer vision can be used to identify who wants to enter the room. This system design is expected to make it difficult for people who are not responsible to enter the storage room and make a log of anyone who has ever entered this room. Safety using facial recognition technology has a higher level of accuracy that is even used in the medical field. Over the past few decades a lot of work has used face detection and face recognition as the best way to identify people because it does not require human cooperation so that it becomes a hot topic in biometrics [8] .

In this study, the device that will be used for the door security system will be connected to Arduino. Arduino is an open source electronic circuit board which contains the main

component, a microcontroller chip. Arduino can be reprogrammed using the Arduino IDE application and C/C++ programming language [9]. Integrated Development Environment (IDE) is a platform to write program for Arduino [10]. Arduino Uno R3 board uses an ATMega 328 microcontroller as the control center. ATmega328 based Arduino microcontroller will be connected to a computer that has a special application that will be designed with the C # programming language and MySQL server as a database. C# language is a case-sensitive programming language as well as C ++ and Java programming languages. The application that will be built is a face recognition application that can capture images and send commands to the microcontroller. Face recognition mechanism that will be built using OpenCV. OpenCV is an open source library for desktop-based programming [11].

Face Recognition is about detect and process images of face and compare it to a database of known faces [12]. OpenCV serves to facilitate face detection programming, face tracking, face recognition, Kalman filtering, and various artificial intelligence methods. OpenCV uses a face detector type called the Haar Cascade Classifier. If an image (can be from a file / live video), the face detector tests each image location and classifies it as "face" or "not face". Classification is considered a fixed scale for the face, for example 50 x 50 pixels. If the face on the image is larger or smaller than the pixel, the classifier continues to run several times to find the face in the image.

III. Research Method

In this study, there are 4 steps consists mechanical design, electrical design, desktop software development, and Arduino software development.

First, mechanical design is a construction design and arrangement of mechanical components used in building a prototype tool. In this study the researchers used infraboard board 40 cm long, 34 cm wide, and 20 cm high as the base plate for mechanical and electrical components namely ATMega328 based Arduino microcontroller, webcam, jumper cable, data cable, electronic door lock. At the center of the board is a partition which divides the board into 2 parts so that the board forms 1 room on one side, where in the middle a small door for the installation of an electronic door lock will be connected to the ATMega328 based Arduino microcontroller.

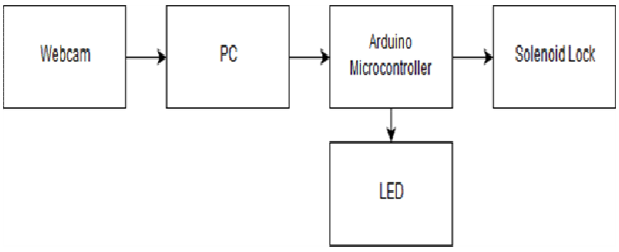

Fig 1. Block Diagram of the Whole System

The electrical design consists of several circuits that have certain functions and are interconnected to form a system. The digital pin 5 and the digital pin 7 will be connected to the green LED and the red LED with the resistor 220Ohm. Pin 9 will be connected to the solenoid lock via the TIP120 transistor. The microcontroller itself will be connected to a PC. The solenoid lock will get a voltage flow from the battery holder.

There are 2 applications that will be designed, namely desktop applications and applications on microcontrollers. The desktop application will be designed using the C # language and the microcontroller application will use C language. On the new dataset registration page, users who act as admin can save the face image that is being captured by the camera as a sample. Twenty sample images will be stored immediately in a relatively short time. The images will be saved directly in the same folder as this application, then the image directory will be saved in the database. After the image is saved, the admin is obliged to test the dataset to ascertain whether the captured image can become a basic guide for this application to recognize a person's face.

Desktop applications must be connected to the microcontroller first in order to send data serially to the microcontroller. Port initiation is intended so that the microcontroller can be used by the application without interruption. Then, the desktop will run the camera to capture images continuously. If there are faces detected in the camera coverage area, the desktop application looks for whether the face is registered in the database. If available, the desktop application will save the face image that opens the door access and sends a signal to the microcontroller so that the door opens. The tables that will be used are admin tables, dataset tables, and log tables. The admin table contains 1 admin username and password. The dataset table will store person identity. The log table will store room access history.

