

University of Missouri - Columbia

Project Proposal - Remote Light Control

Department of Computer Engineering

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Embedded Computing - SS2015

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Objective

The problem that I will address is that of creating an easy to use home automation system that easily allows home led lights to be controlled from a user's phone as well as from the normal wall switch. This solution is designed to mitigate many of the issues which currently plague home automation systems. Currently home automation systems are inflexible, often either the whole system is entirely controlled from your smartphone, or the system is controlled with a tv style remote. In conjunction to this, many of the systems lack a quick response time which is extremely important. The instant that a user requests a system change, the system should react smoothly and quickly.

My goal is to create a seamless home light automation system which allows multiple forms of intelligent control while still maintaining quick and intuitive control.

Alternatives

There are currently many home automation systems, the most popular is X10 and another is the Z-Wave product line.

The X10 uses a system which sends commands over the powerline in the down cycle of the AC power line. This system is reliable but is very slow and unpredictable. It also doesn't allow the user to have any feedback as to the state of the system. In fact the X10 system has no wifi or bluetooth control. Instead it requires the user to either develop his own system or to use a remote control to control the lights. The paddle switch for the wall also only has a single button instead of two presenting a confusing and unintuitive system where the user holds down the button for various times to decide whether the light is being dimmed or brightened.

The Z-Wave system is a much better system in the sense that it does allow wifi and bluetooth control of the system with the proper systems purchased and installed, but requires the user to purchase special light bulbs and switches to control those light bulbs or expensive light switches. The Z-Wave system is the closest to the desired functionality, but still doesn't offer enough functionality control. It doesn't allow the control of the ramp up speeds for the light, which dictates how quickly the light dimming or brightening occurs. It also is a glitchy unreliable system from many of the user's reviews which is a serious problem when one is relying on a system to allow the remote control of a house.

System Goal

The short term goal of my system is to create a simple Android application which can rapidly with little to no delay enable control of a light. Simultaneously the light should always be controllable from a physical position as well since the majority of controlling lights in a home is through the intuitive wall switch.

The long term and final goal of the project is to in fact create a mesh network of low energy bluetooth switches that allows the control of any light in the house without need for a wireless network spanning the house. The mesh network would transmit a request rapidly throughout the home allowing the user to not be connected to not be in range of the desired switch to control, but still be able to control it.

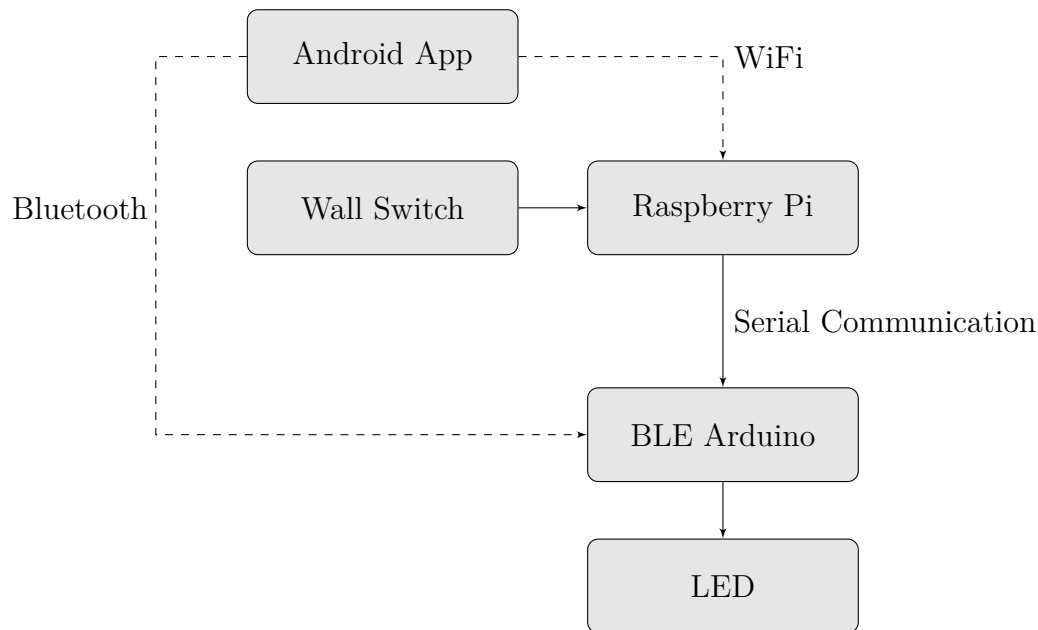
Specifications

For the original prototype, the main system will be controllable by both wifi and bluetooth. Each command will include a unique timestamp to prevent duplicate command execution. Once the user issues a command from either the Android app or physical rocker switch, an LED hooked up to the arduino will signify the state change and potential for controlling a houses light.

The final design would also include a low energy bluetooth network element where the low energy bluetooth arduino would extend the signal request as far as the mesh network will allow.

Here is a list of the components in the system:

- The Android app with BLE compatable phone
- Raspberry pi
- RTL8192cu Wireless module
- Lightblue Bean (BLE compatable arduino)
- 4-channel I2C-safe Bi-directional Logic Level Converter - BSS138 (Serial communication between the Raspberry PI and Lightblue Bean)
- 2 push button switches (generic)
- White LED
- AC 110-240V to DC 5V Switching Power Supply Converter LQ-T10-5



The raspberry pi will act as a server allowing any app to communicate to the wall switch if a wifi network is accessible. The Android app will also attempt to communicate directly to the bluetooth wall switch. In the event of both communications being successful, the timestamp included in in both communications will eliminate duplicate commands being executed. The arduino will then dim the light according to the request made by the user.

Class features utilized in this project:

- The raspberry pi will be using network communications and either a kernel module or a C program to receive communications from the app which it will then pass to the arduino.
- The arduino will need to allow the physical switch to override any requests from the mobile app. This will require a process coded to allow interrupts from the hardware interface.
- Timestamp validation to ensure that a command isn't executed multiple times.

Production Plan

The system's construction will be broken up into several development cycles.

The first development cycle will be to implement the Android app and Raspberry Pi. The second development cycle will be on the arduino allowing BLE communication between the android app and the arduino. It will also include the hardware rocker switch which will allow the control of the lights directly. The final development cycle will interface the raspberry pi and the arduino together through serial communication and fix any issues that may remain.

Strengths and limitations

The strength of this system is that the system is extremely robust. One of the most frustrating issues with current home automation systems is in the number of parts required for the system to function, the unreliability of all those parts, and finally the slow reaction time to user input. Often times one must buy special lights, wall switches, and a base station to allow the user to use an app to control the system. Through the proposed method, the decentralized nature of the control allows the user to issue a command from anywhere with near 100% reliability that the command will be received and be acted upon rapidly.

The limitation of the system is that once a mesh network is established, the speed to transmit across several BLE arduinos has not been tested. Also, added dimming technology is required to allow dimming of any form of light bulb since the prototype will merely be dimming a single LED.