



VIDEO DOORBELL

By:

Trey Brown

Michael Cheng

Jesse Jento

Brittany Marietta

California University of Pennsylvania

CSC 490: Senior Project I

Instructor Comments/Evaluation

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Abstract

The video doorbell is a device made with convenience in mind. For Video Doorbell, there are two main end-users. These end-users are the owner and the visitor. The usage of a camera and Wi-Fi makes it possible for the owner to answer the door even if they are not at home. When a visitor presses the doorbell button the visitor may view and talk to the guest if they choose. The camera saves a picture of the visitor when they press the button. If the owner chooses, they can also save a video of the conversation with the user. The owner can then later view or delete the picture/video if they choose.

The purpose of this document is to define the specifications of the hardware and software. This document specifies the design of the hardware/software and the flow of the data involved. This document gives the development team the ability to minimize any issues that could occur in further steps of the project. To be able to make a Raspberry Pi and the software work together requires constraints on many things. These constraints include: time and cost, as well as hardware and software limitations based on the aforementioned constraints. To have a complete product within the time frame many hours will go into the hardware and software portions of the product. Many separate moving pieces and parts will come together to form our complete product.

Description of Document

Purpose and Use

The purpose of this document is to define the specifications of the hardware and software. This document specifies the design of the hardware/software and the flow of the data involved. This document gives the development team the ability to ratify any issues that may need to be resolved. After the approval of this document, the team will consider the specifications final.

Intended Audience

This document is intended for the hardware and software developers of the Video Doorbell. The information in the document lays out the hardware and software specifications that the developers will follow. The team will use the use-case as well as the constraints to construct a final product that meets the acceptance criteria.

System Description

Overview

The Video Doorbell is a physical product that implements both hardware and software techniques to solve the busy owner's everyday struggle, missing someone at the door. With today's fast-paced society, it is hard to be home to receive every bit of important information or every package. The Video Doorbell aims to solve that issue. It uses the owner's phone to notify them when a visitor rings their doorbell while not at home, or busy. The two main parts are the hardware that will interact with the visitor and the software application portion that the owner interacts with. When the visitor presses the button on the Video Doorbell, the application notifies the owner that someone is present and captures a snapshot of the visitor at the door. After the initial snapshot, the owner can use the application's video interaction feature to answer the door. This feature allows the owner to speak with the visitor for up to three minutes on a single press of the button. The Video Doorbell aims to seamlessly integrate into the owner's everyday life.

Environment and Constraints

End-User Profile

For Video Doorbell, there are two main end-users. These end-users are the owner and the visitor.

- The owner's ability as an end-user is to answer the doorbell at any time. The Video Doorbell requires the owner to have access to Wi-Fi and a cellphone with online accessibility. The Video Doorbell also requires the owner to have access to install the product near their front, side or back door of their home. The Video

Doorbell requires that the owner have the knowledge to operate a smartphone. In addition, they must understand how the application works with the doorbell. The instructions on how to operate the application will be available when inside the app.

- The visitor's ability as an end-user is limited. The visitor's only interaction is with the physical product of the Video Doorbell. A visitor presses the button on the Video Doorbell to initiate a video and audio connection with the owner. The visitor doesn't need to have any background knowledge or training to work it. They simply press the button and wait for a response.

User Interaction

The user interaction involves two main devices, the doorbell, and a mobile device. The visitor only interacts with the Video Doorbell with the press of the button. The owner can then talk to the visitor through the camera and the microphone. The owner can also view snapshots taken by the camera for a short period of time, after which they will be deleted. If the owner chooses, they can also save videos of interactions with the visitor.

Hardware Constraints

The minimum hardware requirements of the Video Doorbell are described below. The final product may include hardware with better specifications than that outlined based on pricing and availability. To keep the cost of the overall product down, there will be specific constraints and specifications for the Video Doorbell. The base of the product uses a cost-effective microprocessing unit or single-board computer (SBC). A very cost-effective SBC is the Raspberry Pi (RP). Minimum specifications expected of this RP are as follows:

- Random Access Memory (RAM): 2GB Minimum

- Storage: 16GB minimum
- Bluetooth 4.0 or newer capability
- Wi-Fi 802.11a or 802.11ac compatible

The minimum specifications of the camera must be 5 megapixels (MP) for a clear image of the visitor.

