SMART DOOR

Nares Chumparat 60070504008

Chanin Wittayaudomkit 60070504031

Department of Control System and Instrumentation Engineering, Faculty of Engineering King Mongkut’s University of Technology Thonburi Bangkok, Thailand

E-mail : nares.chu@mail.kmutt.ac.th

E-mail : chanin.wittayaudomkit@gmail.com

**Abstract** - This document presents our project Smart Door since designed and implementation techniques to do this project until finished. The proposed "Smart Door" is designed to be convenient for us and also compatible with the current Covid-19 situation. Smart Door can unlock the door and open it by scanning the face without touching the door. That why it is appropriate for the current situation. The system will recognize the face when we register as the owner. After scanning to find our face, the system will unlock the door and open the door for us to enter the house. But if it is a guest who hasn't registered his face when the system detects will alert to the web APP and show the body temperature of that person by the temperature sensor. It makes us safer from Covid-19 before welcoming guests into the house. We can press the button to open the door through the web APP. The examples given above are some of the features of Smart Door. There are other features not mentioned above such as the PM2.5 detection system, etc. Other features that are not mentioned above can be found in Section I & Section IV.

**Keywords –** Smart Door, Temperature sensor, PM2.5 sensor, Humidity sensor, Web APP.

1. Introduction

The current situation of Covid-19 has affected our economy. Many people are unemployed and causing more theft. But nowadays, there are many technologies used for home security such as Burglar alarms, CCTV cameras, fingerprint scans, etc. But the basic protection is the door that every home must-have. It protects us from a stranger. That's why we chose the door to develop into a Smart Door.

We call it the "Smart Door" because it's not a normal door. We apply from ordinary doors by adding additional features to make them more diverse. This smart door is also modern and very useful in the current situation of Covid-19. It is an intelligent door that can be opened/closed without touching the door and also can scan the person coming to our home to see how much body temperature is, which helps us a lot to be careful from the situation of Covid-19 and has other functions, such as PM2.5 detection, Humidity detection, Temperature detection outside the house, and etc. Also, it's good for security with a system that alerts us through a web application that someone is passing through the door.

In this document, we propose the concept of design and implementation of the Smart Door project with the Web APP. Including the coding process for use as well. The overview of the system is explained in Section II. In Section II, we explain the specifications of hardware architecture and more detail of the project Smart Door in every feature. In Section III, In this Section we will describe the software architecture of this project. IV, we will explain in-depth how to use Smart Door. Finally, Section V is a conclusion.

1. System Overview and Architectures

The system overview of the Smart Door system is shown in Figure 1 to Figure 7. You will get to know some parts of the Smart Door system, which you will know more in Section IV: How to use Smart Door, which will explain the steps detailed usage.



**Figure 1 : Smart Door Model.**

**Explain for Symbols.**

* Motion Sensor detecting things passing through the

front door.

* Temperature Sensor detecting temperature outside.
* Humidity Sensor detecting humidity outside.
* PM 2.5 Sensor detecting pm 2.5 outside.

* Door Bell switch use to Ring the Bell.

* Camera use to detect face and show in real-time.

*  Temperature sensor detecting for body temperature.

**Hardware Architectures**

**Figure 2 : MCU & UART**

This picture shows the replacement of PIC24FJ48GA002 as microcontroller (MCU). Which this one is the microcontroller that control Figure 3 to Figure 7 by firmware from C language. For UART is use for sends and receive data by Serial Port. For microcontroller (MCU) we supply 3.3 Volts.

**Analog Output Sensor**

**Figure 3 : Analog Output Sensor**

This picture shows the replacement of POT 0 as Humidity Sensor, POT 1 as PM 2.5 Sensor, POT 2 as Air Temperature Sensor, and POT 3 as Body Temperature Sensor. Which all of these are Analog Output Sensor. We will connect the analog output sensor to the ADC port of the MCU, which is a 10-bit analog-to-digital converter, with the values ​​we receive in the range 0-1023. When we want to check the values of the ADC, we need to use zero and span techniques to map the value of the sensor with the range of ADC. For example, in the humidity sensor, we will match the values ​​from 0-1023 to the range 50-100%. For example, when we adjust the value of POT 0 equal 0 k we will get the maximum ADC value and if we adjust POT 0 equal 50 k we will get the minimum ADC value.