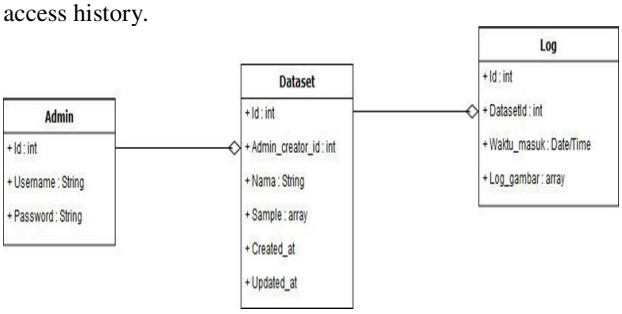

Fig 2. Entity Relationship Diagram

The following is a use case diagram and flow chart of a desktop application that will explain the functions of a desktop application.

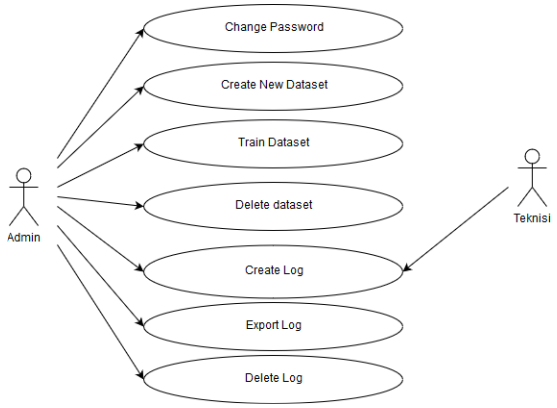

Fig 3. Use Case Diagram

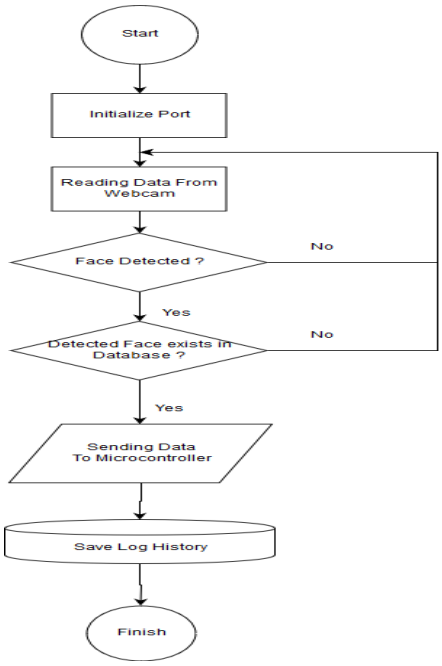

Fig 4. Flowchart Desktop Application

In the microcontroller when a signal is received from a desktop application, the microcontroller will unlock the solenoid for 10 seconds. Whereas the desktop application must be connected to the microcontroller first in order to send data serially to the microcontroller. Port initiation is intended so that the microcontroller can be used by the application without interruption. Then, the desktop will run the camera to capture images continuously. If there are faces detected in the camera coverage area, the desktop application looks for whether the face is registered in the database. If available, the desktop application will save the face image that opens the door access and sends a signal to the microcontroller so that the door opens.

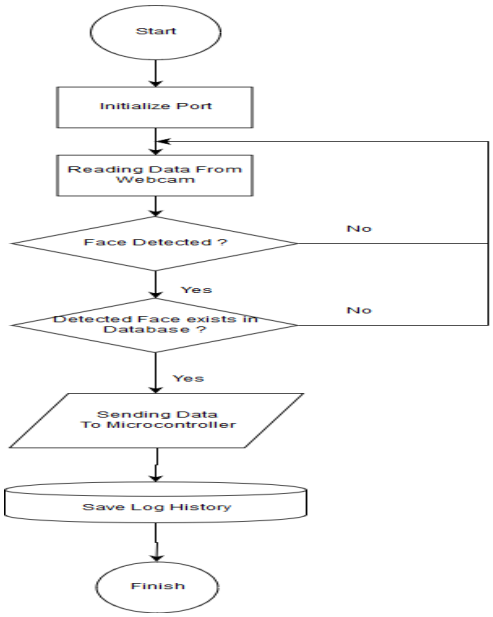

Fig 5. Flowchart Arduino Application

Testing is done to determine the success rate of the tools that have been made. Product testing that can be done in this study is testing based on the distance of the user with webcam and testing based on different facial accessories. Product testing based on the user's distance will be tested with distances ranging from 0.5 meters to the maximum limit that can be captured by the system properly. Each test will be carried out 3 times to get accurate results. The results will be assessed from the accuracy of accuracy in identifying the user's face for each distance.

