Report #1, Part #3 (Modified): Home Security Automation
Group 2
14:332:452:01:00614 Software Engineering

Harmit Badyal

Nikunj Jhaveri

Abhishek Kondila

Kaavya Krishna-Kumar

Kaushal Parikh

Miraj Patel

Nirav Patel

Andrew Russomagno

Sagar Shah

Ashwin Suresh

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Website: https://sites.google.com/view/ruhome2019/home

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1   Modifications from Original Full Report

1. Changed formatting of entire report for ease of examination.

2. Altered Individual Contributions Breakdown for Project Management.

3. Included hand-drawn sketches to elaborate on on-screen appearance requirements.

4. Rounded use case points number down to a whole number instead of leaving it as decimal.

2 Individual Contributions Breakdown

	Sagar	Ashwin	Andrew	Abhishek	Nikunj	Miraj	Kaavya	Harmit	Kaushal	Nirav
					Team Member Name					
Project Management	5%	10%	5%	5%	10%	10%	10%	10%	25%	10%
Customer Problem Statement	25%	25%	5%	5%	13.3%	13.3%	0%	0%	0%	13.3%
System Requirements	0%	0%	0%	0%	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%
Functional Requirements Specification	0%	26%	0%	0%	5%	26%	20%	23%	0%	0%
User Interface Specification	0%	0%	0%	0%	33.3%	0%	0%	0%	33.3%	33.3%
Traceability Matrix	0%	45%	0%	0%	0%	45%	0%	10%	0%	0%
Domain Analysis	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Project Size Estimation	0%	33.3%	0%	0%	33.3%	33.3%	0%	0%	0%	0%
Plan of Work	0%	33.3%	0%	0%	33.3%	33.3%	0%	0%	0%	0%
References	5%	5%	5%	5%	21.7%	21.7%	5%	5%	5%	21.7%

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3   Customer Problem Statement

3.1   Problem Statement

Despite what some people are inclined to believe, we live in a time in a world where anything is possible at any given moment. In this age of terror, we have been constantly looking over our shoulders watching out for ourselves and the ones we love. No matter what we do to protect ourselves and our property, there is always that fear in the back of our minds that we are not protected enough, and have left ourselves vulnerable to unwanted incidents. If cost weren't a factor, and if accessibility weren't an issue, everyone would without a doubt want to get their hands on an advanced home security system that would allow them to be more cognizant of household threats and be able to better micromanage devices in their own home. There are a lot of products out there that that we could use to make our homes more secure, but wouldn't it be so much more convenient to have access to a singular application that could give us the ability to control multiple devices? Having a system consisting of a network of motion-sensors, cameras, lights, and speakers with the ability to work together would without a doubt help to scare off potential and actual threats. In addition to the security benefits that inherently would come with the utilization of our product, we have taken it upon ourselves to go one step further and implement enhanced facial recognition technology to be able to better determine if unrecognized visitors to the house are safe or are potential threats.

With our product, we aspire to make the consumer feel as safe in their home and to have them feel confident in their ability to protect their own home. Being able to have manual control of our homes from our wireless devices is a gamechanger, especially with how nearly everything today can be controlled by our smartphones. With our enhanced facial recognition feature, we want to make it easier for the user to be able to identify potential threats and also to be able to reduce the number of false alarms that the system may trigger. For example, we don't want systems going off multiple times in a day because of a person, whether it is the user itself or the user's friends or family, forgetting to disarm the system before entering the house. The facial recognition feature has the ability to filter people who come up to the front door, determine if they are a recognized person, and if not, upload the intruder/unknown individual's picture to the database, allowing for the user to extract the image from anywhere with internet connection, and if necessary, manually call the emergency services. We believe that with our enhanced facial recognition feature, we will able to reduce the number of home burglaries that occur with the installation of our arducam with our home security system. Even if our system doesn't deter threats, we will be able to capture images of the intruders, and with the cooperation of local police departments, we believe that you will feel much safer knowing that it will be easier to trace down perpetrators. With one singular application controlling various devices all on a singular network, and with the facial recognition feature, we not only eliminate a majority of false alarms to the user, but also allow the user to be more aware of who is setting off

the alarms upon entering the house.

Our system is comprised of a base unit, a mobile application, and a motion sensor that can trigger various devices, including lights, an alarm (built-in feature on base unit) and cameras. The camera will be able to take a picture whenever the motion sensor detects movement. Ideally, the camera would be installed facing the point of entry in order to potentially capture the intruder's face. With the use of the mobile application, the user can wirelessly connect to the base unit when connected to the same wifi network, and request for a picture from the camera. This is especially useful when there are suspicions of an intruder trying to break in and would help scare off the threat and identify the criminal, all without even having to move from where you are. As a customer, this feature minimizes risk of having to deal with a violent criminal face-to-face, and gives them better information if they would like to call the authorities and report the incident. This feature would also come in handy if the user just wanted to check if the door was not properly closed. The lights and alarm work similarly, in that when the security system is engaged, if movement is detected by the motion sensor, the lights will turn on and the alarm will ring. We also plan to implement an "away mode" feature which would automatically turn all the lights off and turn on the motion sensor detection functionality when activated. This is especially useful for users who have left the house and do not recall if they turned off all the lights before leaving. Once the system is engaged by the mobile application, or the base unit before leaving, the customer can be confident that their home is not only more secure, but also saving a lot of energy with reduced electricity consumption. We also plan on implementing a "home mode" feature, in which the motion sensor movement detection which we have to trigger the alarms and cameras will be deactivated, and turn the lights on. Below is a summarized list of features we plan to implement with our system:

- Devices

    - Camera

        * Take picture manually through app
            · Substitution for live feed
        * Take a picture when non-recognized face detected
            · Low priority
        * Disable/enable motion sensor

    - Lights

        * On/off manually
        * On/off when motion sensor tripped

- Alarm

    - Off by default

- On when motion sensor tripped
- Disable/enable motion sensor

- Base Unit

  - Turn on/off light
  - Turn off alarm
  - Take Picture
  - "Away Mode"
    * Turn off lights, activate motion sensor
  - "Home Mode"
    * Turn on lights, deactivate motion sensor

- Mobile app (Android)

  - Used when away from base unit
  - Sign-in (added feature of fingerprint authentication for fingerprint-enabled phones)
    * Turn on/off light
    * Turn off alarm
    * Take picture
    * "Away Mode"
    * "Home Mode"
    * Profiles (parent/child)
      · Low priority
    * Call cops/primary contact
      · Low priority

- Connection between base and phone

  - Wifi Shield connected to Arduino
    * Allow for multiple client interaction
  - Phone connected to shield's SSID
  - Client-server (adding phones to WiFi network

A key factor that will differentiate our system from the rest of the competition is the facial recognition functionality. The mobile application will also be able to call the cops or a saved emergency contact, if the user were ever to feel unsafe in their home so they can quickly get the assistance they need.

Currently, the field for home security systems is disparate and small, with only a few companies that have developed solutions to home security. We have noticed that all of

these solutions are proprietary and do not necessarily work with other systems. We also found that the prices of these bundles sets are unreasonably high, likely determining value based on the promise of security rather than the actual costs of research and development. Our product provides a different angle to home security, by allowing for the integration of various components such as cameras, motion sensors, lights, and alarms, and making it much more cost-effective. We also provide more advanced features than most of these systems currently on the market with our facial recognition feature, making our system one of the most innovative out there.

The market leader in home security is SimpliSafe's Home Security System (https://simplisafe.com/build-my-system), which runs close to $300, including only a base unit that contains the alarm, a key fob, few entry sensors, and a motion sensor, with the ability to purchase a camera for an additional $100. The functionality of this base unit is extremely limited; only alarming the user if the system is tripped by motion while engaged. The user would be able to disengage the system with the included key fob.

This system, the market leader right now, is neither modern nor convenient. Interaction with the system is strictly button based. Our solution would allow for disarming of the system via facial recognition, revolutionizing how we view modern day home security systems. The key fob is not convenient at all, as homeowners will likely not be carrying around the fob when they are in the house. With the development of mobile technology in the past decade, we believe it is crucial to have control of our home security system via mobile application. With our solution, the homeowner and any other member of the household can interact with the security system through the mobile application. With the omnipresence of mobile technology, and with our smartphones in today's era always being within reach, we believe this functionality will truly change the way consumers think about home security systems and make it much more user-friendly.

We will be using mass-produced, common hardware to solve the security issue. We will be able to keep costs down significantly, at approximately half the cost of SimpliSafe's camera bundle Home Security System. This makes our product appealing for all home owners and tenants, because of our ability to provide a feature as inaccessible as home security at a significantly reduced cost. Customers that previously decided to not invest in home security because of the initial costs will now be able to invest in our system and implement it within their homes, making their lives that much easier.

The absence of fear enables people to continue doing the great things that they love to do. We hope to make safety and security an afterthought for all, but still easily accessible when necessary. Our system accomplishes this mission, inspiring confidence and comfort to all.

3.2 Glossary of Terms

HCI: Human computer interaction (back-end or with user).

HUI: Handset user interface through the mobile app.

Arduino Base Unit (ABU): The Arduino Mega is a microcontroller electronic board. Its list of specs contains 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It possesses all the needed support for the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila. This device is used to control the other hardware pieces of the security system such as the lights, alarm, camera, motion sensor and gyroscope.

Security System: Refers to the entire unit as a whole which is composed of the Arduino, lights, alarm, camera, motion sensor, gyroscope, and the mobile app.

Mobile interface/ User Interface(UI): A web-based interface converted for the user's Android smartphones, where they can view and execute operations through the application. These operations can include: device manipulation, system settings, personal information management, and system maintenance.

Properties of security: Refers to features such as confidentiality, authenticity, and/or integrity of transferring secure information.

Away Mode: Camera is on, alarm is on. Lights are on/off depending on the customer's choice

Home Mode: Camera is off, alarm is off. Lights are on/off depending on the customer's choice.

FireBase: Google's mobile platform that helps you quickly develop high-quality apps and store data.

Database: A collection of information that is organized so that it can easily be accessed, managed, and updated to suit the needs of the data. Said data can be classified based on the types of content: graphic, text, numeric, etc.

Facial Recognition: A method of identifying or verifying the identity of an individual using their face.

Unrecognized Visitor: An individual who does not have his/her face registered on the security system.

Recognized Visitor: An individual who has his/her face registered on the security system.

Gyroscope: A device used for measuring or maintaining orientation and angular velocity

Arducam: A camera shield available for Arduino devices that can be utilized to take pictures.

Motion Sensor: A device used to detect if there is motion in front of it.

User/Owner: An individual with access to the mobile app and is able to control the different security features provided by the security system.

User Profile: A personalized profile to interact with the security system for each person that has a registered profile on the security system.

User Privileges/Permission: An ability granted to a particular person who has access to the security system (i.e. Turning on lights and/or setting security modes)

Mobile App: An application that is run on a mobile device to interact with the security system.

Fingerprint Authentication: Using fingerprint to log into a user profile for the security system.

Saved Faces: Faces that have been registered and stored in the database.

4   System Requirements

4.1   Enumerated Functional Requirements

Priority Scale: 1-5 with 5 being highest priority

Identifier	Priority	Requirement	Acceptance Test Cases
REQ-1	5	The system should have an "Away-Mode" where alarm is enabled.	• Test with user activating "Away-Mode" and alarm system subsequently being armed by default (pass).
REQ-2	5	The system should have a "Home-Mode" where alarm is disabled.	• Test with user activating "Home-Mode" and alarm system subsequently being disarmed by default (pass).
REQ-3	4	The Arduino base unit camera shall allow the user to manually take a picture using the mobile app (must be in the same network as the arduino base unit).	• Test with user taking a photo through the mobile app, capturing a real-time event, and subsequently being saved to the mobile app's gallery (pass).
REQ-4	4	The Arduino base unit is connected to a motion sensor that is placed right before the doorstep to sense a motion. When motion is detected, it will signal the Arduino base unit to take a picture.	• Test with triggering motion sensor with human close to Arduino base unit to have picture taken (pass). • Test with triggering motion sensor with human far away (approximately 15 yards) from Arduino base unit to have picture taken (fail).

