

**University of Nevada Las Vegas**

**Department of Electrical and Computer Engineering**

**EE498 Senior Design**

Spring 2020

**Project Title**

Final Project Report

**Insert project photo here inside of this box**

**Group Members:**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| Name (Print) |  | CPE/EE/ME |  |
|  |  |  |  |
| Name (Print) |  | CPE/EE/ME |  |

Instructor: Dr. Grzegorz Chmaj

Faculty advisor:

**Table of contents**

All sections and numbered paragraphs must be listed here along with page numbers

**Abstract**

Write few sentences about your project (100-300 words).

Instruction on how to write an abstract: <https://faculty.unlv.edu/chmaj/forstudents#abstract>

**Introduction & background**

* Introduce the reader to the area in which your project is.
* Describe what your project is doing. Include some layman’s terms styled pictures, schematics, diagrams.
* Describe how your product can be used by the user, when, why.
* Give the examples of devices that perform similar/same functions
* Describe the specific aspects of your device, and how is it different/better than other solutions. Do this in layman-terms styled description, try to advertise your product here.
* not less than 1 page

Deep learning and neural networks

Facenet and other alternatives (VGG, OpenFace, etc.)

Google Nest, Amazon Ring, LG Smart door, and more research

FR to open door, key generator, detect force with accelerometer

*Socket programming, app*

KEEP SIMPLE HERE

Layout of the paragraph

1. Small introduction of our product
2. Comparing other products
3. CNN and deep learning
4. FR to open door, key generator, detect force with accelerometer
5. Etc.

Keyless Entry Door(KED) identifies people’s faces in a video stream, compares them to images in a database, and recognizes known faces. If an individual’s face is recognized, the door unlocks itself automatically. Additional features include a key generator which allows entry through a keypad, and a accelerometer to detect a break in. If a break in is detected, KED will alert the user via an email.

Facial Recognition has been implemented in a variety of products and services. One example is the service FacePRO from Panasonic. FacePRO’s matches a person’s face using live video to a database of registered faces and alerts the user of matching faces. It includes up to 20 cameras on a server and up to 30,000 known faces. A similar product is FaceVACS from Cognitec. FaceVACS also identifies peoples’ faces from video streams and recognize known faces. FaceVACs also provides services like frequent visitors, generate demographic statistics, and more depending on the version of the product bought. While both these products recognize people and alert the user, they are not products the general consumer will buy. They are more focused on business and public use. Recently, states have been coming together to ban facial recognition in public settings, so these products might not be available for businesses in most states. Other products that closely resemble our project are smart doorbell products. Standard features of these products are two-way communication, video recording, and motion sensors. Google Nest has the features mentioned above, along with a facial recognition system. The facial recognition is only used to alert the user if a face is recognized.

Our project is different from the above-mentioned products.

The products above do not mention how they perform facial recognition, but we assume they use deep learning, like our project, in order to the accuracy they mention. Deep learning is a class of machine learning in which neural networks are used to extract information from input. A convolutional neural network (CNN) consists of an input layer and an output layer, along with multiple hidden layers. For our project, an image of a face is sent into a CNN, and its features are extracted as it goes through each of layer of the CNN. It returns a probability that the face in the image is a certain person. There is also different CNN models and each are designed for a specific input. We chose the FaceNet model, since it specializes in facial recognition. It unique in the fact that it is two CNNs connected. One CNN to optimize facial embeddings, while the other CNN extracts information from the facial embeddings. We give the model an image of specific person, which FaceNet uses as anchor for calculations. When an image is passed in, FaceNet calculates how close that the image is to the anchor. We use the probability calculated to determine whether to unlock the door. The user can also use the keypad to unlock the door. The passcodes are randomly generated and expire in order to increase the security.

