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| **Class:** | EE498 Senior Design II | | | **Semester:** | Spring 2020 |
|  | | | | | |
| **Group members:** |  | **Project topic:** | *Keyless-Entry Door Using Facial Recognition* | | |
| *Adrian Ruiz*  *Bryan Takemoto* |  | | | |
| **Document:** | Progress report I | | |

**Abstract**

The Keyless-Entry Door (KED) using facial recognition is developed to provide security and convenience to the front door. Using a camera, the KED captures images of the person’s face and verifies the identity using a convolutional neural network. Once the system verified the person’s identity, the KED unlocks the door using a motor. This gives the impression of a seamless entry as if the door was not locked. If the KED concludes that the identity of the person is invalid, the door remains locked. Inspired by *smart homes*, the KED aims to be integrated into this system. For instance, if a *smart smoke alarm* detects a fire in the house, the *smart smoke alarm* will automatically signal the KED to unlock the door for firefighters, thus, saving the firefighter the trouble of breaking down the door. Unlike traditional locked doors, the KED has sensors to detect unusual amount of forces applied to the door. If the force is large enough, the KED alerts the authorities of a possible break-in. Although facial recognition is the primary method to unlock the door, the KED offers keypad and manual entry with key. An application of the keypad is that couriers can use a temporary key code to open the door and safely drop off valuable packages inside the house. As more embedded systems are integrated into daily lives, the KED pursues to be part of this future market. Hopefully, the KED will see itself as an early adopter to *smart homes*.

**Current state of the project**

Currently, we have the RPi communicating with the ATMega328 and a facial recognition program running on it. The ATmega328 works as a secondary microcontroller to monitor the accelerometer, reads inputs from the keypad, and controls the stepper motor. For facial recognition, first we train a CNN on a separate device. We then transfer the CNN model onto the Pi for use. When the camera attached to the Pi recognizes a face, it sends the frame from the video to the CNN, and the CNN returns a confidence value. If the confidence value is high enough (i.e. how confident the CNN recognizes a person), a recognition is made.

With regards to the CNN, there is a possibility of a false positive, and the program executes slowly on the pi. We fix the false positive problem by testing multiple frames. If a set number of frames return positive, then the recognition is a success. In terms of speed, sending a frame through the CNN also takes about 30 seconds to return a value. We have a couple solutions for this problem. We believe loading and running Raspbian on a SSD will increase the speed of execution of our program and increase the speed of pi in general. Another idea is to run a version a Raspbian without the GUI which could relieve stress on the CPU. Another possibility to increase execution time is to use a different CNN. We are currently using FaceNet which is accurate but at the cost of being very CPU intensive. We are currently looking into other models such as OpenFace. We could also implement socket programming. With a server doing the calculations, the pi would only have to send a frame from a video and receive the confidence result of the CNN.

**Current state and roadmap of the project**

|  |  |  |  |
| --- | --- | --- | --- |
| **Completed steps** | **Step completed** | **Date completed** | **Comment** |
| **Hardware(motors, keypad, etc)** |  |  |
| **Facial Recognition** |  |  |
|  |  |  |
|  |  |  |
| **Incomplete steps / planned goals** | **Step/goal** | **Date to be completed** | **Comment** |
| **Door Model** |  |  |
| **Increasing Speed of Program** |  |  |
|  |  |  |
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|  |  |  |

**Current problems**

|  |  |  |  |
| --- | --- | --- | --- |
| **Problem** | **Severity** | **Idea(s) how to solve** | **Comment** |
| **False Positive** | Easy | Repeated Checks |  |
| **Slow Execution Speed** | Moderate | Moderate |  |
|  |  |  |  |

**All roles in the project**

|  |  |
| --- | --- |
|  | **Required skills** |
| **Role 1** | Microcontroller Programmer |
| **Role 2** | Facial Recognition Programmer |
| **Microcontroller programmer** | * Knowledge of ATMEGA328 microcontroller * AVR Studio experience |
| **Facial Recognition Programmer** | * Knowledge of CNNs * Knowledge of Python |

Table 3. Roles & skills

**Team member roles**

|  |  |
| --- | --- |
|  | **Roles assigned** |
| **Team member 1** | Bryan Takemoto |
| **Team member 2** | Facial Recognition Programmer |

**Members’ tasks**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Contribution of the member to each task 🡻** | | |  |
| **Member name 1** | **Member name 2** | **Member name 3** | **Task/step completed? (yes/no)** |
| **Task/step 🡻** |
| **Microcontroller/ Hardware Setup** | Bryan Takemoto |  |  | Yes |
| **Schematic** | Bryan Takemoto |  |  | Yes |
| **Facial Recognition** | Adrian Ruiz |  |  | Yes |
| **Door Model** | Bryan Takemoto |  |  | No |
| **Socket Programming** | Adrian Ruiz |  |  | No |

**Current Timeline**

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| --- | --- |
| **Week** | **Actions planned** |
| #7 (Feb.26-Mar.4) | * Demonstrate a working breadboard prototype * Work on laying out the PCB * Work on constructing the door |
| #8 (Mar.5-Mar.11) | * Work on laying out the PCB * Work on constructing the door |
| #9 (Mar.12-Mar.18) | * Work on laying out the PCB   Work on constructing the door |
| #10 (Mar.19-Mar.25) | Demonstrate the PCB layout |
| #11 (Mar.26-Apr.1) | * Send PCB out for fabrication * Work on final report   Work on movie |
| #12 (Apr.2-Apr.8) | * Assemble the PCB (continue to work on it as needed)   Register for “How to Effectively Create Research Posters” workshop |
| #13 (Apr.9-Apr.15) | * Attend “How to Effectively Create Research Posters” workshop   Start work on the poster |
| #14 (Apr.16-Apr.22) | * Work on poster * Work on final report * Work on movie   Work on powerpoint presentation |
| #15 (Apr.23-Apr.29) | * Demonstrate assembled PCB to the instructor * Submit the poster for confirmation * Work on powerpoint presentation   **Prepare for Senior Design Competition on 5/8** |