REQ-5	3	When a picture is taken with the Arduino base unit, the system should run a search to check for a match from a saved faces database on Firebase. If the face is not recognized, the arduino base unit will send a notification to the user through the mobile app.	- Test with triggering motion sensor by human who is in database and is a recognized tenant (pass) - Test with triggering motion sensor by human who is not in database and thus is not a recognized tenant (fail), resulting in a notification being sent to the homeowner's phone (pass)
REQ-6	1	The system shall allow the user to turn the lights on and off manually using the mobile app	- Test with user turning on the lights, and the Arduino base unit powering the lights (pass) - Test with user turning off the lights, and the Arduino base unit turning off the lights (pass)
REQ-7	3	The system (Arduino Base Unit) should be able to turn on the lights after the gyroscope is triggered on the door and turn off the lights after a certain amount of time has passed or when manually turned off by user.	- Test with triggering gyroscope at certain angle to react and notify Arduino Base Unit to turn on lights (pass) - Test with checking to see if Arduino Base Unit will turn off lights after a certain amount of time has elapsed, in the case that the user has not manually turned them off yet. (pass)

REQ-8	5	When the system (Arduino Base Unit) is in "away mode," and the gyroscope is triggered, the alarm shall sound until the user manually turns off the alarm using the mobile app.	• Test with triggering gyroscope while Arduino Base Unit is in "away mode" to see if alarm turns on (pass)
REQ-9	5	When in away mode, the alarm will not sound when a registered face opens the door that triggers the gyroscope.	• Test with recognized person while Arduino Base Unit is in "away mode", and trigger gyroscope to see if alarm stays silent (pass)
REQ-10	5	When in away mode, the alarm will sound if an unregistered face opens the door that triggers the gyroscope.	• Test with unrecognized person while Arduino Base Unit is in "away mode", and trigger gyroscope to see if alarm sounds (pass)
REQ-11	2	The alarm should give the user access to turn off manually through the mobile app.	• Test with alarm sounding off (begin with in ringing) when homeowner turns off alarm system in mobile app (pass).
REQ-12	2	The mobile app shall allow the user to log into the app using a fingerprint identification or a passcode as an extra layer of security.	• Test with user logging in with username and password after setup (pass) • Test with user logging in with fingerprint after setup (pass)

REQ-13	4	The mobile app shall control the camera, lights, alarm and motion sensor.	• Test with user turning lights, alarm, and motion sensor off or on, as well as taking a photo (pass)
REQ-14	4	Independent of "Home mode" or "Away mode", the mobile app shall allow the user to separately enable or disable the camera and alarm functionality.	• Test with user disabling automatic photographing by camera and alarm system (pass)
REQ-15	3	The mobile app should allow for multiple devices to control the system. (Addition/deletion of users).	• Test with users, other than the system admin, controlling and adjusting settings that they have permission for (pass) • Test if users, other than the system admin, can control and adjust settings that they don't have permission for (fail)
REQ-16	2	The system should be able to call 911 in case of emergencies.	• Test with user pressing button and being connected on a call with the police (9-1-1) (pass)
REQ-17	3	The mobile app should allow for user to logout of their user account	• Test with user logging of their account on mobile application (pass)

4.2 Enumerated Nonfunctional Requirements

Priority Scale: 1-5 with 5 being highest priority

Identifier	Priority	Requirement	Acceptance Test Cases
REQ-18	2	When the user turns on/off light by pressing a button in the mobile app, the mobile app will send a signal to the server on the arduino base to toggle the lights.	- Test with user turning on button for lights on mobile application, and system responding by turning on light system (pass) - Test with user turning off button for lights on mobile application, and system responding by turning off light system (pass)
REQ-19	3	When the user enables or disables the motion sensor by pressing a button in the mobile app, the app should send a signal to the arduino base to enable or disable the base.	- Test with user turning on motion sensor through mobile app, then seeing if system responds accordingly by simulating movement in front of Arduino and seeing if it is indicated (pass) - Test with user turning off motion sensor through mobile app, then seeing if system responds accordingly by simulating movement in front of Arduino and seeing if it is not indicated (pass)

REQ-20	3	When the user clicks the "home mode" or "away mode" on the mobile application, the app should send a signal to the system to switch modes.	• Test with user selecting a mode and then having system respond accordingly by turning on/disarming system features (pass)
REQ-21	4	Up to five devices should be able to connect to the server simultaneously.	• Test with 5 users simultaneously changing system settings, such as turning on/off lights, motion sensor, taking pictures, etc (pass)
REQ-22	3	The mobile app should be able to add up to 5 unique user profiles to edit the arduino base system.	• Test with user adding unique user profiles to account (pass)
REQ-23	5	Connection/disconnection to home automation system server should be available at all times through wifi connection	• Test with user keeping mobile app open throughout WiFi connectivity and seeing if changes made through mobile app are received by Arduino (pass)
REQ-24	4	When connected to wifi, the user should be able to access all the of camera and alarm features.	• Test with user keeping mobile app open throughout WiFi connectivity and seeing if pictures can be taken and alarm system can be disabled (pass)

REQ-25	4	System should maintain and be aware of its state (i.e. "away mode" or "home mode") even when the app is restarted on any device.	• Test with user recording current set settings in mobile app, then restarting device, and seeing if settings are maintained (pass)
REQ-26	4	Product should be up to date and usable on the current Android OS platform.	• Test with user with Android device on latest Operating System version if they are able to download mobile app (pass) • Test with user with Android device on old Operating System version (version is 2 years old) if they are able to download mobile app (fail)
REQ-27	4	When using the mobile application , the arduino base should be able to identify and successfully execute the correct task.	• Test with user sending commands of changing settings and capturing photos to Arduino and see if it responds accordingly (pass).

Identifier	Priority	Requirement	Acceptance Test Cases
REQ-28	4	The mobile app should be able to successfully authenticate users through fingerprint authentication or passcode verification. If the wrong fingerprint or passcode is inputted, the app should not let the user in.	• Test with user logging in with correct username/password combination (pass). • Test with user logging in with incorrect username/password combination (fail). • Test with user logging in with recognized fingerprint iD (pass). • Test with user logging in with unrecognized fingerprint iD (fail).
REQ-29	4	When a person walks up to the door and the motion sensor is triggered, the arduino base should take a snapshot of the person and save it to Firebase. The server should compare the picture to those stored in the saved faces album.	• Test with recognized user triggering motion sensor and system identifying correctly (pass). • Test with unrecognized user triggering motion sensor and system identifying as unknown user (pass).

4.3   On-Screen Appearance Requirements

Priority Scale: 1-5 with 5 being highest priority

Identifier	Priority	Requirement	Acceptance Test Cases

REQ-30	5	The User Interface should be created such that every page of the UI is intuitive to the user. For example if they want to view photos taken by the arducam, there is a "photos button" on the UI. Or if they want to put the system in "home mode" or "away mode", there should be buttons for those.	• Test with user being able to navigate to every mobile app window, as well as making the customizable settings convenient for the user (pass).
REQ-31	4	The User Interface should include a login for users to sign into the application, which can be both typed credentials or biometrics (i.e. fingerprint).	• Test with user opening mobile application and being met with a login page, which offers fingerprint authentication or empty username/password fields (pass)
REQ-32	3	The User Interface should provide a button to turn lights on and off.	• Test with user being able to locate and switch light settings (pass)
REQ-33	3	The User Interface should provide a button to arm and disarm the alarm.	• Test with user being able to locate and switch alarm settings (pass)
REQ-34	3	The User Interface should provide a button to take a picture using the home system's camera.	• Test with user being able to locate and take photo through camera window (pass)

REQ-35	4	The User Interface should provide a page/button which allows the user to view an image the arducam has taken.	• Test with user being able to locate and access photo library, which stores all photos the Arduino-Base Unit has taken (pass)
REQ-36	2	The User Interface should provide a button to alert the authorities in case of an emergency.	• Test with user being able to connect to a call with emergency services (9-1-1) (pass).
REQ-37	3	The User Interface should provide a button to quickly toggle modes for the home system ("home mode"/"away mode").	• Test with user being able to locate and switch between "home mode" and "away mode" and settings being adjusted accordingly (pass).
REQ-38	4	The User Interface should provide a settings menu to check the permissions of users connected to the same device and to add other users.	• Test with system admin user being able to create/delete users and change their permissions (pass).
REQ-39	4	The User Interface should be navigated through easily with proper placements of back and other buttons.	• Test with user being able to locate "RETURN/BACK" buttons and traverse to all other windows in mobile app from any starting window (pass)
REQ-40	4	The User Interface should provide a settings menu to allow the addition of a new face to the recognized list of faces.	• Test with system admin user being able to add new faces to list of recognized faces (pass).

The mobile application for our product provides the user with an easy to use interface to control the home automation system. It enables management of the home automation system no matter where the user is, but is especially useful when away from the audio detection range of the Arduino Base. When out of the house, the user will be able to monitor the state of his home and its entry points through the app, which will provide functionality to capture a picture of the current state of the doors/areas where the cameras are installed (in the demo, we will only be using one camera installed at the front door). The user will also be able to adjust the home's lighting settings through the app, helpful at times when away, so as to make the home look inhabited and less susceptible to intrusions and robberies. Should they want to feel protected when at home, users will be able to arm the motion-sensor-triggering alarm system through the mobile application if they feel that intruders are present or want extra protection when not awake. Tripping of the alarm system will automatically call the police. The user will also be able to disarm the alarm system when safe at home. The app offers two preset system modes: HOME and AWAY mode, which will automatically turn on/off lights and the security system, depending on if the user is currently away or at home.

The mobile application will start with a login page with two credential boxes (one for the username and one for the password) and a login button to verify the entered credentials. The user can also opt to use the fingerprint sensor on their phone to sign into the system. After a successful login, the user will see light, phone, camera, and alarm icons representing each of the customizable attributes of the security system. The lights can be turned on and off by tapping the corresponding button near the light icon. The user can arm or disarm the motion sensors and alarm system by toggling the switch by the alarm icon. If the user feels unsafe, they can alert/signal to the police by tapping on the phone icon. For added security, the mobile application also provides a way to inspect the front door camera by tapping on the camera icon. By tapping on the camera icon, the user can take a picture of the front door area to get a look at who is at the door. The picture will open on a new page displaying the picture, but will also be saved within the phone's native photo system. The phone icon will be available on this page to provide convenience for contacting police. The user can go back to the interaction page with the other icons by tapping the back button icon on the screen. On the main interaction page, there will also be a gear icon, where the user can tweak their settings such as adding profiles for their family members and managing their user credentials. The main page will also have mode presets for the HOME and AWAY modes, as well as NONE, if custom settings are preferred.

Hand-Drawn Sketches

REQ-34, REQ-35

Rutgers Home Automation System

Username: _____

Password: _____

[Login]

Touch your phone's home button or input login credentials above...
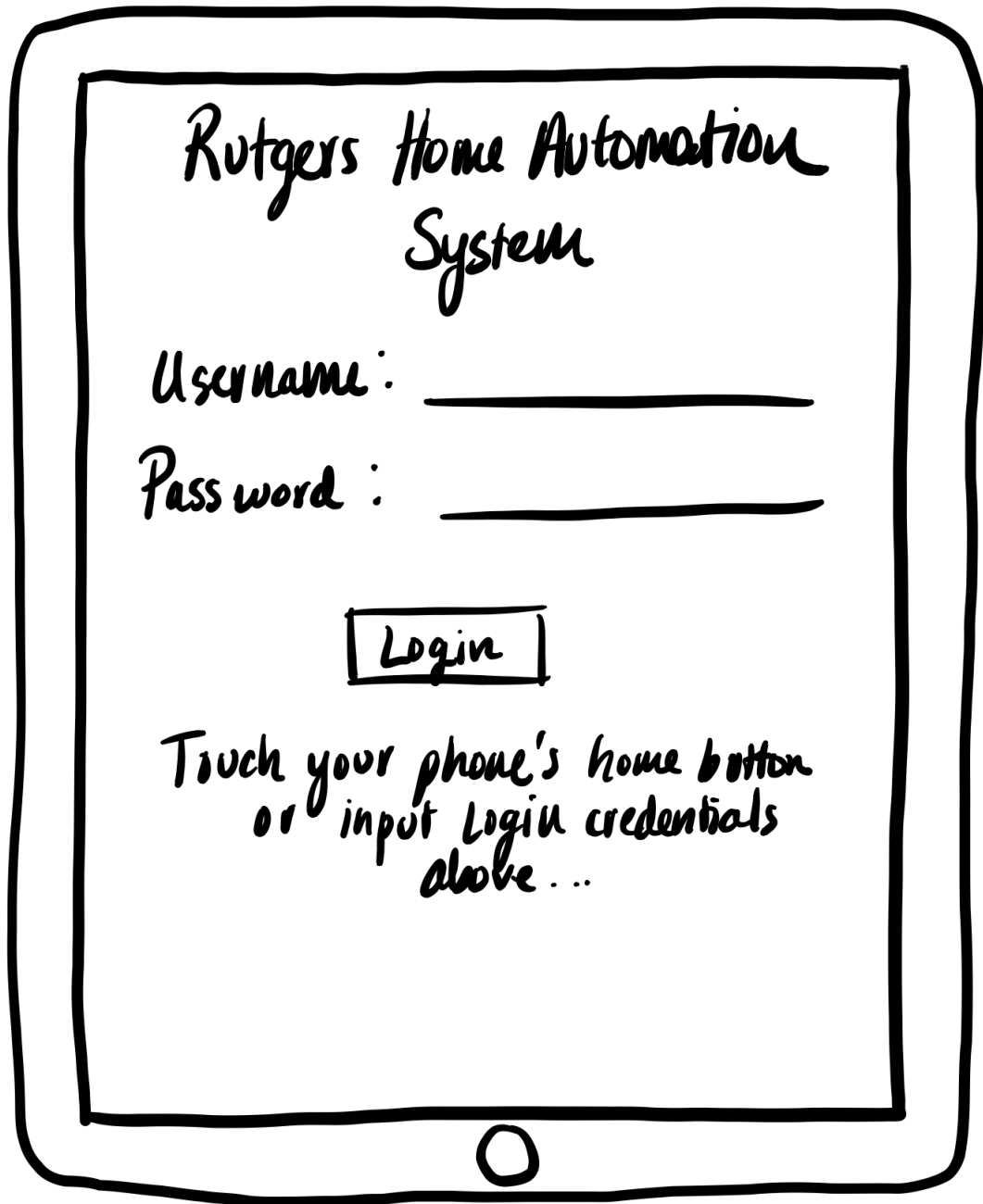
REQ-36, REQ-37, REQ-38, REQ-40, REQ-41,