These constraints of the hardware were defined to achieve a product that is both fast and reliable. In addition to being fast and reliable, the cost is a constraint to achieve a product worthy of the pricing.

Software Constraints

The Software constraints mainly focus on the ability for the app to work on both iOS and Android. We will likely need to use a development tool, such as Xamarin, to make the app work as if it is native to both platforms. We will also use Python to program the pi to communicate with its devices and the server/phone app.

Time Constraints

The time to complete is constrained to the length of a semester. To have a complete product within that time, it is in the team's expectations to have communication consistent enough to complete on-time. Many hours will go into the hardware and software portions of the product. To comply with the time constraints, we will conduct weekly updates for the team to stay on pace.

Cost Constraints

The costs associated with the development of the Video Doorbell include, but are not limited to:

- Microprocessing unit (Raspberry Pi) — \$15 - \$50
- Raspberry Pi Camera Module — \$10 - \$15
- Pushbutton — \$5 - \$25
- Microphone — \$5 - \$10
- Speaker — \$3 - \$8
- SD Card — \$5 - \$15
- Misc. Supplies
- Mobile Device with mobile application capabilities

Acceptance Testing Criteria

Testers

The development team will primarily conduct the testing using the prototype. During the development phase of the project, our Computer Engineer Member will focus on ensuring that the Video Doorbell physical product meets all standards set. These standards are to ensure proper operation of the product over its lifetime. Guaranteeing proper voltage and current levels for each component as well as functionality and cohesion with the product as a whole is crucial in creating the final product. Most of the software testing will be done by the remaining members of the group that has a heavy background in the Computer Science programming field. These members will ensure that understandable, and operational code has been written so that no bugs

occur in the final product. They will work to keep the post-delivery maintenance of the final product at a minimum.

Criteria for Acceptance

Making sure the owners of the Video Doorbell are satisfied is a priority. Therefore, we want to achieve a product that integrates seamlessly into everyday life without causing any extra issues. Using techniques to increase the responsiveness of the system, we believe will contribute to an overall user-friendly product. Faster recognition of initiation of the system process on the hardware side contributes to owner satisfaction.

The final product must:

- Have the app be available for download on all phones.
- Give the owner the ability to speak with and view the visitor at the door from anywhere.
- Give the owner the ability to save/delete interactions with visitors.

Integration of Separate Parts and Installation

The integration of the hardware components is crucial for a product worth buying. The Raspberry Pi will be the integration medium that connects all the components including the Pushbutton, Camera, Speaker, and Microphone together. Once these parts are connected, seamless integration between the hardware (front-end) and software (back-end) is imperative for the final product. There will need to be a connection to the internet via Wi-Fi for the phone application and the Video Doorbell to communicate. Once a connection is established between the internet and the Wi-Fi, the application can then communicate with the camera and microphone.

The installation of the product is simple: the owner installs the product next to any door at their house and downloads the application from their respective app store. The owner can use a drill to mount the doorbell on a wall, or on the frame of the door. After the doorbell is mounted, the owner can then follow the instructions to connect their phone to the Video Doorbell. The doorbell is fully functional upon completion of the installation process.

System Modeling

Functional: Use Cases & Scenarios

Once the owner installs the doorbell, they can then download the app from the app store. After installation, the owner will be prompted to connect to the Wi-Fi. After the initial setup, the owner will receive a notification whenever someone is at their door.

