Gesture and Keyword Control of the Smart House

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1. Introduction

In this project, our group implemented the gesture and keyword control system of the smart house. This control system makes the features of the smart house to be more convenient and adds extra layer of security. The project consists of the breadboard with implemented logic using Arduino Mega and additional components integrated into the cardboard house model. The gestures and keywords are recognised by the Python script that utilizes Picovoice Porcupine, CV Zone, and face recognition modules.

2. Aim

The goal of the project is to create a smart house system that would significantly increase the comfort of people living in it. One additional goal is to utilise the face, voice and gesture recognition system to add additional layer of security.

3. Materials and Methods

1. Arduino Mega;
2. Breadbord;
3. Webcamera: for gesture and recognition;
4. Cardboard: to construct the house model;
5. LEDs: lightning in the house;
6. Laptop with GPU: to run deep learning models locally;
7. I2C LCD display: display temperature in the house;
8. Servo Motor: for the automatic front door opening;
9. A4 paper: to construct the house model.

4. Results

We aimed to create a smart house that can be controlled with only gestures and voice. That's why the most time consuming step was the code implementation.

We located the Arduino Mega on the outer side of the wall so that it doesn't take extra space inside of the house. The LEDs are placed on the breadboard, which is attached to the wall.

To tighten the security of our smart house, we added the face recognition system. Only the registered users can gain access to the controls of the house. The lights and temperature are controlled with the gestures, while the door's motor moves after hearing the voice command.

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4.1. The smart house model and schematic illustration

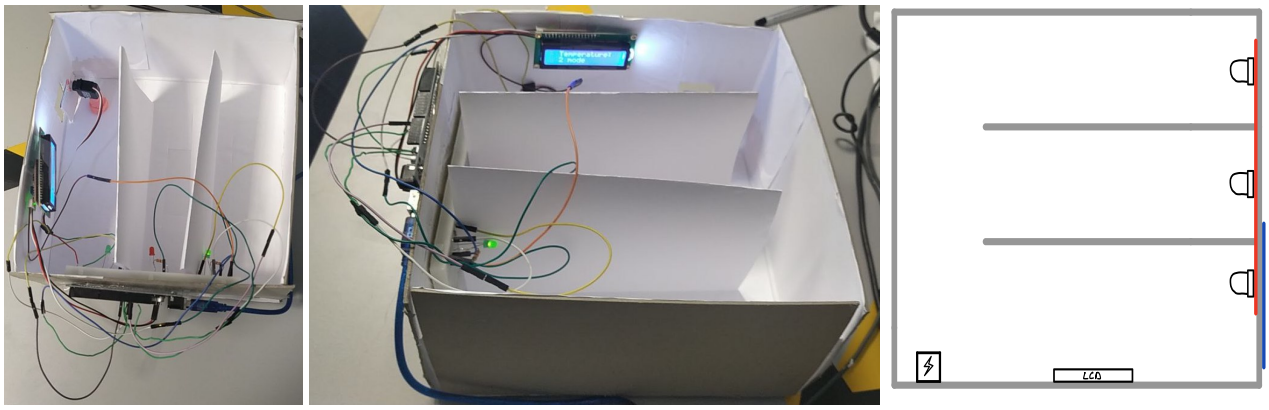

Figure 1: The real-life smart house prototype (on the left & center), and the schematic (on the right).

4.2. Gestures to control the smart house

If the the user is recognized by the face recognition system, then he/she can control the lights in rooms and the temperature with gestures.

4.2.1. Gestures to control the lights in rooms

To control the lights in the rooms, we used the gestures shown in the pictures below. The gestures depicted in figures 1, 3, 5 activate the LED and turn on the light in rooms 1, 2, 3, respectively; the gestures depicted in figures 2, 4, 6 turn off, deactivate the LED and turn off the light in rooms 1, 2, 3, respectively. These gestures must be shown with the right hand.

