Wireless programmable keypad with LCD display

ECE 445 Project Proposal

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I) Introduction

1.1) Objective

Programmable Keypad is handy for people who use hot-key heavy software like Photoshop. However, the common programmable keypad is very expensive, one can cost up to $100 or more[1], and they are not really user friendly for people who are new to the product. The software and hardware manual can be inadequate for the user to get the full grasp of keypad in a short time.[2] Therefore, the goal of this project is to create a user friendly programmable keyboard with LCD screen that can show the users the functionality they install in the key. In addition, the keyboard must be inexpensive, so it can be more accessible to a wide variety of users (under $70).

1.2) Background

QWERTY keyboard is considered the world standard. However, one major problem with QWERTY keyboard in this day and age is that its arrangement is inflexible as it can only support the antiquated key configuration[3]. For people who use software that require a lot of hot keys like Photoshop or playing video games, using QWERTY keyboard can be a bit cumbersome. This is where programmable keypads are handy because they offers shortcuts for any area where keyboard shortcut is useful. However, programmable keypad tend to be expensive. For instance, an XK-24 USB Programmable Keypad, which has 24 keys, is about $145[4]. This is the reason why programmable keyboard are not accessible to a wide variety of customer. Aside from that, using these keyboard require some understanding about keyboard and how they works[5], so they are definitely not easy to use for people who are new to programmable keypad.