Picture (dd/mm/yy : hh:ss)

CALL 9-1-1

RETURN
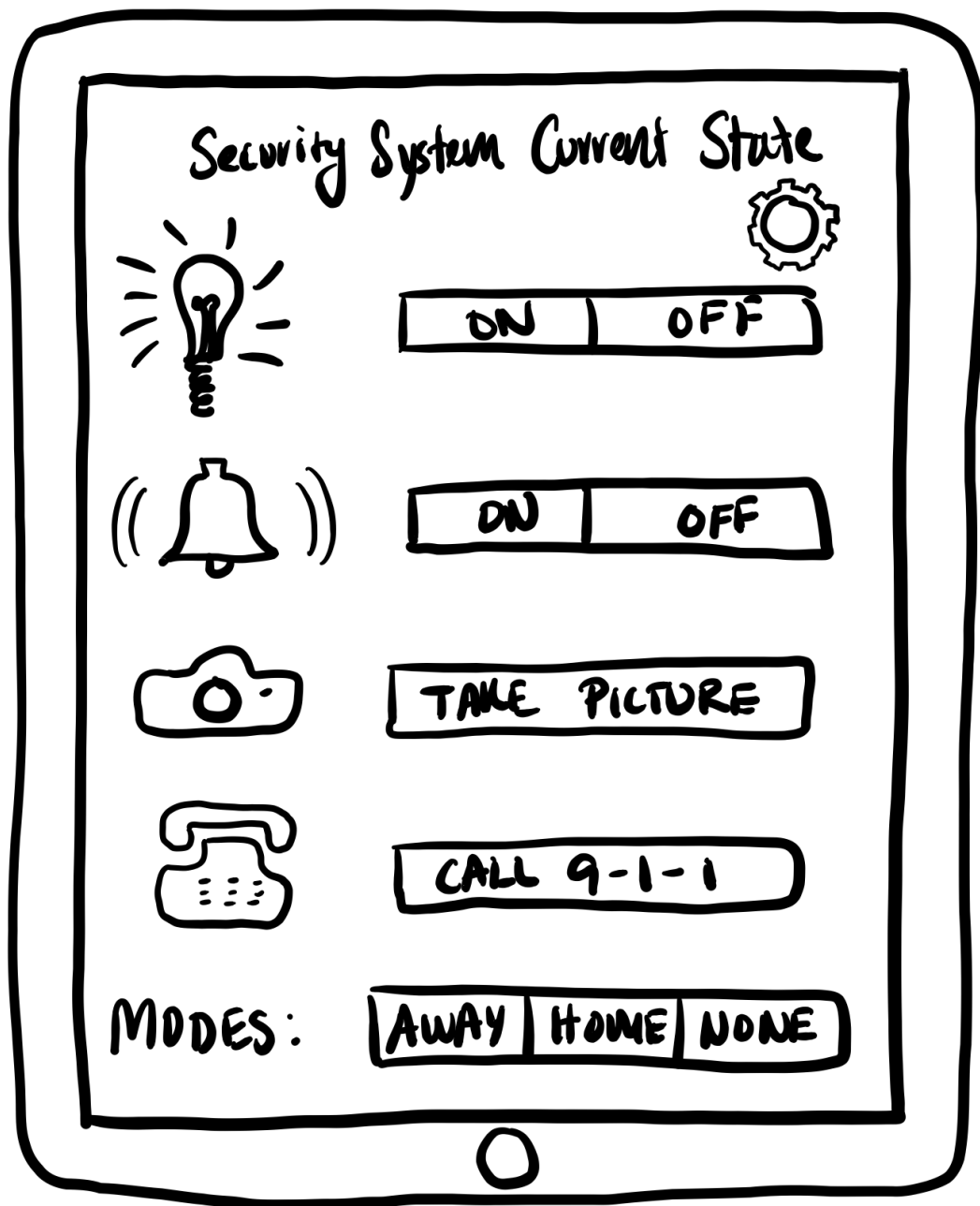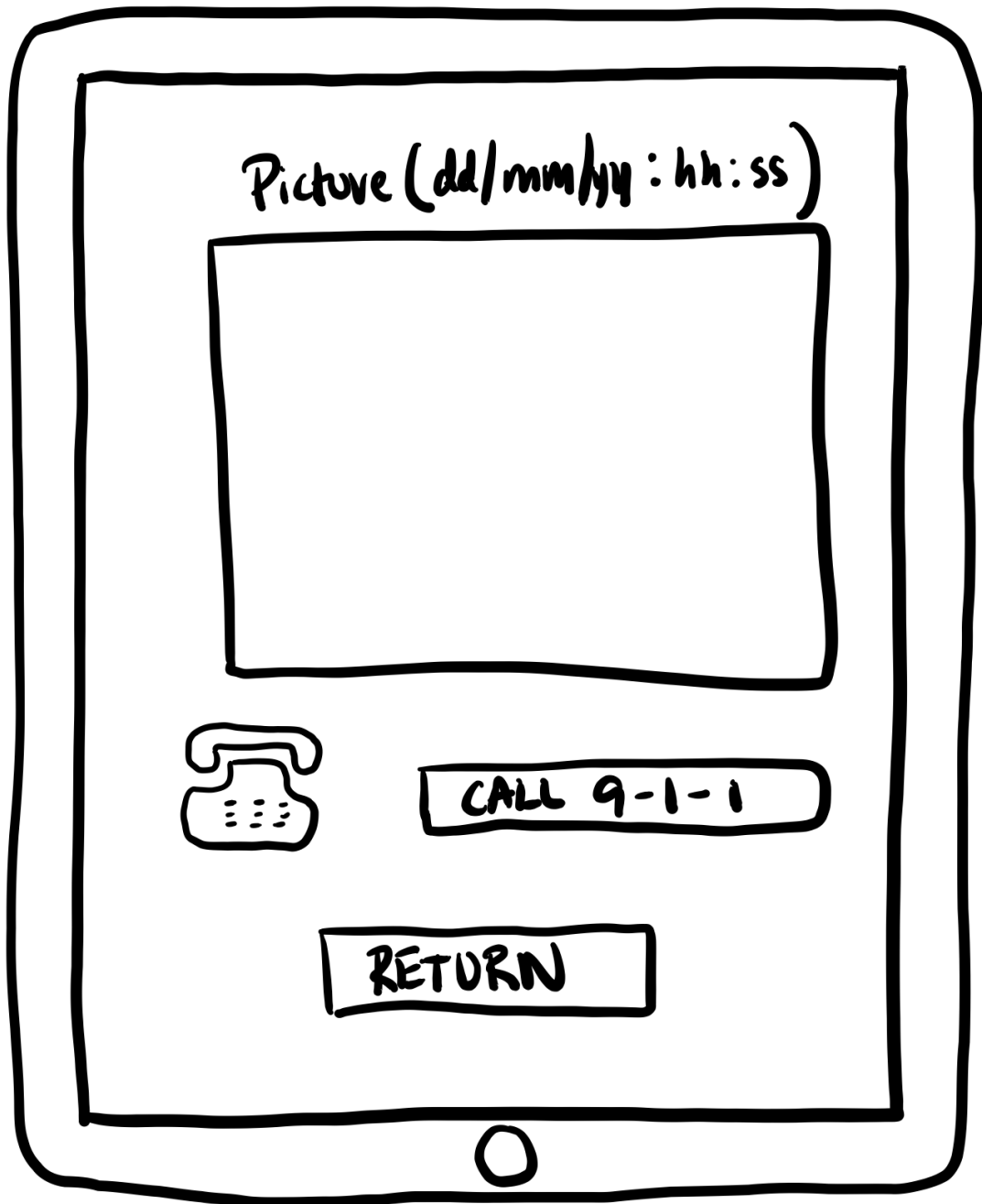
Setting Pages

User	💡	🔔	📷	☎	Modes
Homeowner (You)	✓	✓	✓	✓	✓
Child 1		✓		✓	✓

New User: [   ]

Can Change Lights: [YES] NO

Can Change Alarm: [YES] NO

Can Take Photo: [YES] NO

Can Call 9-1-1: [YES] NO

Can change Mode: [YES] NO

[Create New User]

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5 Functional Requirements Specification

5.1 Stakeholders

Homeowners, Tenants, Landlords, Store Owners, Building/Property Managers, Home Insurance Companies, Home Security Companies

5.2 Actors and Goals

User/Owner - Initiating Actor - they can actively put the Arduino base unit in away mode and home mode. They can take a picture from the mobile app of the front door if they suspect someone is there.

Recognized Person - Participating Actor

Unrecognized Visitor - Participating Actor (could be a mailman)

Intruder - Participating Actor

Arduino Base Unit - Initiating Actor - it involuntarily takes a picture when the motion sensor is triggered

Arducam - Participating Actor

Motion Sensor - Participating Actor

5.3 Use Cases

5.3.1 Casual Description

Use Case Name	Actor	Actor's Goal	System Requirements
UC-1: Take Picture	User	To see what/who is outside the door.	REQ-3, REQ-4, REQ-13, REQ-36, REQ-37
UC-2: Facial Recognition	Arduino Base Unit	To determine if the visitor is an unknown person	REQ-4, REQ-5, REQ-8, REQ-31
UC-3: Light Control	User	To turn lights on/off	REQ-6, REQ-7, REQ-13, REQ-19, REQ-32, REQ-34
UC-4: Gyroscope Triggered/Not Triggered	Arduino Base Unit/User	To turn on lights and turn on alarm once gyroscope sensor is triggered, if visitor is unknown/known	REQ-8, REQ-9, REQ-10, REQ-11

UC-5: Alarm Control	User	To turn alarm on/off	REQ-11, REQ-13, REQ-35
UC-6: Fingerprint & Passcode Verification	User	To restrict access to user only	REQ-12, REQ-29, REQ-32
UC-7: System Control Features	User	To enable/disable automatic alarm, automatic camera, automatic lights functionality, as well as the sensors	REQ-1, REQ-2, REQ-14, REQ-15, REQ-21, REQ-38
UC-8: Call Emergency Services	User	To be able to call 911 if deemed necessary according to potential threats	REQ-17, REQ-37
UC-9 System Connectivity	User	To connect multiple devices/users, including the arduino base unit, to the server via internet connection	REQ-16, REQ-22, REQ-23, REQ-24, REQ-39
UC-10: User Profile Creation and Settings	User	To create new user profiles and give different users different privileges such as which function the new user can control	REQ-23, REQ-24, REQ-25, REQ-26, REQ-29
UC-11: Create new user account	User	To create a new account for a different user on mobile application	REQ-16
UC-12: User Logout	User	To logout of current user account on mobile application	REQ-18

5.3.2   Use Case Diagram
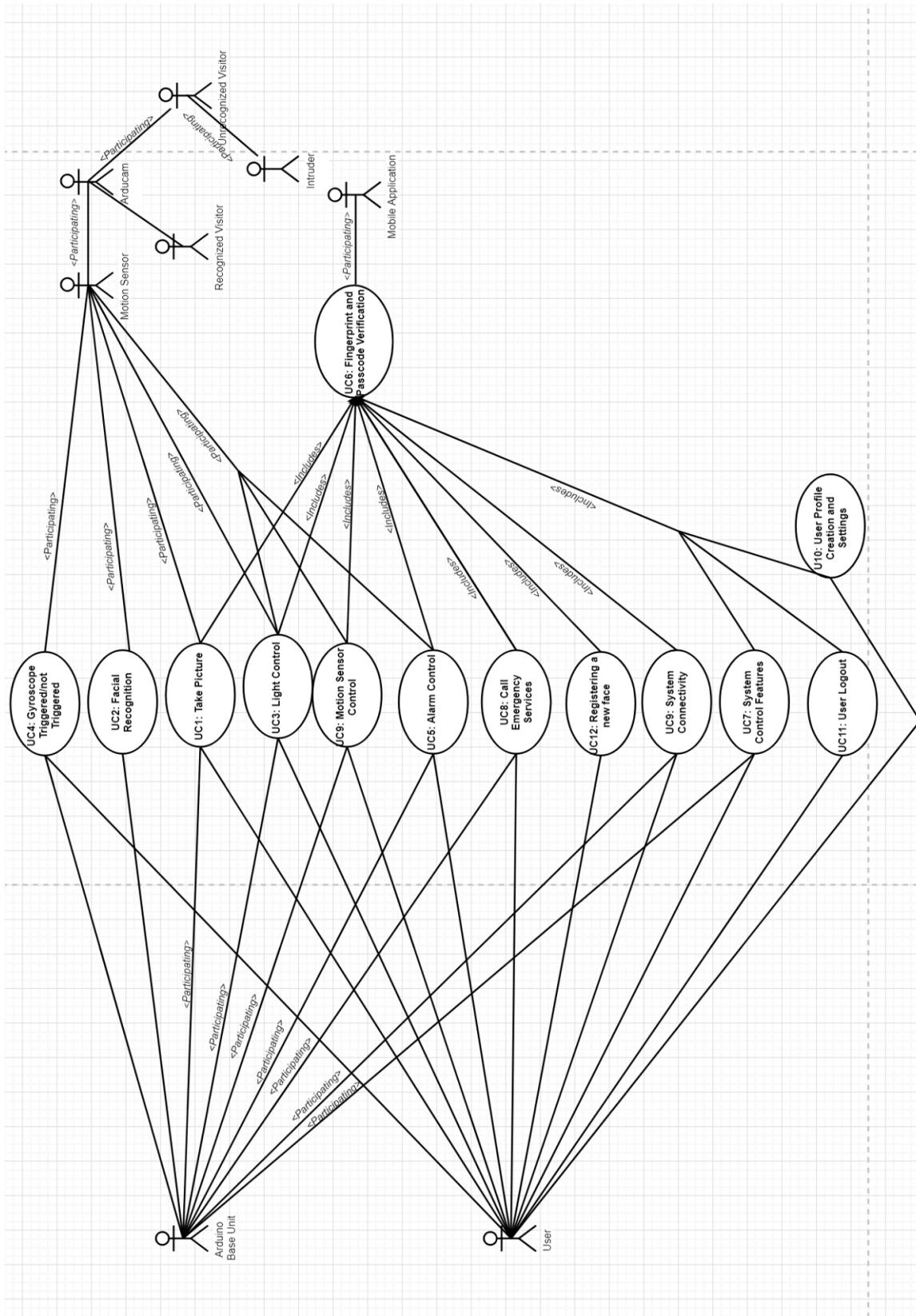
5.3.3 Traceability Matrix

(System Requirement (rows) v. Use Case (columns))

