

Open Sesame

Introduction

In the past, garage doors were used to secure cars or tools for the night. As attached garages have become a standard of building design, garage doors now serve the purpose of a front door for many families. Open Sesame is going to take on the challenge of merging features found in a variety of openers on the market to present a convenient solution to forgetfulness and security. The members of team Open Sesame are Denise Garcia, Ka Hin Lee, Veronica Martinez, Jane McGuinness, and Angela Savela.

Problem Description:

Many homeowners across the world are plagued with the common problem of forgetfulness or absent-mindedness. And arguably, one of the largest issues that forgetful homeowners have to deal with is whether or not they remembered to close the garage door. This concern, however, is not limited to the chronically forgetful. It can affect anyone who is simply not paying attention or is distracted momentarily thus leading to a wide open garage door. Forgetting to close the garage door is a mistake that can easily be made when leaving or even entering the home. An unattended, open garage door can lead to many dangers such as burglary, trespassing or a small child escaping. There are even minor annoyances that can come from an opened garage door such as a pet running away or unwanted weather damage to cars or homes. It is almost impossible to determine whether or not the door was opened or closed once one has left their residence. Lack of control from a distance not only means the door may be left open, but also that it cannot be opened to allow entry to permitted visitors (such as maintenance workers).

Proposed Solution:

Although many people fall victim to a gaping garage door, it does not mean the problem cannot be remedied. The headache of the many will be answered and that answer is “Open Sesame.” In an attempt to tackle these problems, the team will develop the next-generation garage door system. The system will interface with an existing garage door and include the traditional controls while incorporating the capabilities of the new features. Using a network of sensors, the garage door will automatically open as the user’s car approaches, and close upon their departure. This eliminates the need to search for a remote and lessens the likelihood that the door will be left open. In the event that the user wishes to check on the status of their garage door, they will be able to access a smartphone app and request information remotely. The system would be able to relay the state of the garage door by sending a message, or take and send a picture of the door to the user in the event that the user requests visual confirmation. Finally, the user would be able to control the garage door motor from their smartphone, eliminating any concern. They could both close a door when it is left open and open it for permitted guest while at work. Additional security features would include sending status updates to the user whenever the garage door changes position. Additional safety sensors will be included in the garage to prevent the door from closing on any object.

Demonstrated Features:

- Safety system - There will be sensors near the door opening to detect if something above a pre-determined height is directly in the path of the door’s closing motion. If an object is identified as an obstruction, the door will not be able allowed to close.

- Automatic door open/close system - The system will detect if the user's car is within a threshold radius from the garage. If the car is within the radius, the system will automatically open the garage door, and if the car leaves the threshold radius, the system will automatically close the garage door.
- Remote visual of door - There will be a camera to remotely provide a visual of the garage door, which is sent wirelessly to the owner's mobile device. The monitoring system will send a message if there are unexpected garage door openings, and can also be programmed to send updates of the door's status when desired.
- Remote open/close system – The user will be able to remotely open or close the garage door using their mobile phone.
- Classic control panel and remote control - The garage door system will still contain the standard features of a garage door system currently available on the market, namely a classic button control panel in the garage and a remote control that can be placed in a car or a secondary user of the system.
- Battery system - A battery system will be used to power some, if not all, of the sensors and the remote control. The system will be required to provide low power and to have a long lifetime (ideally, a year).
- Fail-safe routines - If the garage door is detected to be open for a long amount of time or if the door never fully closed, a message will be sent to the user's mobile device. In the case of a power outage, the system will have a recovery mode.

Available Technologies:

The main aspect of the project is the sensor system that will detect both the car (when leaving and arriving) and anything that would obstruct the opening and closing of the door. To accomplish this, as well as to provide images of the door to a mobile device, the system requires the technologies listed in Table 1.