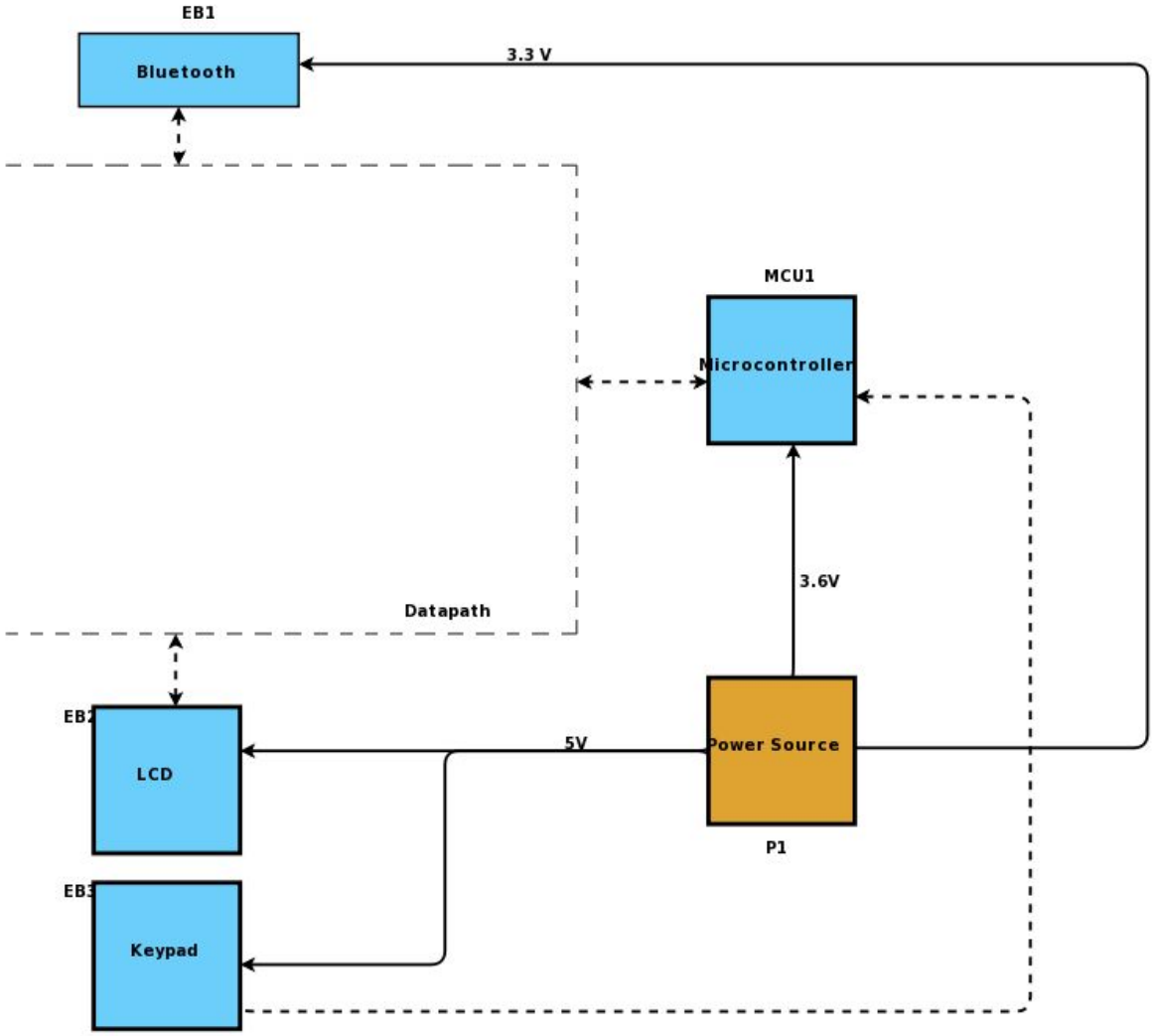
1.3) High Level Requirement

- Wireless connection to computer via Bluetooth
- Provide a number keypad for 13’ inch laptop
- Provide a media controller. The keystrokes allow users to play or pause the current music or video on the host computer, change the brightness of the screen etc.
- Allow user to set up additional functionality for the keypad using add-on software
- Compact design

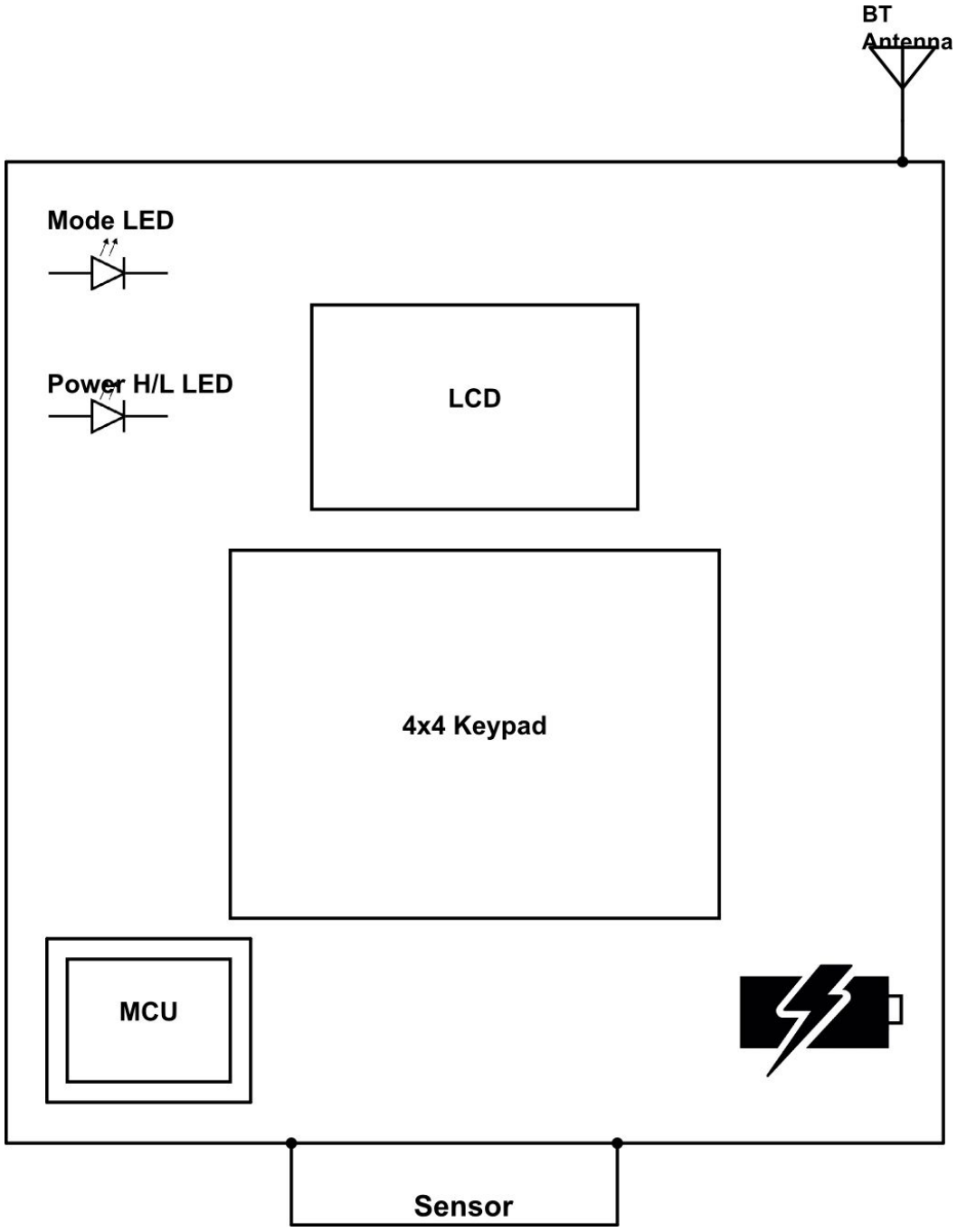
- (optional) Sensor implementation that automatically powers the LCD screen to be on/off according to the detection of the presence of individual user.

