ACOUSTIC NAVIGATION FOR MOBILE ROBOTS

Bi-Weekly Report

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Introduction

Our design project is going according to plan. We have already received all of the major parts and are working diligently on the final aspects of our design. We have passed some of our troubles and are working to complete the design. Below is on outline of our status concerning different aspects of the design, as well as an update on our scheduling, cost, and new issues with our design.

Current Design

Figure 1 illustrates our current design. We have decided to fabricate two separate printed circuit boards: one for the microphone array itself and one for the microcontroller. This will allow us more modularity and ease of maintenance and fabrication. The microphone array board will consist of the 8 microphones patterned in such a way that each microphone has 45^{o} of coverage. Further, the board will have a resistor pack that will develop the output signal for each microphone. We will route the signals to the microcontroller board via a 10-pin connector. The microcontroller prepares the microphone signal to be presented to the microprocessor of the Mark III. This board will accept the eight microphones data into an 8:1 multiplexor that is controlled by the Mark III's processor. Once a microphone is selected, it will be sent to the filter (LMF100). The filter has two inputs, one for the microphone data and one from the crystal and 4-bit counter (74LS191) circuit, which will provide 8 center frequencies through a processor controlled 8:1 multiplexor. The filter also provides us with gain, and we will use this to amplify the signal for rectification. After the filter, the signal will be rectified and sent to the A/D converter (ADC0801). This will convert the rectified signal into an 8-bit digital signal that is sent to the processor. In all, we will use 14 of the 16 interface bits on the Mark III. Six bits will be used for the multiplexers, and eight bits will be used for the microphone signal. However, we also have the capability to send the microphone signal to the processor in analog format, as the processor has analog capabilities.

Microphone Directionality

Our microphones, although described as unidirectional on the Panasonic datasheet, do not appear to be very directional. We have tested the microphone's signal strength at varying levels and distances and although there is slight directionality, it is hardly practical. We will ultimately need to implement a sound-dampening fixture, which is described in the following section. This will give us the directionality that we need to really apply this design to real-world environments. We will get the sound dampening material this week, and begin testing soon. We plan on having a directionality polar graph after testing.

Microphone Fixture

Our microphone fixture has been designed and manufactured (Figure 2). We created it using plexi-glass, super glue, and a rubberized aluminum cylindrical shaft to support the dividing walls. This fixture will be mounted on our microphone array board, surrounding the mics. It will be covered in the sound dampening material and will provide 3 – 6 dB of attenuation. Although it is yet to be tested, we feel this will provide ample sound absorption and give us the directionality in the microphones we are seeking.

Filter Solution

The schematic for the LMF100 Switched Capacitor filter has now been finalized (Figure 3 & 4). Prior to this, the filter was not producing a signal consistent with any expected output. This was due to one pin, SIa, being incorrectly grounded, instead of being set to Vcc/2. The preliminary filter data, obtained with a single LMF100 on a bare, new motherboard, with two function generators generating both the square clock pulse and the sinusoidal input signal, gave some inconclusive and varying results but proved that a +5 V single supply operation could be achieved. When another LMF100 filter was placed on the breadboard with the rest of the components, and the clock input was from the multiplexed, clock-divided signal, our results proved to be much better. With the clock frequency to the filter at 125 kHz, and a signal generator set to a sinusoid at 1.25 kHz, the filter worked beautifully, achieving a bandpass at exactly 1.25 kHz, and providing the proper gain at that bandpass.

PCB Generation

After attempting to complete our first printed control board in EAGLE 4.0 software, we decided to change to the PROTEL software, mainly because we have a fully licensed version in the labs. Second, the EE department will etch our boards, and they only use PROTEL. However, we are not using the EE unless we are in a time restraint, as the EE department does not perform the drill-thru technique that would require the use of vias. This would make our assembly much more time consuming and subject to failure. We have found a site, http://www.olimex.com/pcb/index.html that will manufacture our boards fairly cheaply at around $75. They allow PROTEL designs and perform all the professional services such as drill-thru, silk screening, etc. Once our design is completed, we will send off for both boards to be etched.