Rev	PW	UC-1	UC-2	UC-3	UC-4	UC-5	UC-6	UC-7	UC-8	UC-9	UC-10	UC-11
1	5							X				
2	5							X				
3	4	X										
4	4	X	X									
5	3		X									
6	1			X								
7	3			X								
8	5		X		X							
9	5				X							
10	5				X							
11	2				X	X						
12	2						X					
13	4	X		X		X						
14	4							X				
15	1							X				
16	3								X			
17	2							X				
18	3										X	
19	2			X								
20	3											
21	3						X					
22	4								X			
23	3									X		
24	5								X			
25	4											
26	4											
27	4											
28	4											
29	4					X				X		
30	4		X									
31	5			X								
32	4						X					
33	3			X								
34	3					X						

35	3	X										
36	4	X										
37	2									X		
38	3						X					
39	4									X		
40	4											
41	4											X
MAX PW		4	5	5	5	4	4	5	2	5	5	
Total PW		19	16	18	17	9	10	21	4	12	11	3

5.3.4 Fully-Dressed Description

Use Case UC-1: Take Picture	
Related Requirements:	REQ-3, REQ-4, REQ-13, REQ-36, REQ-37
Initiating Actors:	User
Actor's Goal:	To see what/who is outside the door
Participating Actors:	Arduino Base Unit (ABU), mobile app, Arducam
Preconditions:	None worth mentioning
Postconditions:	The picture is sent from the Arduino base unit to users mobile application

Flow of Events for Main Success Scenario:			
	→		1. The owner logs in to the mobile app and navigates to the camera section of the app.
	→		2. The owner taps the take picture button
	←		3. A signal is sent to the ABU through the firebase for the Arducam to take a picture
	←		4. The ABU signals the Arducam and a picture is taken
	→		5. The ABU sends the picture back to the owners mobile app

Use Case UC-2: Facial Recognition	
Related Requirements:	REQ-4, REQ-5, REQ-8, REQ-31
Initiating Actors:	Arduino Base Unit
Actor's Goal:	To determine if the visitor is an unknown person
Participating Actors:	Mobile app, stranger at the front door, Arducam, recognized visitor, unrecognized visitor, Motion sensor

Preconditions:		• The arduino base unit (ABU) is in away mode, meaning the alarm is enabled
Postconditions:		The owner is notified there is a recognized/unrecognized person outside the door
Flow of Events for Main Success Scenario:		
	→	1. The motion sensor detects motion in the front door and sends a signal to the ABU
	←	2. The ABU sends a signal to the arducam to take a picture
	←	3. The arducam takes a picture and sends it to the ABU
	→	4. The ABU runs a facial recognition algorithm and checks whether there is a face in the picture that matches any saved faces in the Firebase
	→	5. If it is an unrecognized face, the ABU sends a signal to the user on their mobile application

Use Case UC-3: Light Control		
Related Requirements:		REQ-6, REQ-7, REQ-13, REQ-19, REQ-32, REQ-34
Initiating Actors:		User
Actor's Goal:		To turn lights on/off manually through the mobile app
Participating Actors:		Arduino Base Unit (ABU), Arducam, Motion Sensor, Alarm
Preconditions:		• The arduino base unit (ABU) is in away mode, meaning the alarm is enabled • The owner is in their bedroom as it is night time
Postconditions:		The ABU was successfully able to turn on the lights
Flow of Events for Main Success Scenario:		
	→	1. The owner is in their bedroom when they hear something at the door
	→	2. They log in to the mobile app however they see that no pictures have been updated to the app lately (No one is at the door)
	→	3. Yet still to for safety measures, the owner decides to turn on the lights to scare anyone away
	→	4. The user navigates through the mobile app by clicking the light tab
	→	5. They toggle the lights on with the light button
	←	6. A signal is sent through the google firebase to the ABU to turn the lights on.
	←	7. The lights are turned on.
	→	8. After a few minutes, as the owner gets assured they are safe, they toggle the lights to turn off from the mobile app.
	←	9. Another is signal sent to the ABU and the lights are turned off

Use Case UC-4: Gyroscope is triggered	
Related Requirements:	REQ-8, REQ-10, REQ 11
Initiating Actors:	Arduino Base Unit (ABU), User
Actor's Goal:	The ABU should make the alarm ring when needed and the user should be able to turn off the alarm if need be.
Participating Actors:	Arducam, Alarm, Motion Sensor, friend of the owner
Preconditions:	• The arduino base unit (ABU) is in away mode, meaning the alarm is enabled • No one is in the house • A friend of the owner is dropping something off for the owner and has the house key
Postconditions:	The user was successfully able to turn off the alarm

Flow of Events for Main Success Scenario:			
	→		1. A friend of the owner comes to drop something off at the owner's home
	→		2. They walk to the doorstep and the motion sensor detects the person, the arducam takes a picture and the ABU doesn't recognize the visitor as a know person
	→		3. The person opens the door with the key and the gyroscope is triggered
	←		4. A signal is sent to the alarm and it rings
	←		5. Meanwhile, the owner gets a notification from the ABU that there is someone at the door.
	→		6. The owner sees that it is their friend through the mobile app.
	→		7. The owner quickly navigates to the alarm tab of the mobile app and toggles the alarm system to off.

Use Case UC-7: System Control Features	
Related Requirements:	REQ-1, REQ-2, REQ-14, REQ-15, REQ-21, REQ-39
Initiating Actors:	User
Actor's Goal:	To put the system in home mode
Participating Actors:	Mobile App, Arduino Base Unit (ABU)

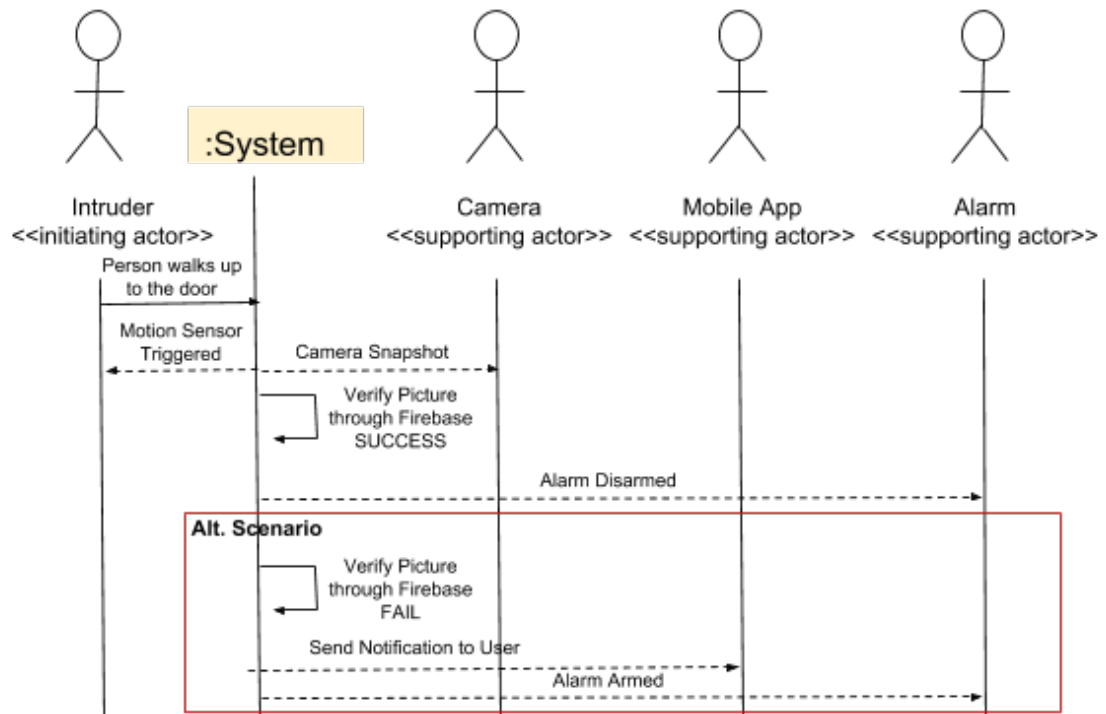|		
Preconditions:		• The arduino base unit (ABU) is in away mode, meaning the alarm is enabled • The user just entered the house from work but forgot to put the system in home mode from the ABU • An unregistered person (friend) is to follow in the house
Postconditions:		The friend is able to walk in and the alarm does not ring
Flow of Events for Main Success Scenario:		
	→	1. The user gets into the house and closes the door
	→	2. He realizes that his friend is still to follow and he hasn't put the system into the home mode yet
	→	3. He logs in to the mobile app and toggles the "home mode" switch
	←	4. A signal is sent to the ABU from thru the firebase for the system to turn into home mode
	←	5. The ABU disables the motion sensor and the alarm
	→	6. The friend enters the house and the alarm does not go off

Use Case UC-10: User Profile Creation and Settings		
Related Requirements:	REQ-23, REQ-29, REQ-39	
Initiating Actors:	User	
Actor's Goal:	To add and give another family member control of system features.	
Participating Actors:	Mobile App	
Preconditions:		• There are already a few devices connected to the system
Postconditions:	A new family member was added to the group members who can control the system features on the mobile app	
Flow of Events for Main Success Scenario:		
	→	1. The user wants to add a family member to the system
	→	2. He logs in to the mobile app and navigates to the settings page
	→	3. He taps on the create new user option
	→	4. He enters a new username and password for the family member
	→	5. The user gives all the permissions to the family member: can change lights, can change alarm, can take photo, can call 911, can change mode
	←	6. The mobile app sends this data to the Firebase and the new user is now officially added to the system.