II) Design

1) Block Diagram



2) Physical Design



3)Functional Overview & Block Requirements

3.1 Power Supply

A consistent power supply is necessary in order to power all of the components in our circuit. We choose to use a standard 9V battery, which benefits the user in the sense that they are easily replaceable and are not hard to find.

We will also built several voltage regulator/divider circuits to satisfy the input voltage requirements of our circuit components. That includes the microcontroller, LCD, keypad, bluetooth module and mounted LEDs.

3.2 *Bluetooth Module*

Our bluetooth module will act as the device to transfer data wirelessly to the intended receivers. We will be able to purchase one from the market at a low price[6], and by taking advantage of the existing firmware we can communicate with our MCU effectively to attain our desired functionality.

Input: signal from the microcontroller

Output: signal to the computer

3.3 *Display unit*

3.3.1 *LCD Screen*

We intend to use a 240x160 pixels screen. The LCD screen is used to show the pattern of the each keystrokes. This way the the user can easily know what functionality or pattern they assign to the keypad.

Input: keystrokes pattern signal from the microcontroller

Output:keystrokes pattern display on the LCD screen

3.3.2 *Mounted LEDs*

We plan to use surface mount LED to indicate the different modes of the keypad as well as the power level of the keypad (High or Low).

Input: signal from the microcontroller

Output: LED light

3.4 *Microcontroller Unit (MCU)*

We intend to use the TI MSP430 as the microcontroller since it is a low power MCU which mean less pressure to the battery. Aside from that, the MSP MCUs also feature a direct memory access controller, enabling memory transfer without CPU intervention. This means higher throughput of peripheral modules and lower system power. The MCU serves as the “brain” of the whole keypad. It takes the input signal from the keypad, and process that signal.

Then it transmit that processed signal to the computer via bluetooth. In addition, its memory also store the keystrokes functionalities.

Input: keypad signal

Output : Bluetooth signal, keystrokes pattern signal for LCD screen

3.5 *Keypad*

We intend to use a 4x4 keypad, with traditional functions such as registering numerical values with the receiver. On top of it, we will add new functions such as play/pause music/video, or even customizable by the user. To achieve this, all the keystroke inputs will go towards our MCU through our data bus, and making use of the processing unit we can manipulate the output signal that's intended to be sent towards the receiver.