Table 1. Required Technologies, Purpose and Estimated Costs

Part	Use	Estimated Cost
Ultrasonic Range Finder	To detect objects in the line of view of the garage door	\$40
Infrared Proximity Sensor	To detect car approaching or leaving the driveway	\$20
Webcam	To take images of the garage door	\$30
Surveillance Camera	To take images of the garage door	\$20
AA Lithium Batteries	To power the sensors, camera, remote control	\$4/battery
Garage Door Opener	To open/close garage door; includes motor with chain system, 2 remote controls, light	\$150

Finally, the project requires wireless technology to send the webcam image to a mobile device and allow the phone to signal the door. The options for this kind of technology can be approached by the use of a mobile app, Bluetooth, ZigBee network, or an electric imp. Bluetooth

creates a personal area network to connect devices, like the webcam to mobile devices. ZigBee utilizes mesh networking to send data over long ranges in a wireless sensor network. The electric imp card allows connectivity between electronic devices that were previously unconnected.

Engineering Content:

In order to address the problem and demonstrate the proposed features, multiple engineering tasks will have to be accomplished. These will be required to not only create the prototype, but also to ensure that it functions as expected. Figure 1 illustrates the connections between the various components of the system.

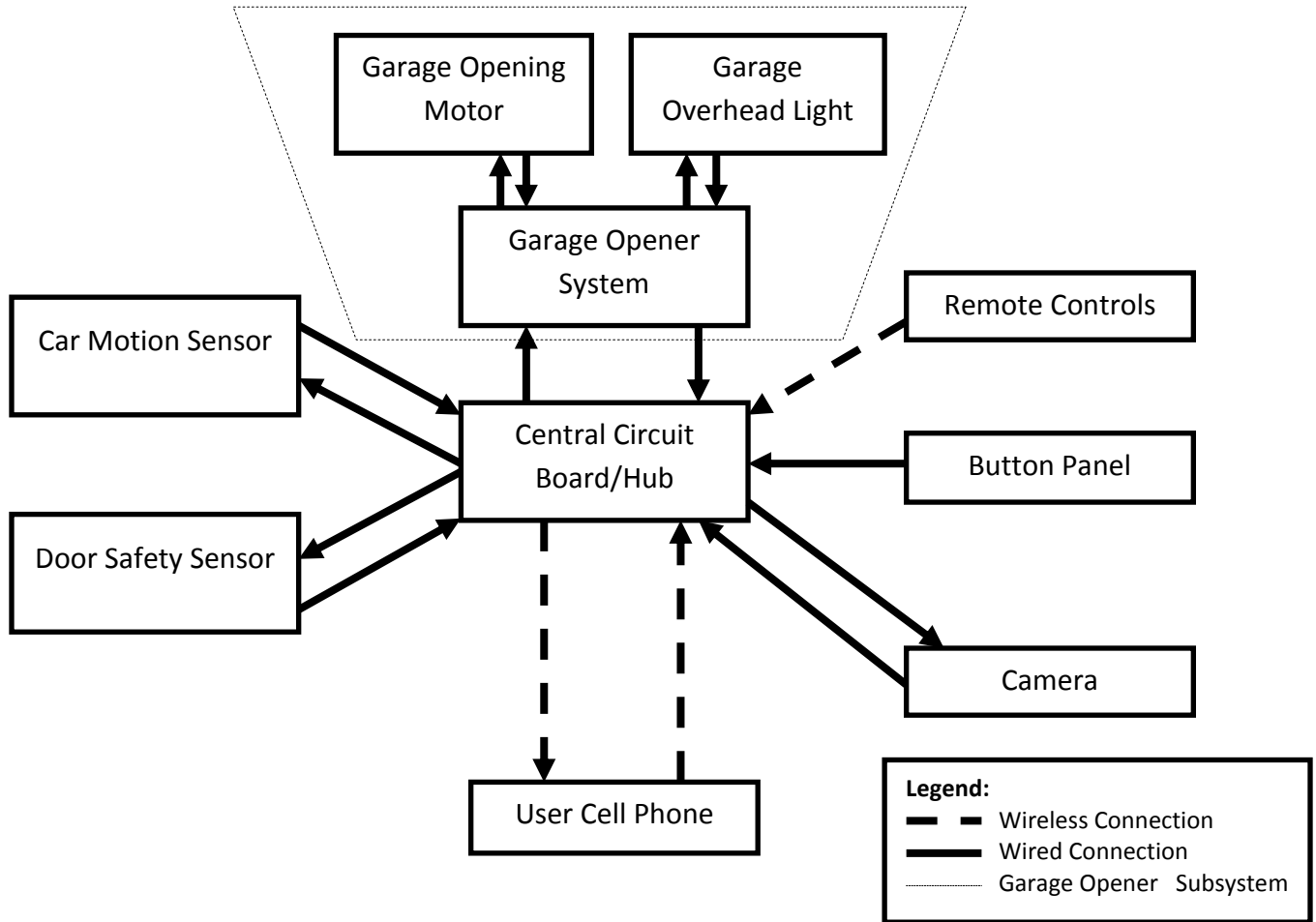


Figure 1. Proposed Block Diagram for the Open Sesame System

Main Hub Interface with Garage Door Opener

A key part of the engineering content will involve interfacing with an existing garage door opening system. As an already built motor and arm system will be utilized as part of the design, the components and circuitry that are built-in will have to be analyzed and understood. The Open Sesame system will have to replace and incorporate the signals that the opener would otherwise get from its basic remote and buttons. Communication with the light system and existing safety features will also have to be established.

Cell Phone Communications

Another subsystem of the project that will require significant engineering is the user interface with the system, particularly from long range. Open Sesame intends to use the capabilities of a cell phone to allow the user to check the status of their garage door (through sensor reading results and photos) and to close or open the door when away from home. This will require programming either a smartphone application or implementing a different wireless system to establish this communication. A way to transmit both images and open/close commands will need to be chosen and then executed.

Main Hub Interface with Sensors

Interfacing and communication will also need to be established between the sensors and the main hub as well as between the camera and the hub. Dialogue with the camera must also be established. Once a camera technology has been chosen, programming and circuitry will need to be created to signal the camera to take a photo at the user's request. This image must also be processed and then sent to the user. Various options for sensor technologies will need to be evaluated. The system will likely require multiple types of sensors to perform all of the automation desired. These sensors and their specifications will have to be fully understood and utilized to connect them to the system effectively.