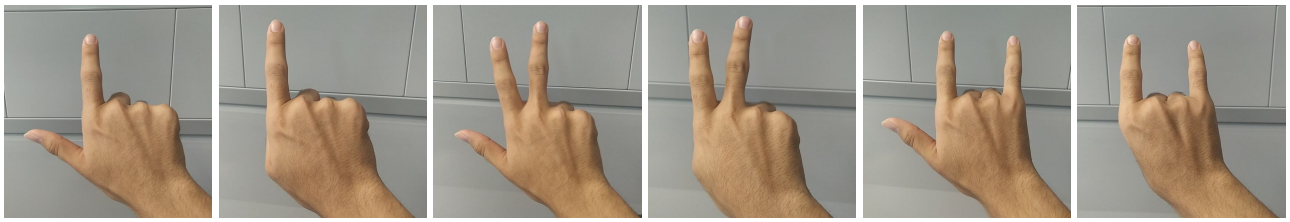

Figure 2: Gestures for lights control.

4.2.2. Gestures to control the temperature in the house

The temperature level is easier to control. In order to set the desired temperature a user need to show the necessary number of fingers of the left hand. For example, the pictures 1, 2, . . . , 6 correspond to the temperature levels 0, 1, . . . , 5.

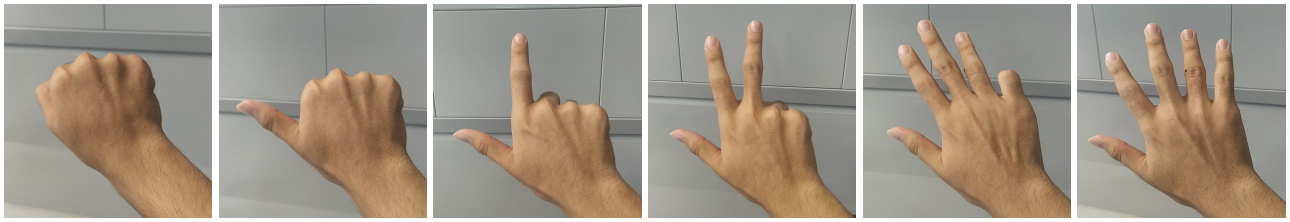

Figure 3: Gestures for temperature control.

4.3. Keywords to control the door motor

To open the door, the user is asked to pronounce the ”Alexa” keyword. The keyword ”Bumblebee” allows the user to close the door. Again, it will work if and only if the user's face is recognized by the system.

4.4. The cost of the components

Component	Cost in dollars
Arduino Mega	$6.99-$13.99
Breadboard	$0.275-$0.60
M-F kit	$0.55
Servo motor	$0.50-$1.20
I2C LCD display	$1.10
M-M kit	$0.30
Nvidia GTX 1660 Ti	$580 - $699
Total Cost	$589.715 - $716.74

Table 1: The price of all components used in the project taken from Alibaba.com.

4.5. The Code

The project code, including the Arduino sketch and the Python script, is available in the following Github repository: github.com/armanbolatov/robt206_project.

5. Discussion and Conclusions

Our main goal during the project was to integrate face, voice and gesture recognition system into the smart house. At the initial stage of our project we only used gesture recogniser as a control system of the smart house, but it happened to be inconvenient in some cases (such as opening the front door). So, we integrated voice recogniser as a system to open the front door.

The next challenge was the security of the house. The house model that we already have was not secure and could be controlled by other people not from this household. The solution was to integrate face recogniser that allowed other components of the control system to work only if the user's face is recognised.

We also had difficulties installing the necessary libraries for the deep learning modules and connecting the model

to the GPU on the laptop.

6. Student Contributions

Arman Bolatov programmed the code for the gesture, voice and face recognition systems.

Daria Gole, Aruzhan Sabyrbek built a house prototype and tested each component.

Every team member was actively involved in fixing bugs and circuitry problems we encountered on the way.