To implement our design, we will be using button switches as our keys, because they are the most cost-efficient option for us. Also, we're going to mark several symbols on top of certain keys to remind the user of the predefined values of said corresponding keys when used under specific modes.

Input : User press a keystroke

Output: signal to the microcontroller

4) Block Requirement

Table 1: System requirement

Requirement
Power Source The voltage regulator must provide 3.3V, 3.6V, 5V from the battery (9V) consistently to maintain the circuit functional.
Bluetooth Bluetooth signals are strong in a reasonable range, and are sending correct data according to the current operating mode.
Keypad Key presses are well registered and transmitted successfully towards the data bus. Keys must be easily-pressible and the marks should be clear and readable.

Mounted LED LED functions properly, and flashes correctly responding to the input signal from MCU.
LCD Screen LCD Screen functions properly, and displays the correct customized symbol to the user. The symbols that are being displayed must be easily understandable and changes accordingly to different user setups.
Microcontroller Unit The MCU should produce desired outputs to all our circuit components given any possible set of inputs. The logics need to be properly designed, implemented, and furthermore, well tested.

5) Risk Analysis

A major concern we have for this project is to ensure that the keypad is compatible with the computer. Even though we can download the firmware for the bluetooth to ensure that it is recognized by the computer, we believe that it will be difficult to figure out the correct protocol so that the computer can recognize the signal sent by the microcontroller. For example, when the user press a key, we have to make sure that the computer can perform the function that the keystroke contain. In addition, it is also difficult to consistently test the bluetooth in areas such as reliability and power consumption. It will take some research, understanding and analysis on our parts before we can handle these problems.

III)Ethics and Safety

We will put our best effort to keep our ethics in accordance with IEEE Code of Ethics #1,5 and 7[7]. Our project involves in complex hardware and software design therefore in order to fulfill IEEE Code Ethics #5, we need sufficient background knowledge to ensure we not only successfully implement the system but also produce a quality product. Under IEEE code of ethics #7, we will openly listen to TA's criticism and advice since they are useful in making sure we are on the right track. As we're aware of, there are existing products on the market that offers similar functionalities to our project, and very likely patented for their design. Although we have

no intentions thus far to market this project commercially, we have to credit sources properly and avoid plagiarism to the best of our abilities. Although we only making a keypad, a harmless device, we realize that there could be unexpected dangers of using the power, and we will do our best to minimize the potential power and circuit failure with in accordance with IEEE code of ethics #1 by optimizing the both hardware and software component.

References

[1]Komar's techblog, "How to make a keyboard-The matrix", 2014. [Online]. Available: blog.komar.be/how-to-make-a-keyboard-the-matrix/. Accessed 21 Sept. 2017.

[2] IEEE Xplore, "Design of Multi-function and Programmable Man-Machine Interface",2014.[Online]. Available: http://ieeexplore.ieee.org/document/6821583/. Access 21 Sep 2017

[3]Chron.com, "Advantages & Disadvantages of Using the QWERTY Keyboard", 2015.[Online]. Available: http://smallbusiness.chron.com/advantages-disadvantages-using-qwerty-keyboard-66874.html Accessed 21 Sep.2017

[4]Amazon.com, "XK-24 USB Programmable Keypad for Windows or Mac". [Online].Available: https://www.amazon.com/XK-24-USB-Programmable-Keypad-Windows/dp/B003MB780E. Accessed 21 Sep.2017

[5]Torpal.com, "From the Ground Up: How I Built the Developer's Dream Keyboard", 2015[Online]. Available: https://www.toptal.com/embedded/from-the-ground-up-how-i-built-the-developers-dream-keyboard. Accessed 21 Sep.2017

[6] LairdTech, "BL 652 Series- Bluetooth V4.2+ NFC ", 2017. [Online]. Available: https://www.lairdtech.com/products/bl652-ble-module. Accessed 21 Sept. 2017.

[7] IEEE.org , "IEEE IEEE Code of Ethics", 2017. [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8.html. Accessed 21 Sept. 2017.