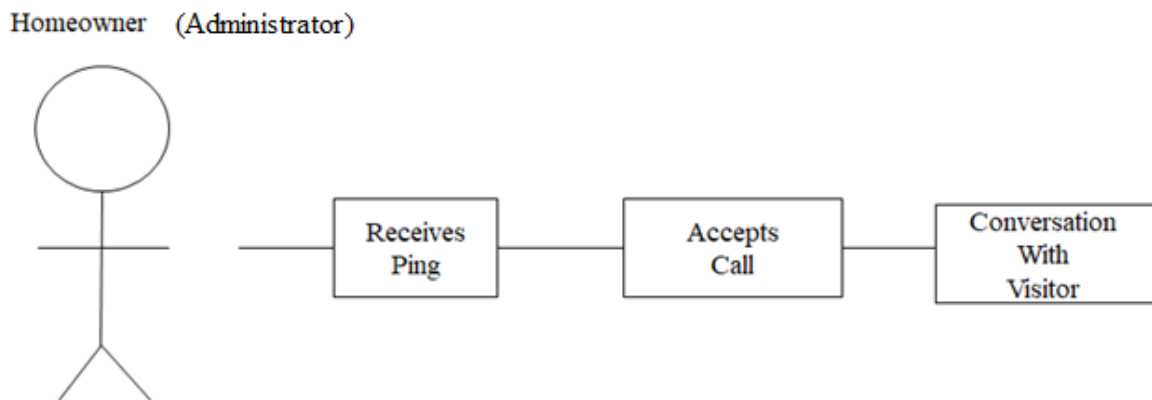


Figure 1 (Owner Answers Call)

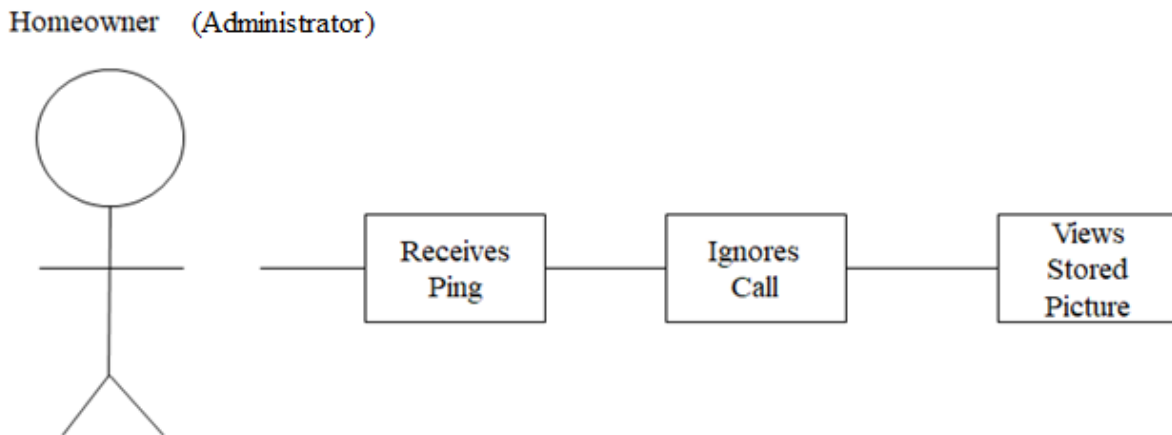


Figure 2 (Owner Denies Call)