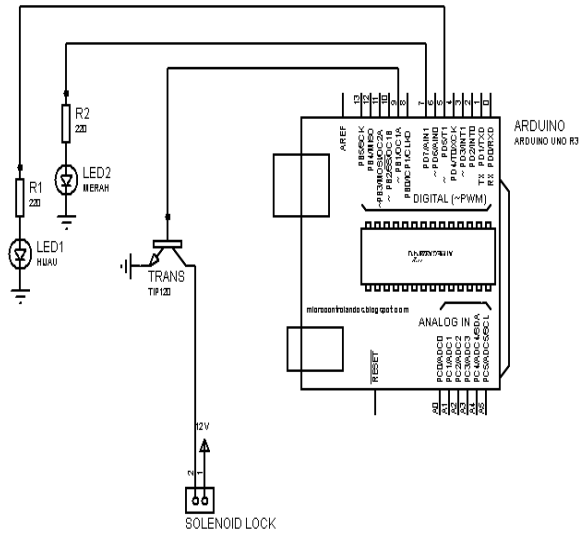

Fig 6. Overall System

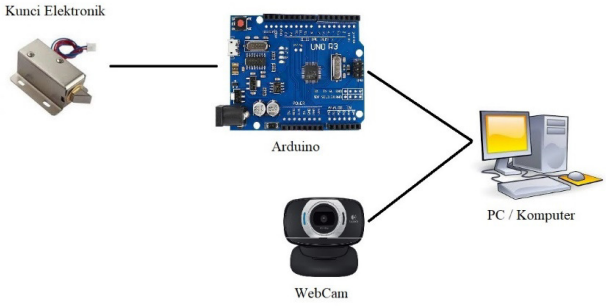

Fig 7. Diagram Blok

IV. Results and Analysis

In the mechanical design of this research is a door design made of infraboard with an electronic lock in the form of a 12 Volt solenoid lock. For solenoid lock power supply will be obtained from 2 pieces of battery holder with a capacity of 4 x 1.5V which will be connected in series to get a voltage of 12 Volts. Electrical design includes the preparation of an ATMega328 based Arduino microcontroller with other components, namely solenoid lock, power supply and LED lights including transistors and resistors. The connection pins of the ATMega328 based Arduino microcontroller are explained in the following table.

TABLE I
PIN CONNECTION

Pin	Solenoid Lock	LED Red	LED Green
Power Pin			
VCC	-	-	-
GND	√	√	√
Digital Pin			
5	-	-	√
7	-	√	-
9	√	-	-

The desktop application is created with a special login page for admin. On the default user login page contained in the database, the username 'Admin001' and the password 'logintomysystem'.

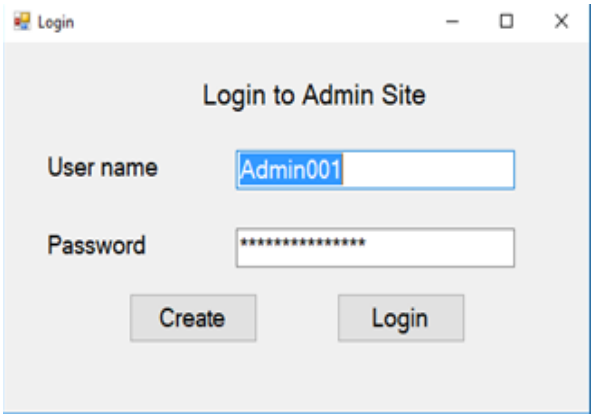

Fig 6. Login Page

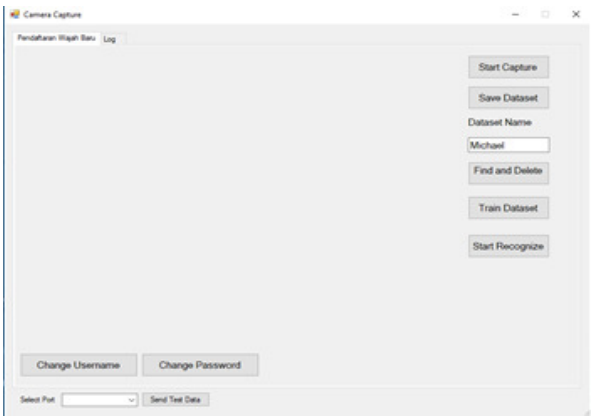

Fig 7. Main Page

In the Face recognition menu, there are the following menus:

1. *Start Capture* : Start taking pictures from webcam and face detection process.

Save Dataset : Save sample pictures of face that have been detected from the webcam to the datasets folder and update the information to the database. The dataset will be saved with the name listed in the Dataset Name box. The following are examples of images that have been saved.

Fig 8. Sample Pictures

2. *Find and Delete* : Search and delete datasets from the database.
3. *Train Dataset* : Train the application to recognize saved faces.
4. *Start Recognition* : To start the security system with face recognition.