Wireless Communications

Since some of the components of the system will not be physically connected to the central hub, wireless options will have to be explored. The wireless communication must be set up, programmed and thoroughly tested to quantify its limits. The engineering required to utilize the technologies available to connect the system to the phone is critical to the success of the project.

Core Program

Due to the variety of sensors and user-interface devices that will be determining door openings and closures, an efficient but thorough program must be developed to handle the decision-making based on these signals. Priority must be assigned to sensors related to safety features and then to the other devices by importance or likelihood of usage. Some memory may also need to be incorporated so the system knows whether the door was last opened or closed, especially in cases of power outage in order to reestablish the system in working order.

Power Supplies and Batteries

Power supplies to the various sensors and remotes that this project will entail will be another problem that must be solved. The source will have to power the sensors running continuously as well as any communication with the rest of the system. Power will also need to be supplied to the remote. Different battery or potential wired power sources will be evaluated to determine which can provide low power with long life. Other considerations such as ability to withstand outdoor environments, recovery from power outages and reliability are also important.

Demonstration of Functionality

In order to confirm that the product works as expected and proposed, a testable version of the system will need to be created. Possibilities include building a small scale model of a home

and garage system that would be able to incorporate the actual sensors, but not a full scale garage door opener. Another option would be to test the system using a real garage door motor and arm, but not attach it to a full-sized garage door for feasibility considerations. As a final test, incorporating the system in an actual home to monitor functionality with a real customer user would be ideal.

Conclusions:

The aim of this project is to modernize a garage door system by taking advantage of today's technologies. Open Sesame will bundle the convenience of a smartphone with this system to create a powerful tool for absent-minded and security-conscious homeowners. The primary goal is to improve total home security through quick sensor status updates and visual picture notifications. The overall effectiveness of the product will be determined by how well the system will be able to notify the user and if the product was able to successfully operate the garage door through sensors input, phone signals and traditional controls.