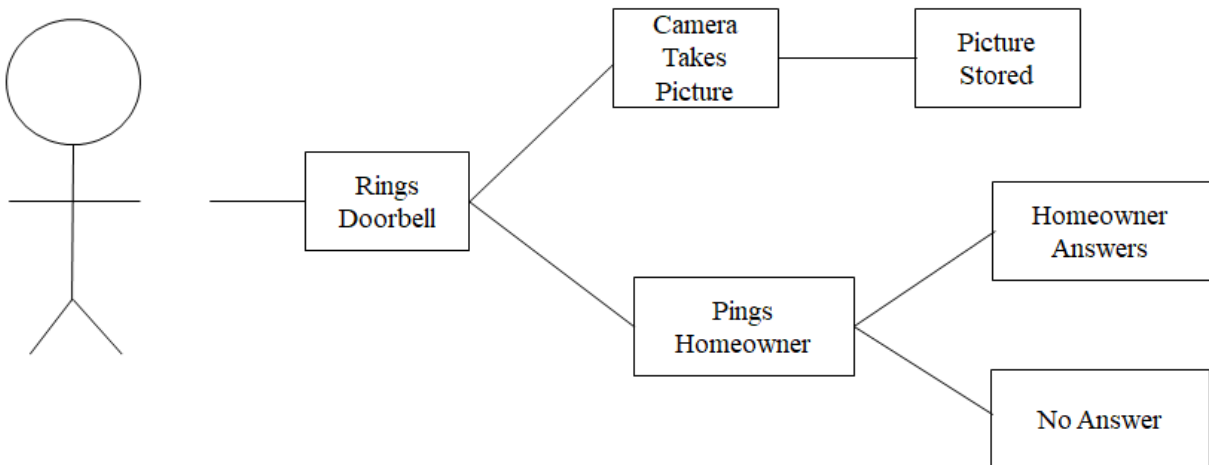
This scenario is as follows:

1. The visitor presses the button on the doorbell (Figure 3).
2. The button triggers the camera to take a picture and upload it to the server.
3. The doorbell sends a request to the server through the Wi-Fi to the owner's phone as a notification.
4. The owner can choose to either speak with the person at the door or ignore the notification.
 - a. If the owner chooses to Ignore the notification, the owner can view the photo taken then the scenario ends (Figure 2).
5. The owner accepts the notification for the request sent by the server (Figure 1).
6. The camera turns on and starts a live video feed which is sent to the owner's phone app.
7. The microphone turns on and communicates its audio to the owner's phone speakers through the app.

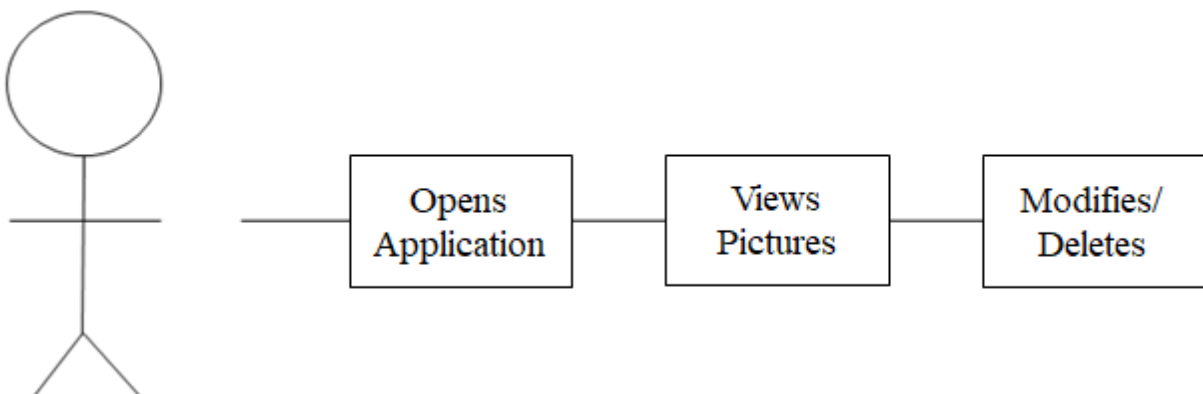
8. The phone app gains access to the owner's microphone and sends the feed to the speaker through the server.
9. The owner is now free to communicate with the visitor at the door.
10. The owner ends the conversation through the app.

A picture is taken and stored when the visitor presses the button. The owner can view this picture at any time by logging on to the app. The owner can delete or view the pictures/videos whenever from their phone.

