# HOME AUTOMATION SYSTEM

Ivan Petrov, Surbhi Seru, and Stoyan Petrov
*School of Engineering Science, Simon Fraser University*

## INTRODUCTION

Quality of life is largely dependent on an individual's independence in performing activities of daily living [1]. The freedom that each individual possesses governs their happiness. Such freedoms include the ability to adjust the environment to meet their needs without having to rely on someone else. This project began by noticing that once a person is physically disabled, their freedoms are largely limited and these individuals often have to rely on someone else for assistance. With advances in technology, this no longer has to be the case.

We have designed and developed a simple and inexpensive Home Automation System that enables individuals to control household features or devices from their computer or a handheld device. The current system includes the control of light switches and doors but the system design is open-ended and it will be expanded to include many other modules such as heaters, televisions, and multimedia systems.

## MOTIVATION

One freedom that is often limited for a person with a physical disability is privacy. Everyone needs their privacy once in a while. One way to create some privacy is to be able to close a room door. Unfortunately, the ability to open and close a door is a seemingly simple task that many individuals are unable to perform on their own, including the disabled and the elderly. Similarly, operating a conventional light switch is also sometimes difficult or impossible for disabled and elderly individuals, depending on their abilities. There are also many other tasks with which the individual may require assistance from another individual or an automated control system. Not being able to operate devices around one's home at will increases an individual's dependency and vulnerability, which in turn affects their well-being [1].

The inspiration for this project came from a conversation with a disabled individual who expressed that he wanted to be able to open and close his door on his own. He is currently able to control his light switches and room heater, but each has its own separate interface: the light switches he controls through his computer and the heater he controls through his wheelchair user interface. We realized that it would be beneficial to have a single automated system to control all these utilities, and more. However, most Home Automation Systems available today are either limited in their capabilities, difficult to operate, and expensive to integrate in the home. With this in mind, we have developed a method to potentially control almost every utility within the household using one device in a simple and inexpensive manner.

Since this project began with the goal of allowing a person with physical limitations to create more privacy by closing their door, a lot of time was spent on designing the door control module. Most residential door openers available today have their own independent user interface (a proprietary remote control) that is difficult to integrate with other user interface systems such as a computer, a tablet, or a multipurpose handheld device. Furthermore, many automatic door openers prevent concurrent manual use of the door, which is an issue when there are multiple individuals of varying abilities using the same space. Similar issues are found with light switch control systems and other environmental control systems. This lack of versatility increases abandonment of assistive technology [2]. Our Home Automation System addresses the issues of versatility and integration and also incorporates expandability.

We believe that improving the luxury and comfort of the user is of utmost importance and hence we have placed added focus on being able to control multimedia devices. Ultimately, a product is successful not only because of its efficiency but also because the user enjoys using it; this is precisely what we aim to achieve. Furthermore, the simple but practical design of the system allows for expandability: one system may include several different individually-controlled modules of the same type and there is room for development of more module types. The key features of our Home Automation System are its usability, versatility, and expandability.

## SYSTEM OVERVIEW

The system consists of a graphical user interface (GUI), a central control unit (CU), and several target modules. At this stage, the target modules are light switches or doors. The CU communicates individually with the light switch modules and the door modules using secured radio frequency (RF) technology. Each module identifies itself with the CU once it is connected. After the CU has identified the various modules available, it supplies this information to the GUI, which is currently accessible via a computer. The user is then able to send commands to the CU to operate the modules as desired using the simple and straightforward GUI. The CU and the GUI interact with each other using Bluetooth to ensure security and reliability.