**Figure 4 : Digital Output Sensor**

This picture shows the replacement of PSW 0 as Doorbell Switch, PSW 1 as Motion Sensor, PSW 2 as Host Away Detection, and PSW 3 as GEL Pump Switch. Which all of these are Digital Output Sensor. We will connect the Digital output sensor with the PSW port of the MCU, which this circuit is active-low which means that when the sensor detecting the logical is high but the signal will become active-low. For example, when we press the button PSW 0 (Doorbell switch) the signal will become low and the value of PSW 0 will get 1 it means On.



**Figure 5 : PWM Input Actuator**

This picture shows the replacement of PWM 0 as an Air Conditioner and BUZZ as a Buzzer. Which this one is the PWM input actuator. Our input actuator is active - high, but the PWM is low, so we use not gates to convert PWM from active-low to active-high, so we can adjust the parameters of PWM to change the operating system of the fan in the air conditioner.



**Figure 6 : Status**

This picture shows the replacement of LED 0 as Door Status, LED 1 as Doorbell Status, LED 2 as Motion Sensor Status, and LED 3 as PWM to Air. Which all of these are Status of Smart Door. This is an active-low LED when we received a low signal that makes LED turn on. For example of working, we use the PSW 0 to set the function to control the working of LED On and Off. In our system, when we press the PSW 0 LED 1 will be Turn On following the coding.



**Figure 7 : Digital Input Actuator**

This picture shows the replacement of RL 4 as Door Locker, RL 5 as BELL, and RL 6 as GEL Pump. Which all of these are Digital Input Actuator. This relay is active-high but the LED is active-low, so we use not gates to convert LED that is active-low to make relay working when the relay is working, it will make 24 Voltage source is connected to the input actuator.

1. Software Architecture



**Figure 8 : Software Architecture**

This Picture Show overall of system work in the Client Side to the Server Side. From Web APP will send data to Flask-Socketio > Pyserial > Uart and Uart send back to Web APP.

**Pyserial :**

This module encapsulates the access for the serial port. It provides backends for Python running on Windows, OSX, Linux, BSD (possibly any POSIX compliant system), and IronPython. But for us, we chose Windows for working the module named “serial”. It automatically selects the appropriate backend.

**Classifier Model :**



**Figure 9 : Classifier Model**

* **Face Detection**

This procedure uses the Histogram of Oriented Gradients (HOG) algorithm, which is an algorithm to separate the characteristics of the object of interest from the background. By comparing the histogram of the vector obtained from the gradients point in each block of the image. The face detection using this method can call the function from the library Dlib.

* **Face alignment**

To make the face suitable for further analysis because the face obtained from the detection is not always the straight face. Therefore must have face layout, such as rotating or resizing for the face that is as close as possible to the face by using the function from Dlib.

* **Face Extraction**

Later, to get the indicators of each face out for comparison and classification. We have to do Face Extraction using the model train by Deep Convolution Neural Network with 27 Convolution layers and faces to train. This model will give 128 face indicators for each face.

* **Training**

After obtaining the face indicators, train the model using Linear SVM classifier, with Input as the Face Descriptor and the Label of that person, save it as a CSV file and output as a model file. Python pickle (.pkl)

**Open CV library:**

OpenCV is used for all sorts of image and video analysis, like facial recognition and detection, license plate reading, photo editing, advanced robotic vision, optical character recognition, and a whole lot more. Which we design and add this feature to our project Smart Door.

**Flask Framework:**

Flask is a web application framework. It is designed to make getting started quick and easy, with the ability to scale up to complex applications. It began as a simple wrapper and has become one of the most popular Python web application frameworks. It is up to the developer to choose the tools and libraries they want to use. There are many extensions provided by the community that make adding new functionality easy.