Visitor (User)



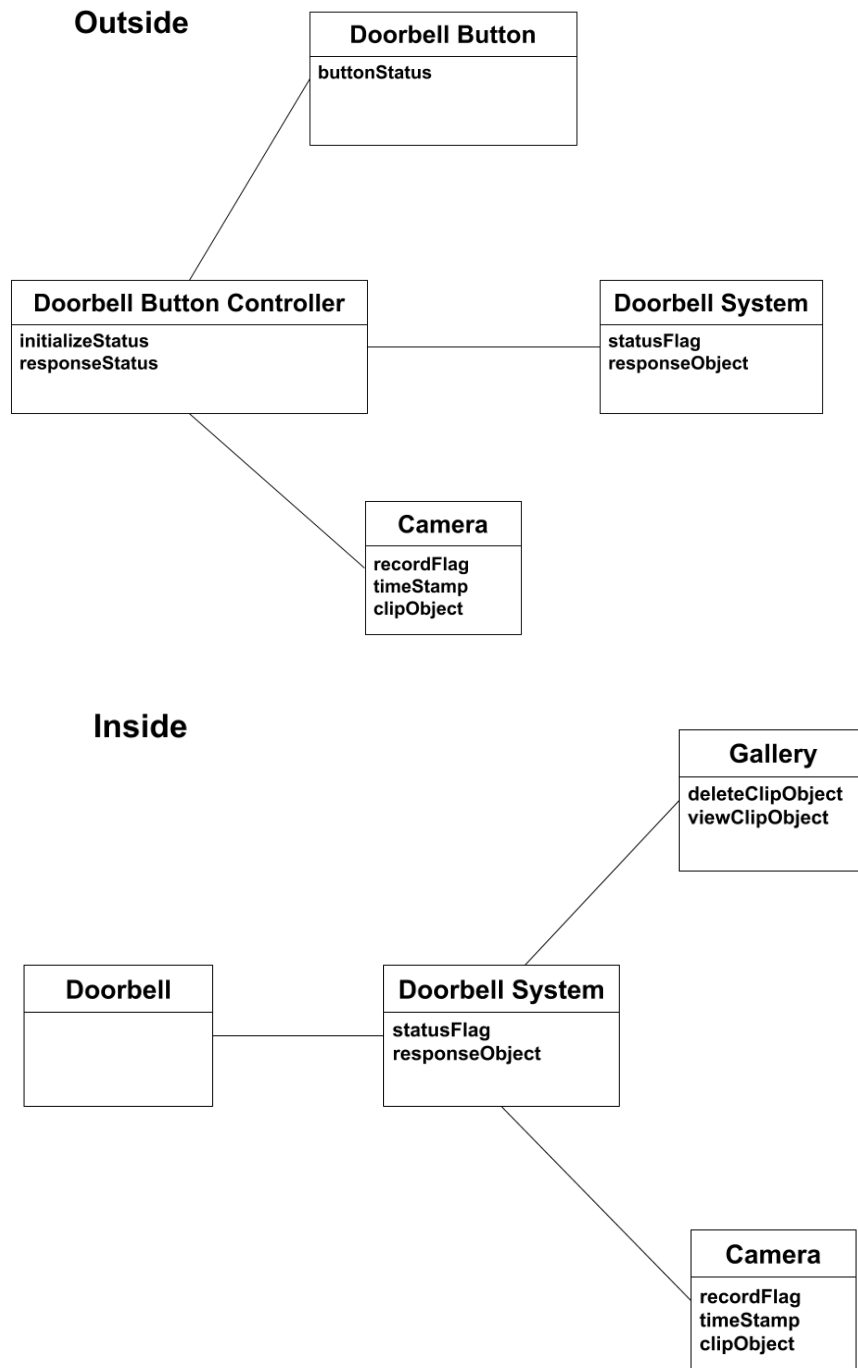
Homeowner (Administrator)



This scenario is as follows:

1. Owner opens their application.
2. Owner uses the login information to access the application
3. Owner accesses a bank of recently taken pictures on the application.
4. Owner chooses to delete/save/view pictures taken by the doorbell.

Class Diagrams



Class Descriptions

Doorbell Button Class - The Doorbell Button class generates a true signal when the button is pressed.