**Current Market Solutions**

* Describe the market: is the device popular, consumer, specialized, seen only in the industry etc. Find out how many is sold each year, etc.
* Table containing the comparison of parameters, functions, prices – is very welcome.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Vendor** | **Video Resolution** | **Misc.** | **Facial Recognition** | **Function 2** | **Price** | **Comment** |
| **FacePro** | PanaSonic | NA | Up to 20 Cameras per Server | In-House algorithm  Above 90 percent accuracy |  | TBD by User | Needs to be ordered and installed by Vendor |
| **Google Nest**  **Hello** | Google | 1080p | Enables two talk communication | Recognizes faces and sends alerts to user |  |  | Needs to be ordered and manufactured by vendor |
| **KED** | You | 1080p | Email Alerts of break in | FaceNet  Highly accurate |  |  |  |

Table 1. Comparison of available devices

In the table, indicate the best parameter value for each device. (e.g. for Param 1, the row corresponding to Device 2 is highlighted, as it has the best value of Param 1 among all listed devices).

* Include table that contains the pros and cons of each device listed in Table 1. The table below contains the examples – insert your own there. But leave 'Strengths' and 'Weaknesses'.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Resolution** | **Battery life** | **Price** | **…** | **Strengths** | **Weaknesses** |
| **FacePro** | NA | Long | Very high |  | * High Amount of Security * Massive amount of Saved Data | * High price * Public Installation is illegal in some states |
| **Nest Hello** | HD | Long | Affordable  ($229) |  | * Long battery life * Affordable price | * Low resolution |
| **KED** | HD | NA | Affordable  ($240) |  | * High resolution * Low price |  |

Table 2. Strengths and weaknesses of available devices

**Research results**

Describe the research work you have done for your project, exclude the market research that is provided above. Research results could contain, for example, parameter testing, why the camera you wanted to use was bad, why you had to use that specific microcontroller or why the power supply that you wanted to use was not suitable.

**Specification of the project**

**Functionality & conceptual design:**

* Use diagrams and descriptions to describe **how** the device is working and **what** it is actually doing (use flow/case diagrams)
* Include use-cases:
  + You have actor1 doing action A, the system responds with the response A'
  + You have actor2 doing action B, the system responds with the response B'
  + (example) actor=user walks into the kitchen and says "coffee". System starts the coffee-maker and pours the coffee in the mug.
* Block diagrams must be here
* Modular description must be here

**Architecture:**

* Focus on architecture details in this section: describe each object and all signals
* Start with architecture overview. Provide high-level diagram, describe each component briefly, including: input(s), operation, output(s)
* Start the paragraph for each component, describe it and then expand the component into lower level, providing the diagram for that too. Repeat expand until you reach desired details level.
* Conclude with the diagram containing all the objects expressed at low level.
* All architecture details should be described in this subsection: objects, their inputs/outputs, relation to other objects.

**Design**

* Focus on the technical details in this section. Include all schematics, drawings, pictures etc. Each object mentioned in 'Architecture' should be explained here with:
  + The implementation of the object: electrical, programming, mechanical
  + Signals coming in: what type of signal, protocol used (if any), interfaces, electrical parameters etc.
  + How the object is implemented in details:
    - If you have the schematics, provide it here
    - If you have the algorithm that you will use as object implementation – provide it here
* If possible, provide schematics (or other implementation) for both high and low level objects.
* If you have PCB design, include it in this section along with the corresponding schematic.

**Simulation**

Include any simulation results that you did so far for this project (if applicable)

**Testing**

Provide the description of how to test your device, when it will be finished

* Inputs / actions to the device
* Expected outputs or reaction of the device

If you did any tests (either tests of prototype, or just some component) – include test procedure and results in this section.

**User's manual**

Write the user's manual for the end customer: how to setup, use, how to connect, etc.

**Step 1**

Connect the motor, keypad, RPi, and reed switch to the appropriate ports on the printed circuit boards

**Step 2**

Connect the Camera and AC adapter to the RPi. Connect the RPi to a monitor/TV. Power up the RPi

**Step 3**

Either take a frontal picture of your face with included camera or import a picture and save it in the KED folder on the RPi. Make sure the picture of your face is well lit with even lighting.

**Step 4**

Close out of the KED folder and open a terminal on the RPi. Navigate to the KED folder and run the KED main program

**Step 5**

After KED boots up, the main menu is displayed on the monitor. Displayed are different actions that can be performed.

