

<b>Class:</b>	EE498 Senior Design II	<b>Semester:</b>	Spring 2020
<b>Group members:</b>	<b>Project topic:</b>	Keyless-Entry Door Using Facial Recognition	
Adrian Ruiz Bryan Takemoto	<b>Document:</b>	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 monitors the accelerometer, reads inputs from the keypad, and controls the stepper motor. For the facial recognition program, we first train a CNN on a computer. Next, we transfer the CNN model onto the RPi. Then, the RPi's webcam captures a frame of a person's face which is then processed by the CNN. Finally, the CNN will return a confidence value that is used to determine if the person is valid or not.

Regarding to the CNN, we are faced with one big problem with its current implementation. The issue is that the CNN is computational heavy for the RPi. Our present CNN is using a neural network called Facenet. The primary advantage of using Facenet is its accuracy, but at the cost of speed. We plan on trying a different CNN that is lighter than Facenet while acknowledging the risk of false positives. Another solution is continuing to use Facenet but replace the video stream with image capture. The justification for this is valuing accuracy to avoid false positive from Facenet over video.

After fixing our CNN problem, our next phase is to get a door constructor and begin testing the accelerometer. For now, the accelerometer is not configured to alert the RPi of excessive force. It only measures the acceleration for the RPi to display and performs no further action. Once the door is constructed, we will extend the functions of the accelerometer by having the RPi alerting the user of a break-in.

Although our project's state is not satisfactory in terms of the speed of the CNN, it has achieved our goal of using facial recognition to open the door. We will continue to improve it from this point on.

## Current state and roadmap of the project

Completed steps	Step completed	Date completed	Comment
	Key Management	2/8	The RPi can generate keys and periodically check if an expired key need to be removed from the list.
	Motor and Accelerometer	2/15	Both motor and accelerometer are programmed to be controlled by the RPi. Again, accelerometer is programmed to record the acceleration but lacks actions to react to a break-in.
	Facial Recognition	2/15	As stated, we have a working CNN but it's very slow. We will continue to work on finding a faster CNN or optimize our current one.
Incomplete steps / planned	Step/goal	Date to be completed	Comment
	Construct a Door	3/7	A small door will be constructor so we can attach our circuit to it.
	Improve CNN Performance	3/1	Finding alternative solutions to improve our current CNN or replace completely (if a different CNN is more favorable).
	Accelerometer	2/28	Needs to react to a break-in.

## Current problems

Problem	Severity	Idea(s) how to solve	Comment
Accelerometer	Easy	Program it to react to a break-in	After the door is completed, we will attach the circuit to the door and begin testing the sensitivity of the accelerometer. Once we capture the "break-in" sensitivity, we'll program the RPi to print a message of a possible break-in.
CNN Performance	Moderate/High	Optimize our current CNN or find a better one.	Although we have a working CNN, we wish to optimize it or find a better one that can support video stream. If we can't, we plan on switching the video feed to a single image capture using a button.

## All roles in the project

	Required skills
<b>Role 1</b>	Microcontroller Programmer
<b>Role 2</b>	Facial Recognition Programmer
<b>Microcontroller programmer</b>	<ul style="list-style-type: none"> <li>▪ Knowledge of ATMEGA328 microcontroller</li> <li>▪ Knowledge of Raspberry Pi programming</li> <li>▪ AVR Studio experience</li> </ul>
<b>Facial Recognition Programmer</b>	<ul style="list-style-type: none"> <li>▪ Knowledge of CNNs</li> <li>▪ Knowledge of Python</li> </ul>

Table 3. Roles & skills

## Team member roles

	Roles assigned
<b>Team member 1</b>	Bryan Takemoto
<b>Team member 2</b>	Facial Recognition Programmer

## Members' tasks

	Contribution of the member to each task ↓			
Task/step ↓	Member name 1	Member name 2	Member name 3	Task/step completed? (yes/no)
<b>Microcontroller/ Hardware Setup</b>	Bryan Takemoto			Yes
<b>Schematic</b>	Bryan Takemoto			Yes
<b>Facial Recognition</b>	Adrian Ruiz			Yes
<b>Door Model</b>	Bryan Takemoto			No
<b>Improve the CNN</b>	Adrian Ruiz	Bryan Takemoto		No

## Current Timeline

Week	Actions planned
#7 (Feb.26-Mar.4)	<ul style="list-style-type: none"> <li>▪ Demonstrate a working breadboard prototype</li> <li>▪ Work on laying out the PCB</li> <li>▪ Work on constructing the door</li> </ul>
#8 (Mar.5-Mar.11)	<ul style="list-style-type: none"> <li>▪ Work on laying out the PCB</li> <li>▪ Work on constructing the door</li> </ul>
#9 (Mar.12-Mar.18)	<ul style="list-style-type: none"> <li>▪ Work on laying out the PCB</li> <li>▪ Work on constructing the door</li> </ul>
#10 (Mar.19-Mar.25)	<ul style="list-style-type: none"> <li>▪ Demonstrate the PCB layout</li> </ul>
#11 (Mar.26-Apr.1)	<ul style="list-style-type: none"> <li>▪ Send PCB out for fabrication</li> <li>▪ Work on final report</li> <li>▪ Work on movie</li> </ul>
#12 (Apr.2-Apr.8)	<ul style="list-style-type: none"> <li>▪ Assemble the PCB (continue to work on it as needed)</li> <li>▪ Register for “How to Effectively Create Research Posters” workshop</li> </ul>
#13 (Apr.9-Apr.15)	<ul style="list-style-type: none"> <li>▪ Attend “How to Effectively Create Research Posters” workshop</li> <li>▪ Start work on the poster</li> </ul>
#14 (Apr.16-Apr.22)	<ul style="list-style-type: none"> <li>▪ Work on poster</li> <li>▪ Work on final report</li> <li>▪ Work on movie</li> <li>▪ Work on powerpoint presentation</li> </ul>
#15 (Apr.23-Apr.29)	<ul style="list-style-type: none"> <li>▪ Demonstrate assembled PCB to the instructor</li> <li>▪ Submit the poster for confirmation</li> <li>▪ Work on powerpoint presentation</li> <li>▪ <b>Prepare for Senior Design Competition on 5/8</b></li> </ul>