5.4   System Sequence Diagrams

Use Case 1: Facial Recognition
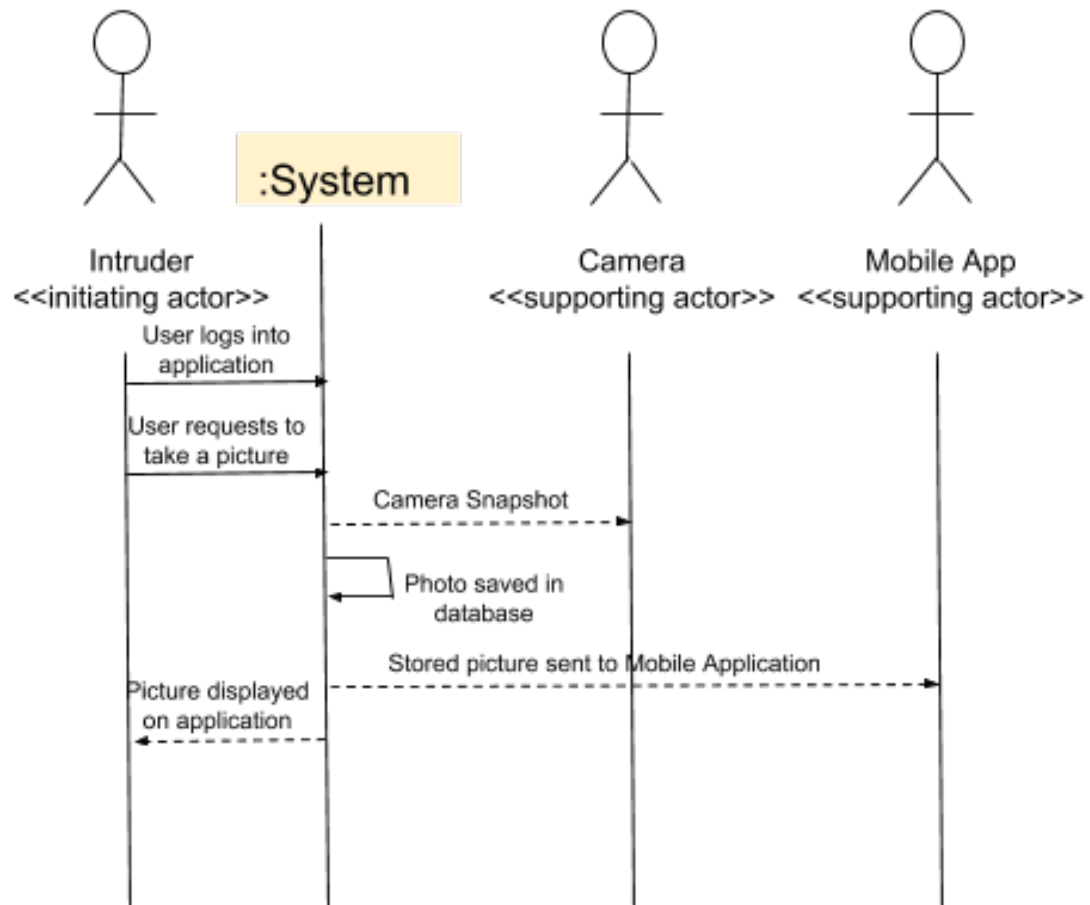
Use Case 2: Facial Recognition

| Intruder <<initiating actor>> | :System | Camera <<supporting actor>> | Mobile App <<supporting actor>> | Alarm <<supporting actor>> |

Person walks up to the door

Motion Sensor Triggered

Camera Snapshot

Verify Picture through Firebase SUCCESS

Alarm Disarmed

Alt. Scenario

Verify Picture through Firebase FAIL

Send Notification to User

Alarm Armed

Use Case 3: Light Control

	:System	Lights	Mobile App
User			
<<initiating actor>>		<<supporting actor>>	<<supporting actor>>

Person hears something

Person wants to turn the lights on

User presses lights on button on mobile app

Signal Sent through mobile app

Switch toggle on app is now on — Lights turn on

Person wants to turn the lights off

User presses lights on button on mobile app

Signal Sent through mobile app

Switch toggle on app is now off — Lights turn off

Use Case 4: Gyroscope triggered

Friend of user
<<initiating actor>>

:System

Camera
<<supporting actor>>

Mobile App
<<supporting actor>>

Alarm
<<supporting actor>>

Friend walks up
to the door

Motion Sensor
Triggered

Camera Snapshot

Verify Picture
through Firebase
FAIL

Person tries to
open the door

Send Notification to User

Gyroscope is
triggered

Sound alarm

User sees that is
the friend in
notification

User toggles
alarm off on app

Alarm is turned off

Use Case 7: System control

Friend of user
<<initiating actor>>

:System

Camera
<<supporting actor>>

Alarm
<<supporting actor>>

Motion Sensor
<<supporting actor>>

User enters house

User realizes friend is coming

User logs into app

User switches to home mode

Camera Disabled

Alarm Disabled

Motion Sensor Disabled

Correction: System Sequence Diagram for UC-10: User Profile Creation and Settings. Ignore diagram heading.

Use Case 7: System control
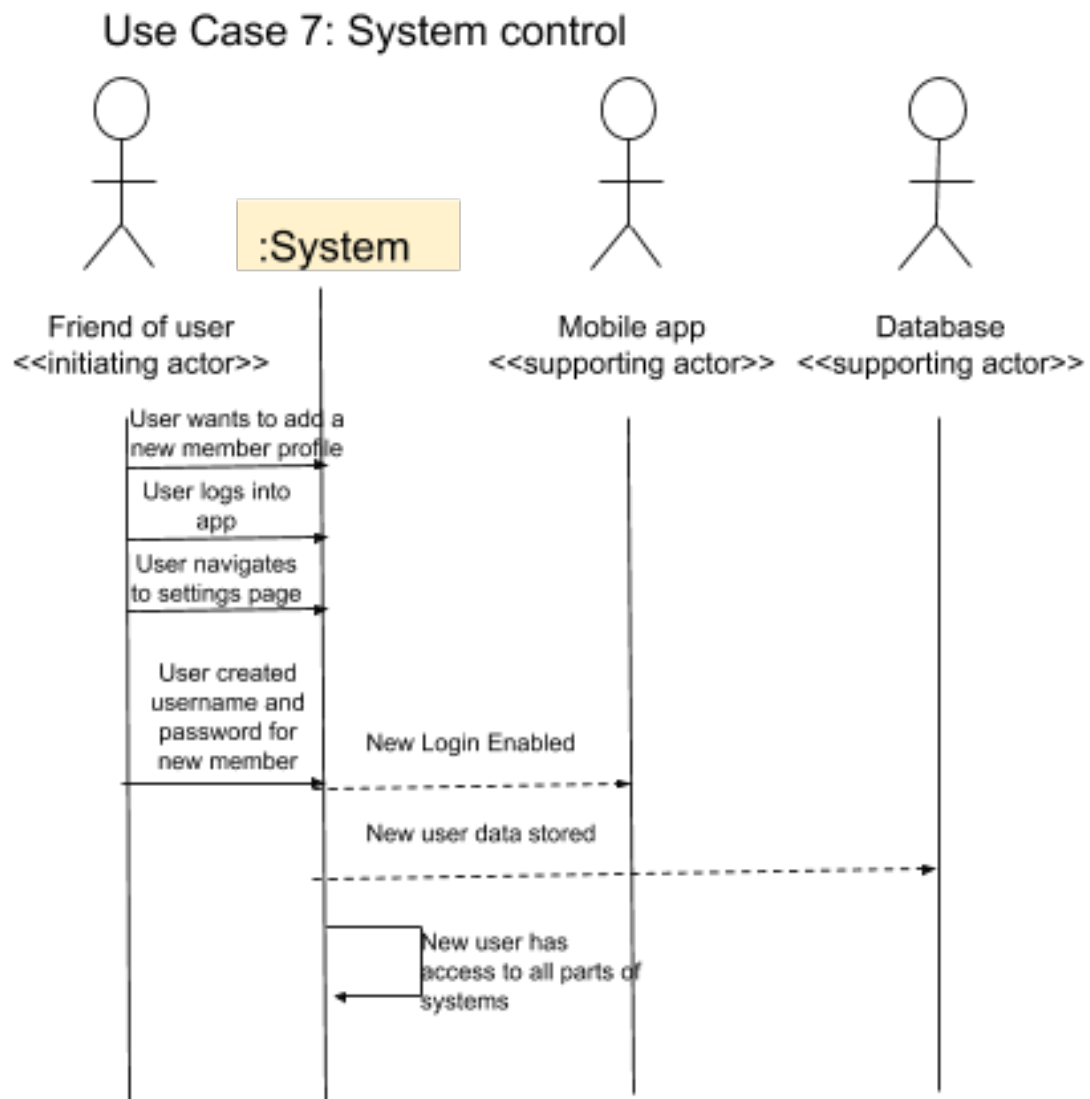
6 User Interface Specification

6.1 Preliminary Design (Screen Mock-Ups)

Login Page

2.

Security System Control Panel

| ON | OFF |

| ON | OFF |

ACCESS CAMERA

DIAL 9-1-1

MODE | AWAY | HOME | OFF |

3. Picture (dd/mm/yy : hh : mm : ss)
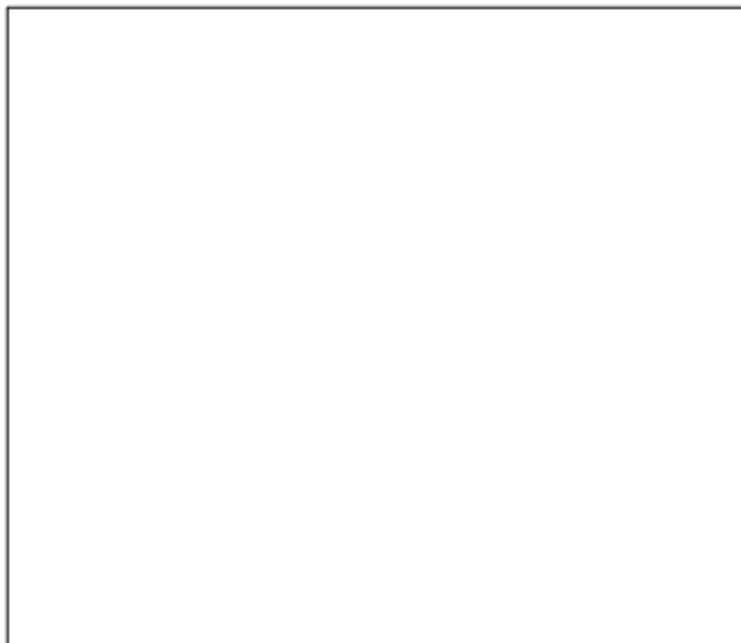
DIAL 9-1-1

4.

Setting Pages

User	💡	🔔	📷	☎	**MODE**
Homeowner (You)	✓	✓	✓	✓	✓
Child 1	✓		✓	✓	

Enable/Disable Automatic Features

💡 Enabled | Disabled

🔔 Enabled | Disabled

📷 Enabled | Disabled

👤 Face Rec Settings

← Create New User →

5.

New User Setup

Username: [   ]

Password: [   ]

Confirm
Password: [   ]
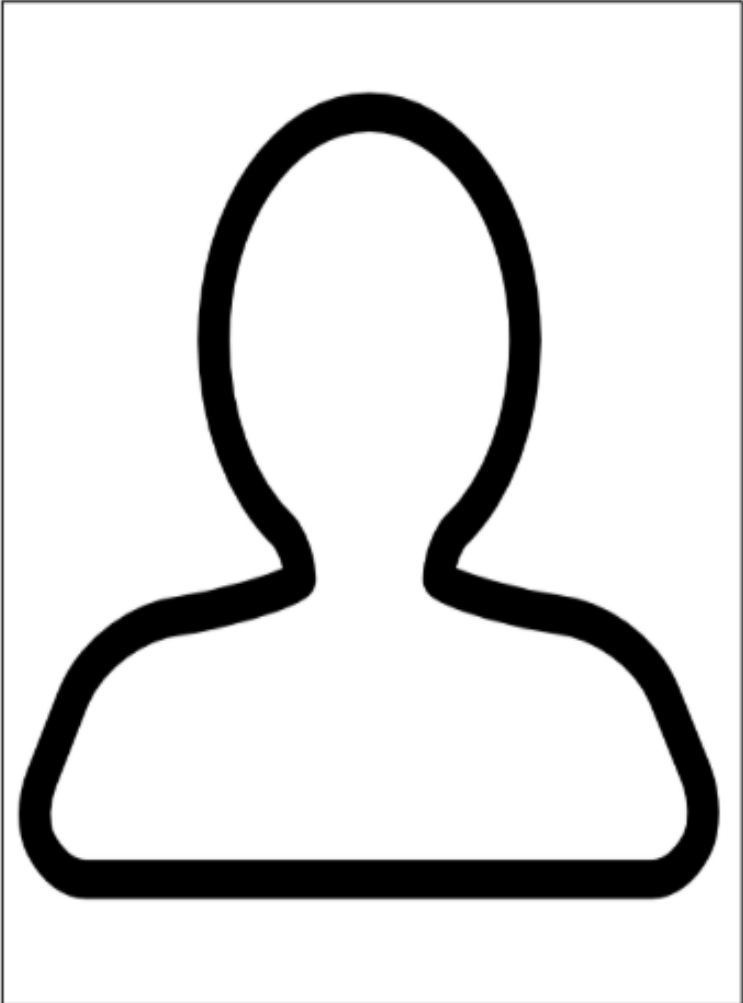
Can Change Lights:	YES	NO
Can Change Alarm:	YES	NO
Can Take Photo:	YES	NO
Can Call 9-1-1:	YES	NO
Can Change Mode:	YES	NO

← [Create Account]

6.

Register New Face

Align yourself with this layout

Retake

Add Face

7.

First Time User Setup

Username:

Password:

Confirm
Password:

Create Account

←

8.

Pictures

9. Picture (dd/mm/yy : hh : mm : ss)

10. Setting Pages

User	💡	🔔	📷	☎	**MODE**
Child 1	✓		✓	✓	

Enable Fingerprint Login

ON	OFF

11.

System Setup

Device
Found ✓

Wifi Name

Phone Name

Confirm Setup

12.

Registered Faces

Add New Face

13.