**Flask Logo**

**Websocket Transporter:**



**Figure 10 : Websocket Transport**

Flask-SocketIO gives Flask applications access bi-directional communications between the clients and the server. The client-side application can use any of the SocketIO official clients libraries in Javascript, C++, Java, and Swift, or any compatible client to establish a permanent connection to the server.

IV. How to Use Smart Door

Smart Door has many features that help us more conveniently. We will explain the process in detail. Beginning with the owner, the user must register their faces in the system. The first feature is face detection when detecting the host's face will unlock the door for 3 seconds before automatically locking and activate Air-conditioner works automatically. We can adjust the value Frequency and Duty circle ratio on Web APP to speed up the fan in air conditioner.

![A screenshot of a cell phone

Description automatically generated]()![A screenshot of a person

Description automatically generated]()**Figure 11 : Detecting Host’s Face**

**Figure 12 : Show Status of Air Condition and Control the Air Condition**

But for the guests that coming when it detects a face, it will capture the picture and sending the notification to Web APP and LINE application.

![A screenshot of a social media post

Description automatically generated]()**Figure 13 : Detecting Guest face**

![A screenshot of a cell phone

Description automatically generated]()

**Figure 14 : Send Notification to LINE Application**

Also, it can detect body temperature by Temperature sensor and show the value in real-time on the Web APP. And when they press the Doorbell switch will ring the bell and send a notification to the Web APP with message “ Someone ring the doorbell ”. We can see the face of the guest and the body temperature of the guest in real-time on the Web APP. Then we can press the Gel pump to release Gel and decide to unlock the door and open the door for guests via pressing a button on the Web APP. For detecting things passing through the front door by Motion Sensor , it will alert on Web APP with message “ Detecting Something !!! ” in real-time when detecting anything passing around the front door and we also has the feature to detecting when host gone outside it will Alerts on Web APP with message “ Host gone outside !! ” and the air conditioner will ![A screenshot of a cell phone

Description automatically generated]()Turn Off as Show in Figure 12.

**Figure 15 : Show the Alerts on Web APP**

![A screenshot of a cell phone

Description automatically generated]()There are other functions, which are to check the exterior of the house, such as humidity detection , temperature detection , and PM 2.5 detection It will read the value of humidity, value of temperature, the value of PM2.5, and have Date and Time show on Web APP in real-time. Also Show in Graph too.

**Figure 16 : Show the Value that detecting**

**![A picture containing green, sitting, street, white

Description automatically generated]()![A screenshot of a cell phone

Description automatically generated]()Figure 17 : Show the Graph chart in Real-time**

**How to memorize the face into the System.**

First you will see that the system detects my picture as guest because, I didn’t add my face into the system.

**![A screenshot of a social media post

Description automatically generated]()**

**Figure 18 : Detecting as Guest**

Then first step is prepare your picture about 5-10 pictures. Move all picture together in Folder : “ facedata ” and run the training.py and wait for a moment to memorize the face into the system.

![A screenshot of a cell phone

Description automatically generated]()

**Figure 19 : Move into folder**

**![A screenshot of a computer

Description automatically generated]()Figure 20 : Running training.py**

Then it already saves my face into the system. The detecting face must detect me as the host now. Show in the Figure below.

![A picture containing screenshot

Description automatically generated]()

**Figure 21 : Detecting as Host**

V. Conclusion

In this document, the design and implementation of Smart Door for various types of features. This document doesn’t have only hardware architecture is proposed but also software architecture and implementation techniques are described in this document. We use C language to design the firmware of the microcontroller (MCU). Next, the hardware design is presented using program Proteus and show monitoring on the Web APP. The flowchart of the system operation was discussed in the software architecture.

Overall, the Smart Door project was as successful as expected. But we think that our documents will make others think or be inspired to work on projects like us or improve our projects and we still believe that we can improve this project in the future.