Figure 1 presents an overview of the system, including modules and user interface devices that are yet to be developed. An advantage of our design is its flexibility; the user is able to add as many or as little modules as they desire and each of them will be recognized individually by the CU.
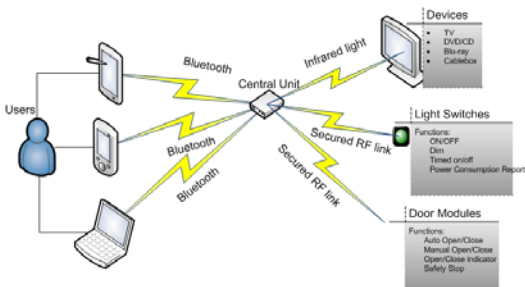


Figure 1: Design Overview

### Installation and Setup

The ease of installation and setup is an important factor that encourages or discourages an individual from obtaining any type of assistive technology. For this reason, we have strived to create a system that is simple and intuitive to install and set up.

The interfaces between the Home Automation System modules and the original devices are easy to install. The light switch module comes with a standard sized replacement light switch and face plate with the system circuitry built in. The replacement light switch module is powered through the mains, as with the existing light switch. Since the extra module circuitry is small, there is nothing visible on the outside of the light switch, thus it does not affect the aesthetics.

The door control module mounts onto the inside hinge-side wall beside the door with an extended arm that attaches to the door. The arm is connected to a motor that enables the opening and closing of the door. Both the module and the arm are easy to mount and do not require any specialized equipment or skills. The wall unit is in a compact box and both the wall unit and arm may be made available in a variety of colors to increase the aesthetic appeal of the system. The door control module is powered by a standard DC power adapter that may be plugged in any nearby power outlet.

The CU is also powered by a standard DC power adapter and may be placed in any central location in order to communicate with all the modules as well as the GUI. The user will install a simple program on their computer that runs the GUI, which enables them to communicate with the CU and operate the system. Due to the modular design of the system, the GUI software will not store any information on the local hard drive. This design will allow the user to install several control interfaces on different computers or devices and they will all synchronize with the CU.

### User Control

The user interface allows the user to control each module separately and uniquely. Each of the light switches may be turned on, off, or

dimmed to a certain intensity using the GUI. At the same time, the light switches are also designed to allow for manual on/off control. Similarly, the doors may be opened, closed, or stopped at a certain position, but can also be moved manually. Allowing for manual control of modules adds to the overall user experience and practicality of the system.

Safety

As with all assistive technology systems, safety is of highest priority. Each module complies with the relevant safety standards and has feedback mechanisms in place. This is especially important with the door control module because the system has to be prepared for situations when there is an object obstructing the path of the door. To achieve this, we have feedback mechanisms that measure the current supplied to motor and the angle of the door so that when the current and angle are not correlating properly, the CU becomes aware that the door is being obstructed. In order to do this accurately we are using a fast microcontroller that provides real time information.

If the CU recognizes that a module is malfunctioning in any way, it will notify the user by relaying this information to the user interface. The user will then be able to take appropriate steps to restore the module's functionality.

## FUTURE DEVELOPMENT

Future developments of the system will include separate modules for the control of amenities including heaters and fans and multimedia systems including televisions, stereos, DVD players, and PVRs. As with the door and light switch modules, these will be universally designed to be able to interface with most common units.

The GUI software will later be ported so that it may be used through various other devices including handheld tablets and cell phones. This is possible because of the simplicity and versatility of the communication between the GUI and the CU.

## CONCLUSION

Our Home Automation System is aimed to improve the quality of life of disabled and elderly individuals by providing easy access to everyday utilities and increasing their independence. Independence is our greatest luxury and as the user becomes more independent, their quality of life increases [1]. The open-ended design of the Home Automation System allows for easy expansion of the modules and integration of more user interface devices – the possibilities are essentially limitless. Overall, our system will enable disabled and elderly users to be able to control their entire home with their fingertips in a simple and elegant manner.

However, what began as a system to assist a physically disabled individual to improve their privacy has become a complete Home Automation System that may be used by abled and disabled individuals alike. It allows every user unprecedented control of their home and we believe that this system and its simple, modular design could change the way we interact with our homes.

## ACKNOWLEDGEMENTS

## REFERENCES

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