Registered Face

6.2 Preliminary Design (Navigational Paths) and User Effort Estimation

Use Case UC-1: Take Picture		User Effort
Login Page (1)	Step 1: The user opens up the app on their mobile device.	Navigation 1. Tap on app
Login Page (1)	Step 2: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor
Main Control Panel Page (2)	Step 3: The user presses the "Access Camera" button and the screen changes to a new page.	Navigation 1. Tap on access camera
Access Camera Page (3)	Step 4: The user presses gray circle in the middle of the screen to take a picture and the screen will change to a new page.	Navigation 1. Tap on gray circle
Selected Picture Page (9)	Step 5: The user now sees just the picture in a larger view.	Look at the Screen

Use Case UC -2: Facial Recognition		User Effort
Phone (No Specific Page)	Step 1: The user receives a push notification on their mobile device that an unrecognized face is at the door.	Look at the Screen

Login Page (1)	Step 2: The user opens up the app on their mobile device.	Navigation 1. Tap on app
Login Page (1)	Step 3: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor
Main Control Panel Page (2)	Step 4: The user presses the "Access Camera" button and the screen changes to a new page.	Navigation 1. Click on access camera
Access Camera Page (3)	Step 5: The user can view the picture by clicking on the album icon in the bottom right corner.	Navigation 1. Click on album icon
Pictures Page (8)	Step 6: The user can view a grid of the latest photos in the app's photo gallery.	Look at the screen
Selected Picture Page (9)	Step 7: The user can view photos closer by clicking on them.	Data Entry 1. Click on a photo

Use Case UC -3: Light Control		User Effort
Login Page (1)	Step 1: The user opens up the app on their mobile device.	Navigation 1. Tap on app

Login Page (1)	Step 2: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor
Main Control Panel Page (2)	Step 3: The user presses either the on or off button next to the picture of the light to either turn off or on the lights.	Data Entry 1. Tap on either on or off

Use Case UC - 4: Gyroscope Triggered/Not Triggered		User Effort
Phone (No Specific Page)	Step 1: The Arduino camera captured an unrecognized face gyroscope detects the door opening causing the alarm to sound. This sends a push notification to the user's mobile device.	Look at the Screen
Login Page (1)	Step 2: The user opens up the app on their mobile device.	Navigation 1. Tap on app

Login Page (1)	Step 3: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor
Main Control Panel Page (2)	Step 4: The user must press the off button next to the picture of the alarm to turn of the alarm.	Data Entry 1. Tap on either on or off

Use Case UC - 5: Alarm Control		User Effort
Login Page (1)	Step 1: The user opens up the app on their mobile device.	Navigation 1. Tap on app
Login Page (1)	Step 2: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor

Main Control Panel Page (2)	Step 3: The user must press the off button next to the picture of the alarm to arm or disarm the alarm.	Data Entry 1. Tap on either on or off

Use Case UC - 6: FingerPrint and Passcode Verification		User Effort
Login Page (1)	Step 1: The user opens up the app on their mobile device.	Navigation 1. Tap on app
Login Page (1)	Step 2: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor

Use Case UC - 7: System Control User		User Effort
Login Page (1)	Step 1: The user opens up the app on their mobile device.	Navigation 1. Tap on app

Login Page (1)	Step 2: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor
Main Control Panel Page (2)	Step 3: The user presses the settings icon (gear and wrench icon) in the top right corner of the screen to access the settings page.	Navigation 1. Tap on the settings icon
Admin Settings Page (4)	Step 4: The user can use the toggle buttons to choose to enable or disable the the ability to arm the alarm, the automatic lights in response to the triggering of the gyroscope and alarm, and the camera's ability to automatically search take a picture and scan an individual's face by disabling the motion sensor.	Data Entry 1. Tap the enable or disable buttons.

UC-8: Call Emergency Services		User Effort
Login Page (1)	Step 1: The user opens up the app on their mobile device.	Navigation 1. Tap on app

Login Page (1)	Step 2: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor
Main Control Panel Page (2)	Step 3: The user can press on the "Dial 9-1-1" to call Emergency Services.	Data Entry 1. Press the dial button

UC-9: System Connectivity		User Effort
Login Page (1)	Step 1: The user opens up the app on their mobile device.	Navigation 1. Tap on app
Login Page (1)	Step 2: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor

System Setup Page (11)	Step 3: The user will follow on screen instructions to connect their device with the arduino system and the wifi network.	Data Entry 1. Tap the proper device
System Setup Page (11)	Step 4: The user will press the "Complete Setup" button to confirm the connection of their mobile device to their arduino system.	Navigation 1. Tap the complete setup button

UC-10: User Profile Creation and Settings		User Effort
Login Page (1)	Step 1: The user opens up the app on their mobile device.	Navigation 1. Tap on app
Login Page (1)	Step 2: The user enters their login credentials (username and password and press login button or fingerprint identification).	Data Entry 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor
Main Control Panel Page (2)	Step 3: The user presses the settings icon (gear and wrench icon) in the top right corner of the screen to access the settings page.	Navigation 1. Tap on the settings icon
Admin Settings Page (4)	Step 4: The user presses the "Create User" button near the bottom of the screen to get to a new page.	Navigation 1. Tap the create user button

New User Setup	<u>Step 5:</u> The current user enters a username and password for the new user to be added to the system. The current user must also re-enter the password again to confirm.	<u>Data Entry</u> 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on confirm password 6. Type in credentials
New User Setup Page (5)	<u>Step 6:</u> The current user must use the toggle switches to set the desired privileges for the new user.	<u>Data Entry</u> 1. Tap selection for can change lights 2. Tap selection for can change alarm 3. Tap selection for can take photo 4. Tap selection for can call 9-1-1 5. Tap selection for can change mode
New User Setup Page (5)	<u>Step 7:</u> The current user must press the "Create Account" button to confirm the new account.	<u>Navigation</u> 1. Tap on create account

UC-11: User Logout		User Effort
Login Page (1)	<u>Step 1:</u> The user opens up the app on their mobile device.	Navigation 1. Tap on app

Login Page (1)	<u>Step 2</u>: The user enters their login credentials (username and password and press login button or fingerprint identification).	<u>Data Entry</u> 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor
Main Control Panel Page (2), Admin Settings Page (4), General User	<u>Step 3</u>: The user press the small door with an arrow button on the bottom corner of any screen the button appears to log out of the app.	<u>Navigation</u> 1. Tap on the logout button

UC-12: Registering a Face		User Effort
Login Page (1)	<u>Step 1</u>: The user opens up the app on their mobile device.	<u>Navigation</u> 1. Tap on app
Login Page (1)	<u>Step 2</u>: The user enters their login credentials (username and password and press login button or fingerprint identification).	<u>Data Entry</u> 1. Tap on username 2. Type in credentials 3. Tap on password 4. Type in credentials 5. Tap on login Or 1. Tap on fingerprint sensor

Main Control Panel Page (2)	<u>Step 3</u>: The user presses the settings icon (gear and wrench icon) in the top right corner of the screen to access the settings page.	<u>Navigation</u> 1. Tap on the settings icon
Admin Settings Page (4)	<u>Step 4</u>: The user taps on the Face Rec Settings button near the bottom of the screen which sends them to the Registered Faces Page.	<u>Navigation</u> 1. Tap on Face Rec Settings button
Registered Faces Page (12)	<u>Step 5</u>: The user taps on the Add New Face button on the top right of the screen to take them to the Register New Face Page	<u>Navigation</u> 1. Tap on Add New Face button
Register New Face Page (6)	<u>Step 6</u>: The user must align themselves with the camera on their phone and hit the circular capture button to take the picture.	<u>Data Entry</u> 1. Tap on the gray circle to take a picture
Register New Face Page (6)	<u>Step 7</u>: The user can either retake the picture or hit the add face button to add the face to the registered faces.	<u>Data Entry</u> 1. Tap gray circle to retake picture OR <u>Navigation/Data Entry</u> 1. Tap on add face button

7   Domain Analysis

7.1   UC-1: Take Picture

7.1.1   Concept Definitions

Concept Name	Type	Responsibility Description
Controller (Arduino Base)	D	Rs. 1: Coordinate actions of concepts associated with this use case and delegate the work to other concepts.
Mobile App Picture Interface	D	Rs. 2: Take in the requests of the user and relay the signal to
Mobile App Security Interface	D	Rs. 3: Takes login from user to allow them to access features in the app.
Server Connection	K	Rs. 4: Take in request sent from mobile app interface to send a signal to the arduino base
ArduCam	D	Rs. 5: Takes picture as requested by the user
Database Connection	K	Rs. 6: Stores picture data that user requested, and stores the username and passwords of the system users

7.1.2   Association Definitions

Association Name	Concept Pair	Association Description
Conveys request	Mobile App Security Interface → Database Connection	Mobile app security Interface checks password against what is stored in database
Conveys request	Mobile App Picture Interface → Server Connection	When user requests to take a picture, the app will send a signal to server to execute request
Conveys request	Server Connection → Controller	Request from server is sent to the Arduino base controller
Execute	Controller → ArduCam	Controller instructs Arducam to take picture
Execute Request	ArduCam → Server	ArduCam sends signal to server when picture has been taken

| Save Data | Server connection ← → Database Connection | Server signals save picture to database Database notifies server to update mobile app picture interface |
| Send Information | Database Connection → Mobile App Picture Interface | Mobile picture interface is updated with picture from database. |

7.1.3   Attribute Definitions

Concept	Attributes	Attribute Description
Search Request	User Identity	Used to determine the user's credentials to authorize them to enter application
	Application Display	Storing and retrieving pictures taken that are saved on Firebase
Archiver	Picture Storage	Needs to store and update database for system update
Controller Request	Call for Action	Tells Arduino base to execute function (ie. take picture)
	Call for Storage	Calls to Database to store information
	Call for Search	Searches existing stored information to verify user request (ie. authororize if user is allowed to enter application)

7.1.4   System Operations Contract

Operation	Take Picture
Preconditions	- One user is already registered into the system and has access to the mobile app. - The Arduino system has already been set up. - The Arducam is on and working

Postconditions	
	• A new photo is added to the database • A new photo is displayed on user's mobile device

7.1.5 Domain Model Diagram
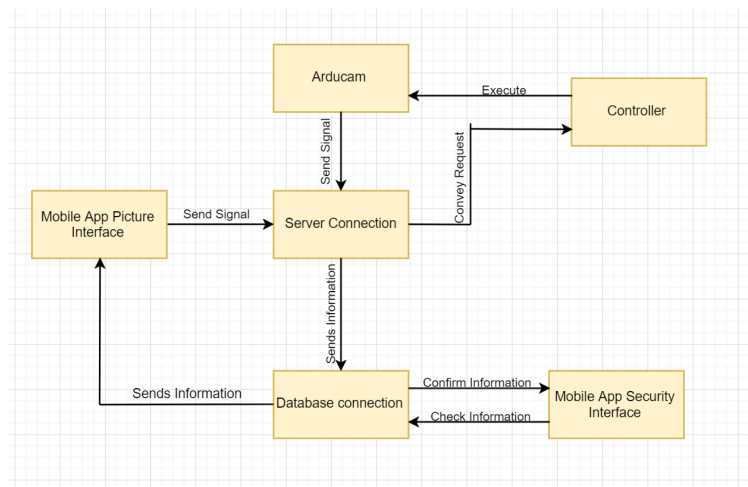
7.2 UC-2: Facial Recognition

7.2.1 Concept Definitions

Concept Name	Type	Responsibility Description
Controller (Arduino Base)	D	Rs. 1 : Coordinate actions of concepts associated with this use case and delegate the work to other concepts.
Database Connection	K	Rs. 2 : Stores the picture data of the images captured by the ArduCam
ArduCam	D	Rs. 3 : Takes a picture when triggered by the user or motion sensor
Motion Sensor	D	Rs. 4 : Determines when there is someone at the door so the arducam can take a picture
Mobile App Notifier	D	Rs. 5 : Sends a notification to a user's device to notify them about suspicious persons
Server Connection	K	Rs. 6 : Take in requests when the ArduCam takes a picture of a suspicious person and sending a signal to the arduino base

Mobile App Picture Interface	K	Rs. 7: Provides a way for the user to view a picture taken by the ArduCam

7.2.2 Association Definitions

Association Name	Concept Pair	Association Description
Conveys request	Motion Sensor → Controller	Motion Sensor sends a signal to the controller when there is movement at the door.
Execute	Controller → Arducam	Controller instructs ArduCam to take a picture
Save Data	Server Connection ← → Database Connection	Server signals to save the picture to the database and perform facial recognition. The Database notifies the server to update the mobile app picture interface.
Send Information	Server Connection → Controller	Send and receive signals from the server to the controller and vice versa.
Send Information	Database Connection → Mobile App Picture Interface	Mobile app picture interface is updated with picture from database
Send Information	Server connection → Mobile App Notifier	The server updates the mobile app notifier to send a new notification to notify the user about the picture taken by the ArduCam.

7.2.3 Attribute Definitions

Concept	Attributes	Attribute Description
Database Connection	Access Database	Provides a means to access the database when required by the mobile app.
	Picture Transfer	Storing and retrieving pictures taken that are saved on Firebase
Archiver	Picture Storage	Needs to store and update database for system update

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Controller Request	Call for Action	Tells Arduino base to execute function (ie. take picture)
	Call for Storage	Calls to Database to store information
	Call for server and database connect	Tells the controller to connect to the database and send/receive signals to the server

7.2.4 System Operations Contract

Operation	Take Picture
Preconditions	- One user is already registered into the system and has access to the mobile app. - The Arduino system has already been set up. - The Arduino system is armed and the ArduCam is active.
Postconditions	- A new photo is added to the database - A notification is sent to the user on their mobile app.