**Step 6**

For set up, navigate to “ARM/DISARM the security.” This toggles the security of KED. If the disarmed, KED will not send an email alert to you in case of a break in. It is strongly advised to keep this option on.

**Step 7**

Navigate to “Generate Key” option. Selecting this option will open the key generator menu. Keys are another option of unlocking KED. Keys have an expiration date. You can select what time and how many days the key will be expired. The type of key can be also changed here like if this a key for a friend/family or for type of courier. If the numbers in the key is not to your liking, the key’s numbers can be randomized with the regenerate command. 10 keys is the limit that you can use.

**Step 8**

Exit the Key menu. Navigate to the “Settings” option. The sensitivity of KED can be changed here. Higher Sensitivity makes it easier for KED to recognize your face, but it is more likely to trigger false positives. Accelerometer sensitivity can also be changed here. Higher Sensitivity leads to can detect break ins better at the cost of more false positives.

**Roles & skills in the project**

Provide all the roles with skills, required in the project. Relate each role with the objects present in *Architecture* section. Each object from *Architecture* section must be listed in this table.

|  |  |  |
| --- | --- | --- |
|  | **Objects involved** | **Required skills** |
| **Role 1** |  |  |
| **Role 2** |  |  |
| **Microcontroller programmer** | * Camera image analyzer | * Knowledge of ATMEGA168 microcontroller * C++ programming * AVR Studio experience |
| **Image processing specialist** | * Camera image analyzer | * Knowledge of image processing algorithms |
| **CAD designer** | * Device case | * CAD skills sufficient to design the device case |

Table 3. Roles & skills

List all the roles mentioned in Table 3 and assign names of team member to each role:

|  |  |
| --- | --- |
|  | **Assignment** |
| **Role 1** | Name |
| **Role 2** | Name |
| **Microcontroller programmer** | John Smith |
| **Image processing specialist** | Walter White |
| **CAD designer** | Kate Brown |

Table 4. Roles assignment

**Parts list**

Include datasheets as attachments if you have them (Att. id is the attachment id – for example: “1” means “Attachment 1”. Collect all the attachments as PDF files. Merge all the attachments to the final report, so they are at the end of document in the numbered order.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Parameters** | **Picture** | **Att. id** |
| **Part 1** | Par1, par2, par3… |  |  |
| **Part 2** | Par1, par2, par3… |  |  |
| **Microcontroller** | ATMEGA168 (attachment 1) | http://www.mattairtech.com/media/catalog/product/cache/1/image/9df78eab33525d08d6e5fb8d27136e95/d/i/dip28.jpg |  |
| **…** | … |  |  |
| **…** | … |  |  |

Table 5. List of required parts

**Project timeline**

Include general past project timeline – what happened when

* Add any interesting information
* Add the delays if solving the problems causing delays was interesting

**Final remarks**

Include anything related to the project that you want to add/mention.

**References**

Include all the documents that you cited / referred to in the whole document

[1] B. Marshall, The study of surveillance cameras,

**Marketing flyer**

Prepare the marketing flyer – at least 2 pages (so it could be printed both-sides). Include buzzwords, key functions, large, good quality and good looking pictures. Use only layman’s words in this section. Start marketing flyer at the top of new page. This flyer can be later used during the Senior Design competition day – you would just have to print it.

**Consider this template as a guideline, not as a form that you fill. Each of elements above must be included (if applicable), but I encourage you to extend this with anything that you consider worth to place in this report. Don't send the report with just tables filled and few sentences of description. This report needs to be a comprehensive description of what you have done during the semester and as complete as possible manufacturing/technical manual describing your device.**

Include all the information that you submitted in progress reports or any previously submitted documents.

Combine all the documents (diagrams, attachments etc) into one single PDF file.

The final report is the maximum comprehensive description of your project – include everything about it. Include all technical details.

Remember to name your file using the following syntax:

LastnameLastname-Project\_topic.docx

(Acceptable file formats: doc, docx, pdf).

**Remove all text in green.**