Doorbell Button Controller Class - The Doorbell Button Controller class stores the signal and generates a true flag and a response request if the stored signal is true.

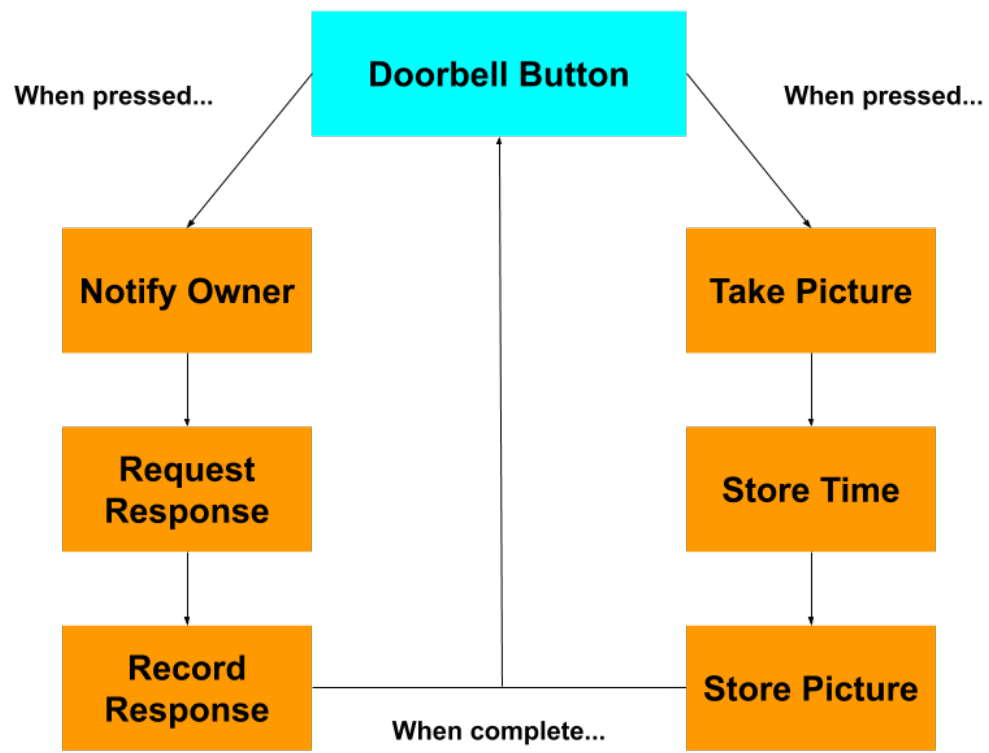
Doorbell System Class - The Doorbell System class stores the flag and generates an alert if the stored flag is true. This alert will request a response, and the response will be stored as soon as one is made.

Camera Class - The Camera class stores the flag and generates a photograph when the stored flag is true. Furthermore, the timestamp of the photograph is generated.

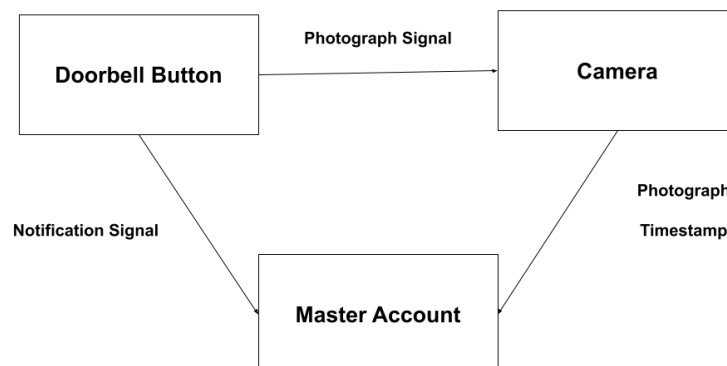
Gallery Class - The Gallery class stores the photograph as well as its timestamp. Also, it generates an interface that allows the owner to view and/or delete photographs.

Doorbell Class - The Doorbell class is the base class for all the classes listed above.