7.2.5 Domain Model Diagram
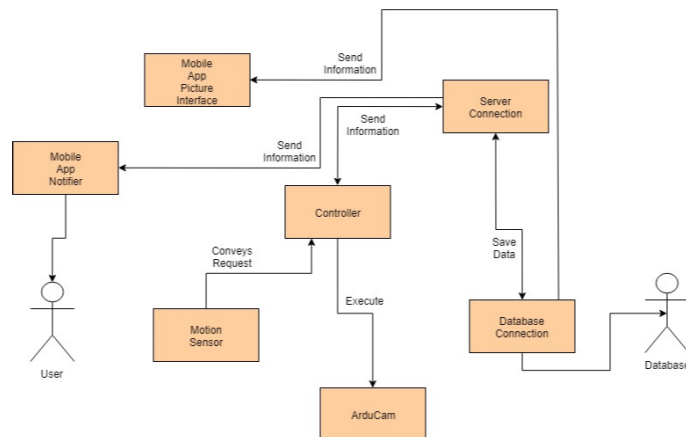
7.3 UC-3: Light Control

7.3.1 Concept Definitions

Concept Name	Type	Responsibility Description
Controller (Arduino Base)	D	Rs1. Coordinate actions of concepts associated with this use case and delegate the work to other concepts.
Gyroscope	K	Rs2. Stores the current angle of the door
LightsStatus	K	Rs3. Holds the current state of the lights in the house. 1 for being on, 0 for being off.
LightsChecker	D	Rs. 4 : Checks that the LightsStatus is 0 when the controller is in away mode. Checks that the LightsStatus is equal to the UserLightsPref when controller is in home mode. Triggers the LightsStatus to 1 when receiving a signal from the Controller
TargetAngle	K	Rs. 5 : Stores value that, when exceeded, says that the door is opened
UserLightsPref	K	Rs. 6 : Stores the value of lights that the user's inputs.
LightsUI	D	Rs7. Shows the user a switch to turn the lights on or off and sends the current status of the switch to the UserLightsPref

7.3.2 Association Definitions

Association Name	Concept Pair	Association Description
Sends Angle Data	Controller → Gyroscope	Gyroscope passes angle data to the Controller.
Open Door	Controller → TargetAngle	Controller checks if Gyroscope angle is greater or equal to the TargetAngle
Control Lights	LightsChecker ← → LightsStatus	LightsChecker gets the LightsStatus and changes it according only

Trigger Lights	Controller → LightsChecker	Once the gyroscope angle exceeds the TargetAngle, the controller sends a signal to the LightsChecker to trigger the lights to 1.
User Preference	UserLightsPref → LightsUI	LightsUI sends the current status of what the user chose as their lights preference to the UserLightsPref. This value is stored.
Set Lights to User Pref	Controller → UserLightsPref	Controller sends a signal to the LightsChecker about the UserLightsPref so that it changes to what the user wants.

7.3.3   Attribute Definitions

Concept	Attributes	Attribute Description
TargetAngle	TargetAngle	Angle at which the door is considered open
	DoorAngle	Used to hold the current angle of the door.
Lights Status	Status	If Lights are on, the value is 1. If the Lights are off the value is 0.
Lights Checker	Status	Copied over from the Lights Status concept, holds the current value of the lights
	Trigger	Listens to Controller for a signal to change the value of the status is 1.
	UserLightsPref	Stores the value that the user puts for the lights.

7.3.4   System Operations Contract

Operation	Take Picture
Preconditions	- The Controller is set up. - The Gyroscope is listening and transmitting data on the angle of the door. - Lights work and respond to the Controller's commands.

Postconditions	
	• Light is enabled/disabled manually by user via app. • Arduino Base Unit enables light upon gyroscope being triggered.

7.3.5 Domain Model Diagram
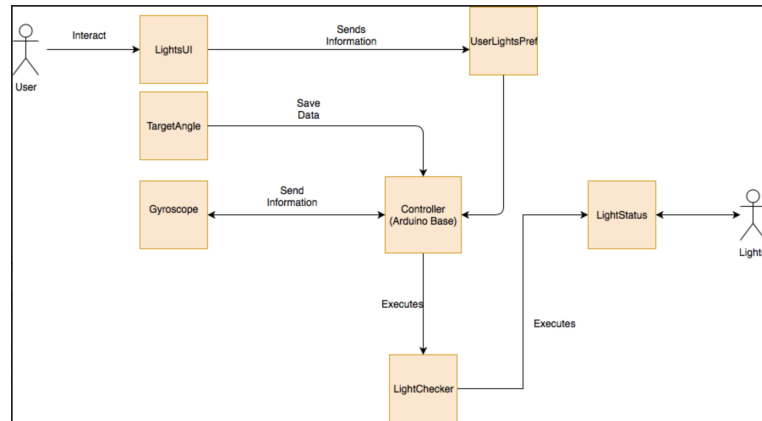
7.4 UC-4: Gyroscope is Triggered

7.4.1 Concept Definitions

Concept Name	Type	Responsibility Description
Controller	D	Rs1. Send signal to alarm and light to turn on
Gyroscope	D	Rs2. Read angle change when door is opened
Alarm	D	Rs3. Sound an alarm if unrecognized face is detected and door is gyroscope passes TargetAngle
Lights	D	Rs4. Turn on light if unrecognized face is detected and door is gyroscope passes TargetAngle
TargetAngle	K	Rs5. Stored value that, when exceeded, says that the door is opened
FaceRecognized	K	Rs6. Store collection of recognized faces, and send signal to camera if unrecognized face is detected

MotionSensor	D	Rs7. Send signal to turn on camera if motionSensor detects motion
Camera	D	Rs8. Take a picture if unrecognized signal is detected
MobileApp	D	Rs9. User notified when unrecognized face opens door
RemoteAlarmDisable	D	Rs10. Send signal to controller to disable alarm

7.4.2 Association Definitions

| Association Name	Concept Pair	Association Description
Sends Angle Data	Controller → Gyroscope	Gyroscope passes angle data to the Controller.
Alarm Activate	Controller → Alarm	Controller send signal to activate the Alarm noise.
Lights Activate	Controller → Lights	Controller send signal to activate the Lights on.
Gyroscope Trigger	Gyroscope → TargetAngle	TargetAngle checks if the Gyroscopes angle matches and activates the alarm system accordingly.
Face Recognized	Controller → FaceRecognized	Controller sends the picture the FaceRecognized for picture authentication.
User Notified	Controller → MobileApp	Controller sends a signal to the MobileApp to notify the user of alarm trigger.
Alarm Disabled	Controller → AlarmDisable	Controller sends AlarmDisable signal to the alarm system to turn it off.
Alarm Disable Requested	MobileApp → AlarmDisable	MobileApp requests that AlarmDisable is activated.
Picture Capture Requested	MotionSensor → Camera	MotionSensor signals the Camera to take a picture.
Picture Authorization Requested	Controller → Camera	Camera sends picture data to Controller to be processed.

7.4.3 Attribute Definitions

Concept	Attributes	Attribute Description
Search Request	User's Identity	Used to determine if the user is a resident, which in turn allows a user to enter the house.
	DoorAngle	Used to detect the possibility of unauthorized opening of the door.
Notifier	Mobile App Alert	Mobile app of the owner that gets notified of any alarm triggers.
Postprocessor	Recognized Picture	Recognized face for entry or denial of access.
	Trigger Angle	Marks when the door has been triggered as open.
	Disable	Ready to be disabled after alarm is activated.

7.4.4 System Operations Contract

Operation	Take Picture
Preconditions	- The Controller is set up. - The Gyroscope is listening and transmitting data on the angle of the door. - Lights work and respond to the Controller's commands.
Postconditions	- Light is enabled/disabled manually by user via app. - Arduino Base Unit enables light upon gyroscope being triggered.

7.4.5 Domain Model Diagram
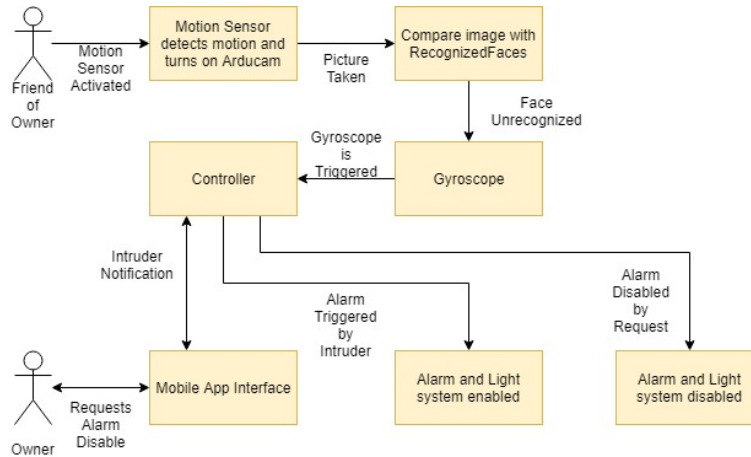
7.5 UC-7: System Control Features

7.5.1 Concept Definitions

Concept Name	Type	Responsibility Description
Controller	D	Rs1. Send signal to alarm and light to turn off
Alarm	D	Rs2. Turn off alarm once Controller sends the off signal
FaceRecognized	K	Rs3. Store collection of recognized faces, and send signal to camera if unrecognized face is detected
MotionSensor	D	Rs4. Send signal to turn on camera if motionSensor detects motion
Camera	D	Rs5. Take a picture if unrecognized signal is detected
MobileApp	D	Rs6. User clicks the"home mode" switch
RemoteAlarmDisable	D	Rs7. Send signal to controller to disable alarm
LoginDatabase	K	Rs8. Checks users login credentials.

7.5.2 Association Definitions

Association Name	Concept Pair	Association Description
Alarm Deactivate	Controller → Alarm	Controller send signal to disable the Alarm.

Face Recognized	Controller → FaceRecognized	Controller sends the picture the FaceRecognized for picture authentication.
User Notified	Controller → MobileApp	Controller sends a signal to the MobileApp to notify the user of alarm trigger.
Alarm Disabled	Controller → AlarmDisable	Controller sends AlarmDisable signal to the alarm system to turn it off.
Alarm Disable Requested	MobileApp → AlarmDisable	MobileApp requests that AlarmDisable is activated.
Picture Capture Requested	MotionSensor → Camera	MotionSensor signals the Camera to take a picture.
Picture Authorization Requested	Controller → Camera	Camera sends picture data to Controller to be processed.

7.5.3 Attribute Definitions

Concept	Attributes	Attribute Description
Search Request	User's Identity	Used to determine if the user is a resident, which in turn allows a user to enter the house.
Notifier	Mobile App Alert	Mobile app of the owner that gets notified confirming the alarm disable.
Postprocessor	Disable	Ready to be disabled by the owner at any time.

7.5.4 System Operations Contract

Operation	Take Picture
Preconditions	- The Controller is set up. - The Gyroscope is listening and transmitting data on the angle of the door. - Lights work and respond to the Controller's commands.

Postconditions	
	• Light is enabled/disabled manually by user via app.
	• Arduino Base Unit enables light upon gyroscope being triggered.

7.5.5 Domain Model Diagram
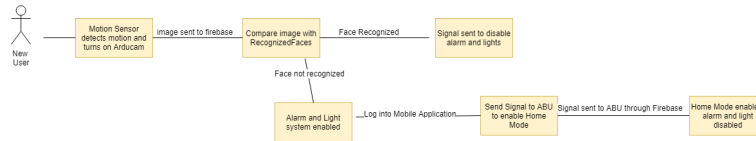
7.6 UC-10: User Profile Creation and Settings

7.6.1 Concept Definitions

Concept Name	Type	Responsibility Description
Database	K	Rs 1. Stores the list of current users and each user's respective privileges.
UserAdder	D	Rs 2. Connect to and update database to add new Users and give new users privileges on the mobile app
Database Connection	D	Rs 3. Send request to database to retrieve all user information and current privileges.
Mobile App User List Interface	D	Rs 4. Provide an interface on the mobile app for a user to view all the other users with access to the system and view each user's privileges
FormProvider	D	Rs5. Rs 5. Provide a form that asks for the new user's information such as name, picture etc.

