Remote Communication with a Microcontroller via a Bluetooth Enabled Android Device

by

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ABSTRACT

The intent of this paper is to show that it is possible to create a single Android application that is capable of working with an extensive number of electronic devices, without the devices creator having to know anything about developing an Android application. To do this a standard communication protocol must be established between Android powered devices and other electronic devices. To limit the scope of this task this paper will consider communication to be between an electronic device powered by a typical microcontroller and an Android 4.0 (Jelly Bean) or later powered device. Additionally communication between the two devices will occur over Bluetooth communication channels V2.1 or later.
1. INTRODUCTION/BACKGROUND

1.1 Background

All communications between devices require that the devices agree on the format of the data. The set of rules defining a format is called a protocol [2]. Communication protocols are almost everywhere we look from computers to televisions to basic mp3 players. They can even be compared to social mannerisms in today’s culture. Take the activity of answering a phone, when someone answers the phone they say “Hello” or some other equivalent greeting. This first phrase lets the person on the other end of the phone know that its their turn to speak and that the person they have called is ready to receive information. This can be equated to flow control within a communication protocol which is used to let one device know that another device is ready for some communication or data transfer to occur.

If a product developer wishes to make an electronic device that allows the end user to control said electronic device from their smart phone or tablet, since there is currently no standard communication protocol they would be forced to develop their own basic protocol. They would not only have to develop the software on the electronic device side but they would also have to design a custom application for the end users cell phone or tablet. As a basic example consider a company which designs keyboards for computers. There is a standard communication protocol and standard human interface driver for all modern USB keyboards. This allows the keyboard manufacture to develop and produce a keyboard without requiring them to write custom software for the computer.

1.2 Prior Work

Much work has been done amongst the amateur robotic community to develop platforms that are controlled by remote devices. Additionally several companies offer small robotic devices that can be controlled by mobile devices typically from the Android of Apple operating systems. These systems come with proprietary software for both the robot and the mobile device that is specifically designed to control only the device sold by the
manufacture. Figure 1, the Rover Revolution available from Brookstone, is one such example which allows the end user to remotely operate the device from an application on an Apple or Android device. This device also has advanced capabilities that allow the user to remotely control the vehicle while also streaming video from an onboard camera. Due to the high bandwidth requirements to support streaming video the device utilizes WIFI instead of Bluetooth or other lower frequency RF communication protocols. [2]

![Figure 1 - Rover Revolution available from Brookstone](image)

Parallax a popular supplier of microcontrollers and other components commonly used by armature robotic developers offers tutorials and educational material for many of their products. In one such tutorial as seen in Figure 2 Parallax demonstrates the ability to send commands to a Propeller microcontroller remotely from a PC via a Bluetooth Serial Port Profile. [3] Additionally the example provides open source software for the microcontroller, mainly programs that were already available as published open source library’s tied together with a single custom application. The example utilizes an RN-42 Bluetooth adapter and the user sends commands to the microcontroller via a serial terminal like HyperTerminal or in the case of the example the Parallax Serial Terminal. This example will be used as the foundation for my work on the microcontroller side of the task.
An alternative approach to controlling a robot via a cell phone was demonstrated by MicroTronics Technologies [4] can be seen in Figure 3. In this application a call is placed from a users cell phone to a cell phone mounted on the remote platform. The platform mounted cell is connected to the microcontroller through a decoding module. Commands are sent by pressing one of the numeric key on the operator’s cell phone, frequencies are transmitted over the cell network and are received on the platform mounted cell and interpreted by the microcontroller as commands. The benefits of this set up is that it requires no additional software to be installed on the cellphone, as it utilizes existing functionality built in to make simple calls.

The downside is that the system is limited to only 12 unique codes correlating to the 12 keys on / frequencies created by a phone (10 Numeric keys 0 through 9, the pound key and the asterisk key) and only one command can be sent at a time. Another difference is
that the signals are sent over a cellphone network, so the range is only limited by the size of the cell network, however the devices will only work where cell service exists and are dependent on a network outside the users control.

1.3 Objective

At the conclusion of my work I expect that I will have developed a communication protocol that meets the prescribe definition of a communication protocol as described earlier.

I also expect to have implemented the communication protocol and demonstrate its use on a physical device.
2. METHODOLOGY/IMPLEMENTATION

Developing a communication protocol for use between typical electronic devices and mobile devices such as tablets and cell phones is possible in that the foundation and principals / rules i.e. the protocol should be transferable across any platform. However due to the number of mobile platforms available (Windows, iOS, Blackberry, Android), the number of data transfer methods (Bluetooth, Wi-Fi, Ethernet) and the number or electronic devices it would be an extensive task to demonstrate/implement the communication protocol across all of the available platforms. It would also be a trivial task in that relatively no unique work would be required. For the most part it would be a task of translating the code from one language to another. Instead I plan to develop an open source communication protocol using only open source hardware and software. This will allow me to develop the communication protocol in a cost effective manner while still remaining flexible so that it can be expanded to other operating systems and devices as need dictates.

2.1 Required resources

To develop and implement a communication protocol between a mobile device and another electronic device there are several pieces of both software and hardware that are required. On the mobile device side both an IDE and SDK are required for programming the electronic device. Additionally a physical device will be required for implementation / testing. On the Electronic device side an IDE and SDK are required for programming the microcontroller as well a physical microcontroller for implementation/testing. Additionally since Bluetooth will be used for data transfer between the devices a Bluetooth module that is compatible with the selected microcontroller will be required.
3. RESULTS AND DISCUSSION
4. CONCLUSION(S)
5. REFERENCES

[1] Definition of a communication protocol
http://www.webopedia.com/TERM/C/communications_protocol.html
[3] Parallax RN-42 Bluetooth to PC demo
http://learn.parallax.com/project/rn-42-bluetooth-pc-demo
http://www.projectsof8051.com/mobile-controlled-robot/
6. APPENDICIES