The steps for registering new faces are as follows:

1. Click "Start Capture".
2. Type the name you want to save in the Dataset Name box.
3. Click "Save dataset" when a face is detected. Then, wait a few seconds to wait for the image storage process. The user can move his face facing left and right when storing images. If the new dataset storage has been successful, a notification window will appear that the image storage has been successfully carried out.
4. Click "Train Dataset" with the same dataset name as the previously saved dataset to train the application in the introduction of the saved face dataset.

How to recognize faces can be done by clicking the "Start Recognize" button and the face recognition system will run automatically. If there are faces that have been stored and trained that are detected on the image from the webcam, the application will send a digital signal in the form of a string "1" to the microcontroller serially. If the application sends a digital signal in the form of a string "1" to the microcontroller, the application will log and take pictures of faces that have been detected into the computer. Next, the log can be seen from the Log tab in the application.

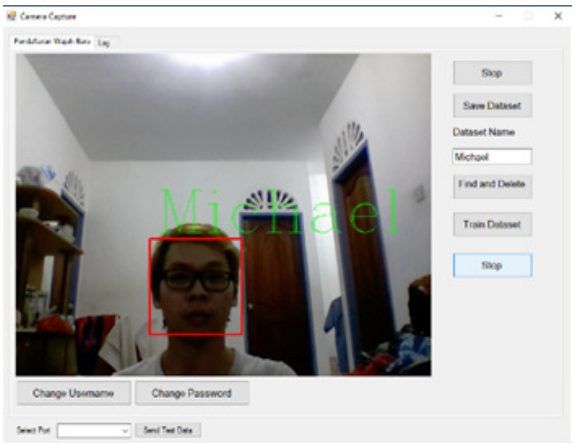

Fig 9. Face Recognition

The Arduino application uploaded into the ATMega328 based Arduino microcontroller functions as the receiver of the digital signal sent from the computer and translates it into an LED light indicator then unlocks the solenoid door. The pin that is connected to the ATMega328 based Arduino microcontroller is the 5 digital pin for the green LED light, the 7 digital pins for the red LED light and the 9 digital pins for the solenoid key. When the microcontroller is run, the microcontroller will automatically read the input from the computer continuously (loop). The normal state of the microcontroller will turn on the red LED sign the microcontroller is running properly and the solenoid key is locked. If the microcontroller receives a digital signal from the computer in the form of a string containing "1", then the microcontroller will turn off the red LED light, turn on the green LED, and then unlock the solenoid. The solenoid key that is opened will last 6500 milliseconds or 6.5 seconds. Next, the key will return to its normal state so that if the door is closed, it will automatically lock.

This test is done to find out how far the ability of this application is in detecting and recognizing faces. Testing The following are the results of 3 times distance testing of this application.

TABLE III
SYSTEM PERFORMANCE I

Distance	Detection	Recognition	Conclusion
0.5 meters	Succeed	Succeed	Sukses
1.0 meters	Succeed	Succeed	Sukses
1.5 meters	Succeed	Succeed	Sukses
2.0 meters	Succeed	Succeed	Sukses
2.5 meters	Succeed	Succeed	Sukses
3.0 meters	Succeed	Failed	Failed
3.5 meters	Succeed	Failed	Failed

TABLE IIIII
SYSTEM PERFORMANCE II

Distance	Detection	Recognition	Conclusion
0.5 meters	Succeed	Succeed	Sukses
1.0 meters	Succeed	Succeed	Sukses
1.5 meters	Succeed	Succeed	Sukses
2.0 meters	Succeed	Succeed	Sukses
2.5 meters	Succeed	Succeed	Sukses
3.0 meters	Succeed	Succeed	Sukses
3.5 meters	Succeed	Failed	Failed

TABLE IVV
SYSTEM PERFORMANCE III

Distance	Detection	Recognition	Conclusion
0.5 meters	Succeed	Succeed	Sukses
1.0 meters	Succeed	Succeed	Sukses
1.5 meters	Succeed	Succeed	Sukses
2.0 meters	Succeed	Succeed	Sukses
2.5 meters	Succeed	Succeed	Sukses
3.0 meters	Succeed	Failed	Failed
3.5 meters	Succeed	Failed	Failed

V. CONCLUSION

Based on the results of research and discussion, it can be concluded from this study, that the Face Recognition method can be implemented into a door security system using an ATMega328 based Arduino microcontroller. In its implementation, the door security system using ATMega328 based Arduino microcontroller can help record history automatically. This face recognition system can work well at a distance of less than 3 meters

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