7.6.2 Association Definitions

Association Name	Concept Pair	Association Description

| Conveys Requests	Database Connection → Mobile App User List Interface	Database Connection obtains the data from the database and pass the data to Mobile App User List Interface to displays the results to the user.
Provides new user form	FormProvider → Mobile App User List Interface	The Mobile App User List Interface provides the user the option to add a new user and the FormProvider gives the page to specify the user's credentials
Relays user data	FormProvider → User Adder	The inputted data from the user on the FormProvider is passed to the UserAdder which connects to the database and updates it with the new user.
Provides Information	Database Connection → Database	Database Connection access stored information the database and obtains the data to pass on to other concepts.
Sends user info	User Adder → Database Connection	UserAdder sends the new user's information to the Database Connection

7.6.3 Attribute Definitions

Concept	Attributes	Attribute Description
UserAdder	User's Information	Used to identify the person using the system
	User's privileges	Used to determine what features the user can access in the system.
Form Provider	Textboxes	The user needs a place to write their credentials (name, username, password, etc)
	Toggle buttons	Used to set the desired privileges for the new user (can control lights, alarm, camera, etc)
Database	User List	Contains the list of Users and each user's information
	Privileges	Contains data on each users different privileges
Mobile App User List Interface	User List	Shows all the recognized users of the system

7.6.4 System Operations Contract

Operation	Take Picture

Preconditions	• One user is already registered into the system and has access to the mobile app. • The Arduino system has already been set up.
Postconditions	• A new user was added to the system • The database is updated and the new user's face is added to the list of recognized faces

7.6.5 Domain Model Diagram
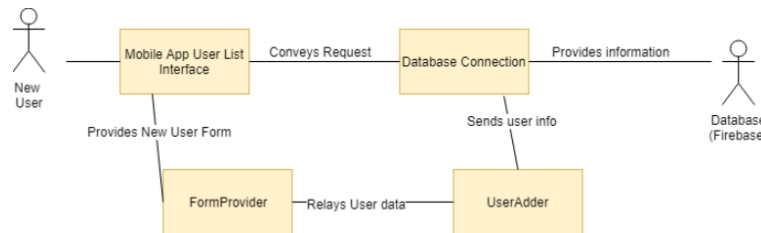
7.7 Traceability Matrix

(Use Cases (rows) v. Domain Concepts (columns))

Use Case	PW	Controller	Mobile App Pic Interface	Mobile App Security Interface	Server Connection	Arducam	Database Connection	Gyroscope	Alarm	Lights	Target Angle	LightsChecker	LightStatus	User Lights Pref	Lights UI	RemoteAlarmDisable
UC1	19	X	X	X	X	X	X									
UC2	16															
UC3	18										X	X	X	X	X	
UC4	17	X	X	X	X	X	X	X	X	X						
UC7	21	X	X	X	X	X	X		X	X						X
UC10	11															

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8 Project Size Estimation

8.1 Unadjusted Actor Weight (UAW):

Actor Name	Description of Relevant Characteristics	Complexity	Weight
User/Owner	User is interacting with the system via a graphical user interface (is able to modify settings on the arduino base unit manually and is also able to take photo from front door upon request).	Complex	3
Visitors	Visitors to the front door interact with the system by triggering the motion sensor. Depending on if the visitor is recognized and if the visitor also opens the door, the ABU will respond accordingly.	Simple	1
Arduino Base Unit (ABU)	The ABU is the main controller to the motion sensor, the arducam and the gyroscope. It is responsible for processing signals from the user such as take picture or turn on/off devices	Complex	3
Arducam	Is responsible for taking a picture when signaled to buy the ABU	Simple	1
Motion Sensor	Is responsible for detecting motion and indicating to the ABU that someone is at the door	Simple	1
Database	Is responsible for storing all the images of the different recognized faces and the all the pictures that the arducam takes (for the past day or past week)	Average	2
Alarm	Sounds when the gyroscope detects that the door opened (by an unrecognized face)	Simple	1
Light	Turns on/off when the door opens	Simple	1

UAW = Simple x 5 + Average x 1 + Complex x 2 = 5 + 2 + 6 = 13

8.2 Unadjusted Use Case Weight (UUCW):

Use Case	Description of Relevant Characteristics	Category	Weight
UC-1: Take Picture	Average User Interface. 5 steps for main success scenario. 3 participating actors(Arduino Base Unit, mobile app, Arducam). Its domain model includes 6 concepts	Average	10
UC-2: Facial Recognition	Average User Interface. 5 steps for main success scenario. Multiple participating actors (Mobile app, stranger at the front door, Arducam, recognized visitor, unrecognized visitor, Motion sensor) Its domain model includes 7 concepts	Average	10
UC-3: Light Control	Average User Interface. 9 Steps for main success scenario. Multiple participating Actors(Arduino Base Unit, Arducam, Motion Sensor, Alarm, User) Its domain model includes $\leq$ 10 concepts	Complex	15
UC-4: Gyroscope Triggered/Not Triggered	Average User Interface. 7 steps for main success scenario. Multiple participating actors (Arducam, Alarm, Motion Sensor, friend of the owner, Mobile App, Arduino Base Unit) Its domain model includes $\leq$ 10 concepts	Complex	15
UC-5: Alarm Control	Simple User Interface. Few steps for main success scenario (User just need to access the mobile app to either arm or disarm the alarm, and turn it off if triggered). Multiple participating actors(Arduino Base Unit, Gyroscope, Mobile App, unrecognized visitor)	Simple	5
UC-6: Fingerprint & Passcode Verification	Simple User Interface. Few steps for main scenario (User opens the mobile app and either taps finger for fingerprint reader or inputs passcode to access the app). 2 Participating Actors(User, Mobile App)	Simple	5
UC-7: System Control Features	Complex user interface and processing. 6 steps for main success scenario. 2 Participating Actors (Mobile App, Arduino Base Unit (ABU)). Its domain model includes 8 concepts	Average	10
UC-8: Call Emergency Services	Simple User Interface. Few steps for main success scenario(User opens up mobile app and taps icon representing calling emergency services). 2 Participating Actors(User, Mobile App)	Simple	5

UC-9: System Connectivity	Average User interface and processing, Few steps for main scenario(User is able to connect mobile app to arduino base unit and connect arduino base unit to internet). 3 Participating Actors(Arduino base unit, Mobile app, User)	Average	10
UC-10: User Profile Creation and Settings	Complex User interface and processing. 6 Steps for main success scenario. 2 Participating Actors(User, Mobile App) Its domain model includes ≤ 5 concepts	Complex	15
UC-11: User Logout	Simple User interface. Few steps for main success scenario(User must tap logout button from within the app). 2 participating actors(User, Mobile app)	Simple	5
UC-12: Registering a New Face	Simple User Interface. Few steps for main success scenario(User must take several photos through the Arducam and use mobile app to register new user face). Multiple participating actors(User, mobile App, Arducam, unrecognized visitor, Arduino base unit)	Simple	5

UUCW = Simple x 5 + Average x 4 + Complex x 3 = 25 + 35 + 50 = 110

UUCP = UUAW + UUCW = 123

8.3   Technicality Complexity Factor:

Technical Factor	Description	Weight	Assigned Value For Perceived Complexity	Value * Weight
T1	Distributed System	2.0	4	2 * 4 = 8
T2	Response Time/Performance Objectives	1.0	3	1 x 3 = 3
T3	End-user Efficiency	1.0	3	1 x 3 = 3
T4	Complex Internal Processing	1.0	3	1 x 3 = 3
T5	Reusable Design or Code	1.0	3	1 x 4 = 3
T6	Easy to Install	0.5	2	.5 x 2 = 1
T7	Easy to use	0.5	3	.5 x 3 = 1.5
T8	Portability to other platforms	2.0	3	2 x 3 = 6

T9	Easy to change/System Maintenance	1.0	2	1 x 2 =2
T10	Concurrent Use (by multiple users)	1.0	3	1 x 3 = 3
T11	Special Security Features	1.0	2	1 x 2 = 2
T12	No access for third parties (The system will be used from multiple sites in different organizations)	1.0	0	1 x 0 = 0
T13	No special User Training facilities are required	1.0	0	1 x 0 = 0

Technical Factor Total = 35.5
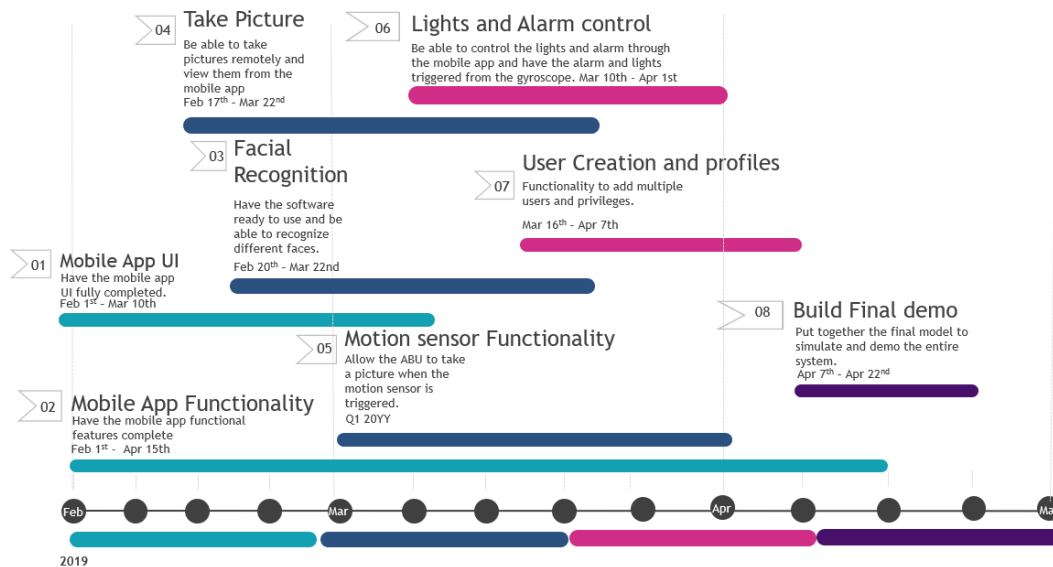
TCF = .6 + 0.01*35.5 = .955

UCP = UUCP x TCF = 117.465 ≈ 117

9 Plan of Work

9.1 Product Roadmap

Product Roadmap

After submission of Report 1, we intend to start getting more in depth with the actual development of our Home Security Automation project. Now that we have our requirements established and our priorities outlined, we know what we need to do in order to get the

project going. We have already started working on developing the Arduino Base Unit, modeling it off of prior groups. We have begun playing around with arducam and LED lights and figuring out how to utilize it in our system. We plan to continue working on the development of the mobile app and enhancing its functionality. The first feature we have decided to implement is the TakePicture functionality because of its extremely high priority and because it is necessary in order for us to implement additional auxiliary features. We want the user to be able to manually take a picture with the use of the app and to have the arduino base unit be able to take pictures automatically when triggered by the motion sensor. Upon starting the TakePicture feature, we would simultaneously work on the facial recognition feature. We are planning to split up into teams and effectively work on these two tasks. We have individuals who are familiar with the hardware aspect and with arduinos in general and we have individuals who are skilled in app development, so we believe that we will be able to find work arounds to deal with any potential roadblocks we may face. Our goal is to be able to implement the picture taking feature, facial recognition, and light/alarm control by the first demo date, and be able to demonstrate significant progress in these areas, as our highest priority use cases. Once we accomplish these features we will probably be able to determine more precise deadlines for the remaining tasks that we need to take care of.

9.2 Product Ownership Description

Hardware: Harmit, Andrew, Kaavya, Kaushal, Sagar

- Hardware refers to the setup of the arduino base unit (ABU) and making sure the physical components work with each other and that the ABU connects to the wifi shield and can be connected by wireless devices. (UC-1, UC-3, UC-4, UC-5, UC-7)

App: Abhishek, Sagar, Nikunj, Kaushal, Kaavya

- App refers to the mobile application functionality and basically the more software-oriented aspect of our project. Our app should give control to the user and allow the user to manipulate settings wirelessly. (UC-1, UC-3, UC-5, UC-6, UC-7, UC-8, UC-10, UC-11, UC-12)

System Connectivity: Harmit, Nirav, Miraj, Ashwin

- System connectivity refers to the arduino base unit (ABU) connecting to the server and connecting to the firebase database, allowing for the user to take and access pictures, and also determine if the ABU should disable the alarm and sensors. (UC-1, UC-3, UC-5, UC-9, UC-10)

Facial Recognition: Kaushal, Nirav, Ashwin, Miraj, Abhishek

- Facial recognition refers to the software determining if the camera picks up a recognized face. The software would need to be able to access the database of

faces successfully and cross-reference the photo taken with those photos. (UC-1, UC-2, UC-9)

10   Project Management

In order to successfully work on the first report, we had to revisit our initial submissions for the first two parts of the first report. Given the feedback from the first part, we had made revisions to it, but we decided to tweak it a little bit by modifying the system requirements in order to better interpret exactly what we intend for our project to do. We didn't really modify the second part of our report as we weren't provided feedback for that part. Using what we had written and decided in our first two parts of the first report, we added to the report our domain analysis for each of our fully dressed use cases. For each domain analysis we defined and elaborated on concepts related to each use case as well as associations between pairs of concepts and attributes. Upon completing each use case we compiled a traceability matrix to map the domains to the respective use cases. We also had to create system operation contracts for each fully dressed use case that we made. That was essentially defining the preconditions and postconditions for each domain analysis.

Upon completion of this part of the report, we decided to create an effective plan of work to determine how we would proceed for the remaining time left in the semester. We went along with our priorities determined by our use case traceability matrix to figure out how much time and which block of time to allocate for working on each use case of our project. We decided that we would tackle the TakePicture functionality of our project and also the facial recognition feature immediately and then work from there in figuring out the rest of our deadlines.

Our intentions are to complete the facial recognition and the TakePicture feature by the time the first demo date comes around. At that point we will have two of our most important use cases done and ready to go. We have also updated our product ownerships, and have decided to split up in teams in order to tackle hardware, app/software, system connectivity, and facial recognition. This will allow us to be efficient in the development of our project. By splitting up into groups we can meet in smaller, more intimate groups, in addition to our weekly full group meetings. This should allow for more frequent meetings and more progress towards the project to be made.

*This project management description focused on progress within the last week and future outlook. For past progress please refer to previous submissions of parts 1 and 2 of the first report.

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