Ultrasonic Keyboard Monitor

Mechatronics ENEL417/517 Lab Project 1

JBS, revised January 2018

1 Introduction

Your task in this laboratory is to create an ultrasonic sensor to detect when fingers are using a keyboard. In radar/sonar terminology, you will look for a change in the field of view ("clutter"). The sensor will take the form of a small PCB with two ultrasonic transducers, some electronics and an "embedded microprocessor". For this laboratory, you will be provided with the circuit already assembled on a small PCB, and you will write software in C and cross-compile it onto the microcontroller to implement the sensing function. The idea is that a burst of sound is emitted from one transducer, and echoes of the original burst are picked up by another, receiving transducer. The elapsed time interval to echoes determines distance, and changes in the echo profile betray movement in the target field.[1] Since the transducers have a strong resonant frequency around 40kHz, the transmitter will only work properly if driven with the correct frequency.

The deadline for this project is the third Friday of semester.

2 Project Specification

You must use the given PCB, an 8-pin PIC12F675 and two ultrasonic transducers. Your sensor will operate in a fixed position on your desk, viewing a keyboard. Program your PCB to display a "heartbeat" in the form of a blink of the LED of about 20ms duration every couple of seconds when nobody is using the keyboard. When moving fingers are detected, the sensor should respond with a clear visual indication, such as 6 Hz flashes of the LED with 50% duty cycle. You may choose to arrange for the device to calibrate on an unused keyboard when the press-button is pushed. The potentiometer may be used to set the sensitivity or the range, whatever seems most useful to you.

The test of your device will consist of its placement, adjustment, and calibration, followed by the addition or removal of objects of various sizes and shapes, typically fingers. Reliability (absence of false positives, lack of sensitivity to object position) is more important than range.

3 Assessment

One third of the marks ($\frac{1}{3}\times 20\%$) will be awarded for "keeping the boss satisfied". This means updating the person assessing your self-management regularly and at least weekly, setting and achieving milestones, answering their questions, etc.

[1] The phrase "target field" is radar/sonar jargon for "stuff that is out there". The "echo profile" is the record of received signal as a function of time, the sum of all echoes from targets and clutter. Clutter is stuff that returns an echo but is not a typically-moving target, like waves when searching for periscopes or walls and furniture when looking for people.

One third of the marks will be awarded for your technical performance. This means showing that you have a grasp on the technical issues (say for example how you process a 40kHz signal with an ADC that samples at 10ksps or less, well below the apparent Nyquist rate) and that you produce a quality solution (code informatively documented, delays implemented most elegantly, etc). This will include the summary report you produce, see below.

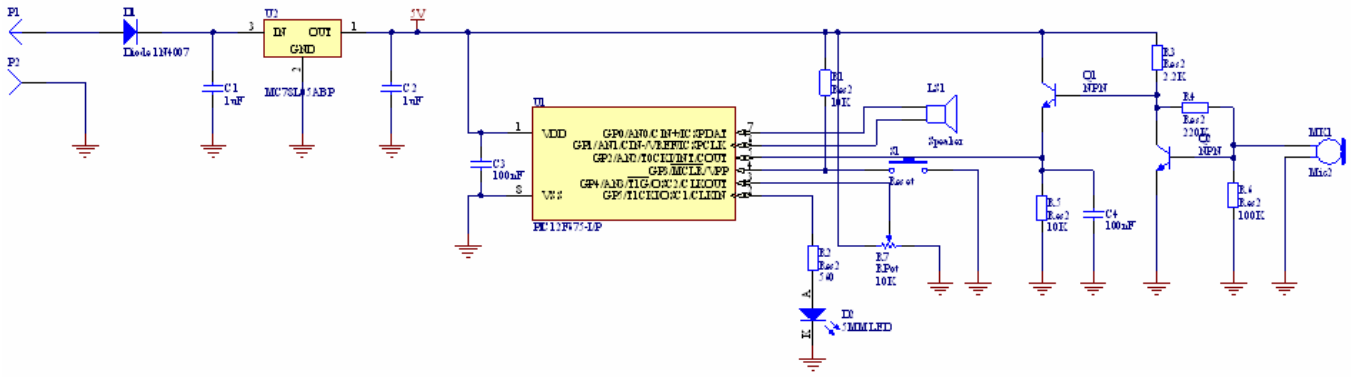
One third of the marks will be given for your final demonstration. By appointment on or before the due date, you will demonstrate your design in action, during a scheduled lab session. You may be asked to describe the challenges you had to overcome, say how well your sensor works, or describe the algorithm you implemented using the whiteboards, etc.

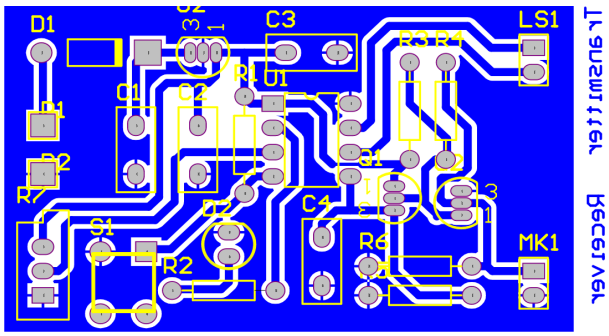
You must email in a brief report, no more than two pages including any diagrams but excluding appendices and code listing. The report should say succinctly what your code does, perhaps what is handled in interrupts and what is in mainline, and how you tested the sensor (some measured data always looks good). At a minimum, a code listing should be appended.[2]

The report should be "sufficient to allow another person to duplicate your work". Don't list the information you were given in the first place, what you have learned (but that engineers in the world already knew), or ideas that did not pan out. Simply what the device does, how it does it, and how well it does it... what you would need to recall to do it all again. Appendices may explain the function of components in the circuit diagram, and the overall flow of the program in the embedded controller, whatever you feel you would like to have on record that is interesting.

4 Hardware

This is the circuit diagram and the PCB overlay to help you become familiar with the hardware that you will use. Note that there is one push button, one LED and one potentiometer. These are the user's way of communicating with the sensor. Two lines drive the transmitter, and one measures the received signal. Errata: The value of C4 has been changed to 2.2nF.





[2]Think a little about how your code looks printed out. Lines wrapping can ruin the readability of code. Appearance of code *is* important!