State Chart



Dataflow Diagram



Components / Tools Needed

There are several components and tools are needed to complete the project as proposed.

These include, but are not limited to:

- GPIO wires: For wiring up the system to have all components work together.
- Cell phone: With an internet connection and functional speaker and microphone.
- Raspberry Pi SBC: Used as the brains of the Video Doorbell
- Camera, speaker, and microphone modules: Used to complete the doorbell physical product.
- Storage card: Used for having the software loaded to the doorbell
- Pushbutton: The button used by the visitor to ping the owner.
- Resistors and Transistors: to regulate and possibly amplify the voltage from the system to the components.

References

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“Pi Camera Module Interface with Raspberry Pi Using Python: Raspb..” *ElectronicWings*,
www.electronicwings.com/raspberry-pi/pi-camera-module-interface-with-raspberry-pi-using-python.

Appendix A: Technical Glossary

Admin - Short for administrator and analogous with the owner.

Android - a Mobile operating system developed by Google.

Bluetooth 4.0 - A personal area network to connect devices wirelessly over short distances.

Breadboard - A construction base for wiring up systems of electronics.

C++ - A programming language used for the main operation of the product.

iOS - The iPhone Operating System.

Microprocessing Unit - A device that contains core computer components on a circuit board.

Push Button - Physical button that the user will press to initiate device operation.

Random Access Memory (RAM) - A form of a computer memory that is accessible quickly.

Raspberry Pi - A small computer that has input and output functionality.

Raspberry Pi Camera Module - A camera module sold to seamlessly work with Raspberry Pi.

Resistor - Hardware that is used to limit the current to a system.

SD Card - A storage device that is used in portable devices.

Transistor - Hardware component used to amplify electric signals and power.

Use Case - Visual description of how the product operates.

User - Described as the person interacting with the physical product, analogous with a visitor.

Video Doorbell - The title of our project to provide a solution to missing visitors at a person's home.

Wi-Fi 802.11a/802.11ac - Wireless internet standards that vary in distance, and throughput.

Appendix B: Team Details

This document was created, revised, and finalized by the following individuals:

Trey Brown - Trey was responsible for the System Description section and the Components/Tools Needed section. Since he is the Computer Engineering Major of the group, he was most knowledgeable about the hardware and cost constraints. He received help from the rest of the members on the software constraints section.

Michael Cheng - Michael was the team leader for this document and he was also responsible for creating the Class Diagrams, Class Descriptions, State Chart, as well as the Dataflow Diagram.

Brittany Marietta - Brittany was responsible for Abstract, Description of Document, Purpose, and Use, and Intended Audience. In addition, Brittany helped ensure that all the formatting and grammar was correct and according to the specifications.

Jesse Jento - Jesse was responsible System Modeling section, helping create all the use cases and scenarios. Jesse also helped in correcting any grammar mistakes.

Appendix C: Workflow Authentication

I, Trey Brown, hereby attest that I have performed the work as documented herein.

_____	_____	_____
Printed name	Signature	Date

I, Michael Cheng, hereby attest that I have performed the work as documented herein.

_____	_____	_____
Printed name	Signature	Date

I, Brittany Marietta, hereby attest that I have performed the work as documented herein.

_____	_____	_____
Printed name	Signature	Date

I, Jesse Jento, hereby attest that I have performed the work as documented herein.

_____	_____	_____
Printed name	Signature	Date

Appendix D: Report from the Writing Center

Cal U Vulcan Learning Commons Report

Client: Trey Brown

Staff or Resource: Brittany Kach

Date: November 14, 2019, 12:30pm - 1:00pm

What course was serviced by this visit?: CSC 490

Did the student request that the instructor receive a visit report?: Yes

Please provide any additional comments relevant to this session.:

How did the process of this consulting session address the established goals?: The client brought in his specifications document for a group project. We reviewed it for grammar and phrasing.

We talked about expanding the abstract so that it acts as more of a summary of the entire document. We talked about word choices like "homeowner."