Robot Progress

We have assembled the Mark III Robot and it is functioning properly. We carefully soldered the circuit board together and did not have many problems with it. After it was constructed, we need to make sure that it would be able to receive data from the computer via its serial port. At first, we could not get the Mark III to connect. We found a Yahoo Group forum on the Internet, which posts questions and answers about common problems with the robot. We found that we were using the connection software for an older version of the robot, and all that was required that we use software compatible with our robot. Once connection was established with the computer, we wanted to run a sample program to test it. We found a sample program that makes the Mark III runs and follows a track by following a black line. The test was successful and our Mark III is ready to go. Once we have finished constructing our microphone array and PCB, we will be designing a program to control its movement according to the direction of sound.

Order Status

We have received all our parts that we have ordered except for the sound dampening material. The company we ordered it from has not processed the order nor bothered to make contact to inform us of the situation. After speaking with the company, we will pick up some similar material at a local car audio shop. Once we acquire the material we will apply it to our custom made microphone array shield so we can test directionality. One problem we are noticing is that soldering the leads on the microphones is a difficult process and the leads that we have attached our very brittle and are not easy to handle. We may need to order another batch in the future, to ensure we will have eight working microphones. Other than that, the only other transactions we have are the actual etching of our microphone array and controller.

Schedule/Future Plans

We have finally worked out our entire microphone and filter issues, leaving us with just completing the rectifier and the analog-to-digital conversion. This, we hope, will be fairly straightforward and easy to implement. After this, we will get the controller board designed and sent off for etching, leaving us only the OOPIC programming to complete and testing. After being bogged down with microphone and filter problems for a couple of weeks, we feel we are now back on track and nearing the end of our design phase of the project. Please refer to Figure 4 for our Gantt chart.

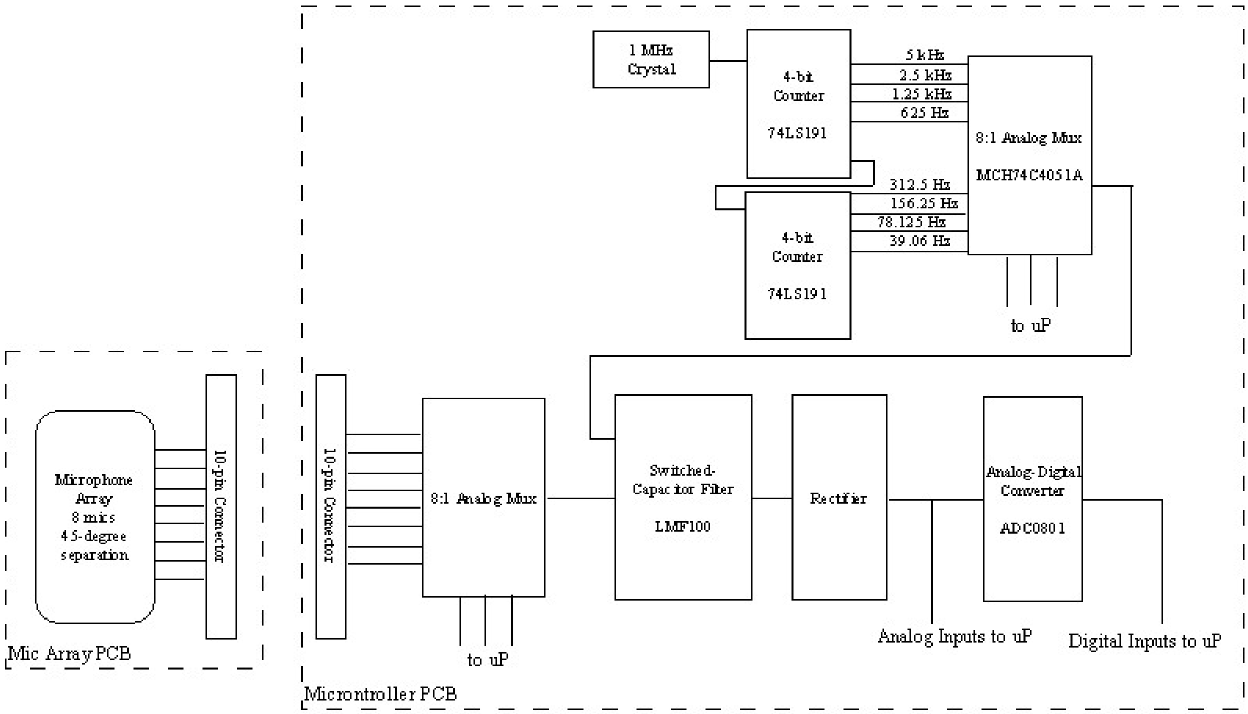

Figure 1 – Design Diagram

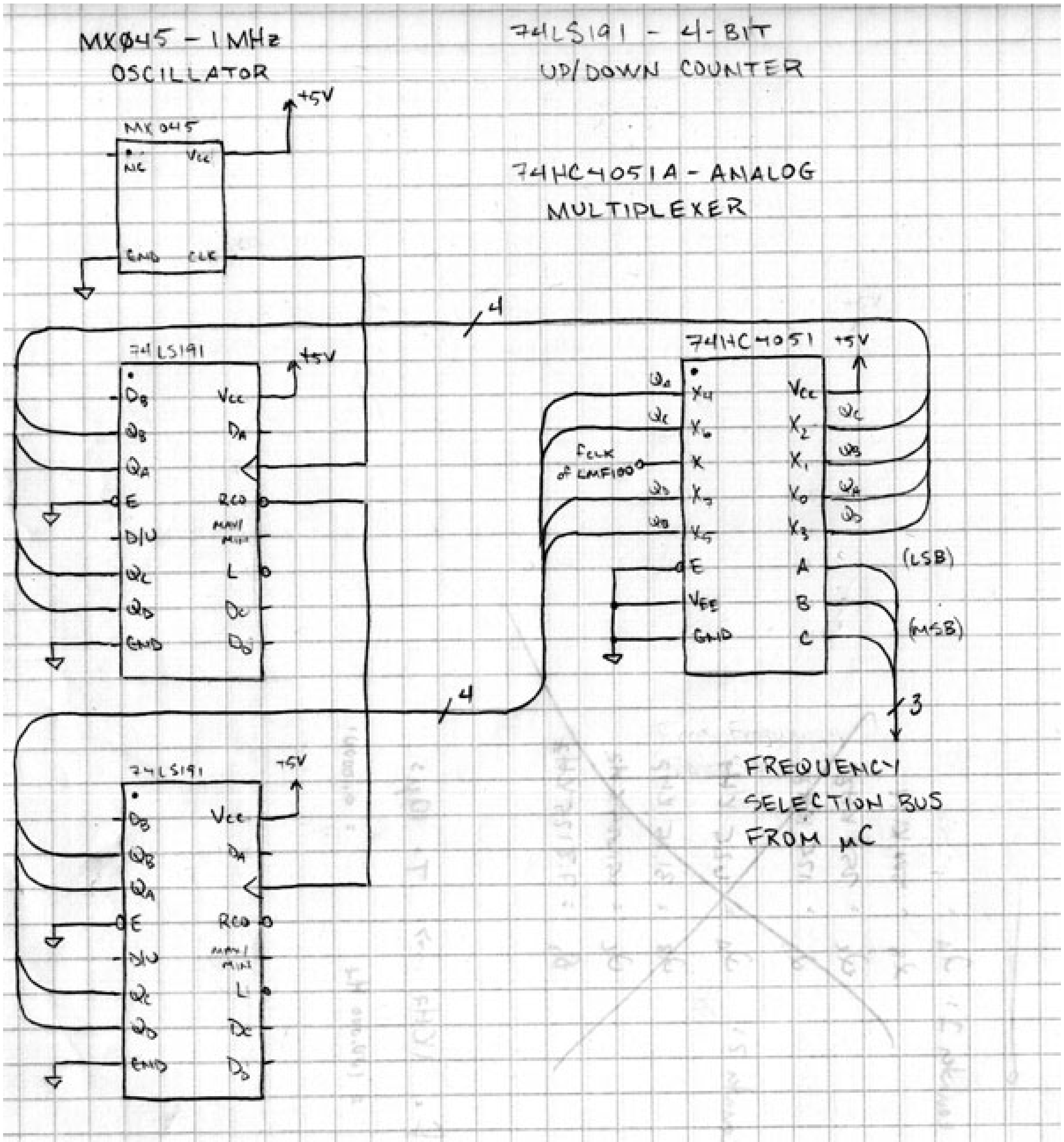

Figure 3 – Clock Division

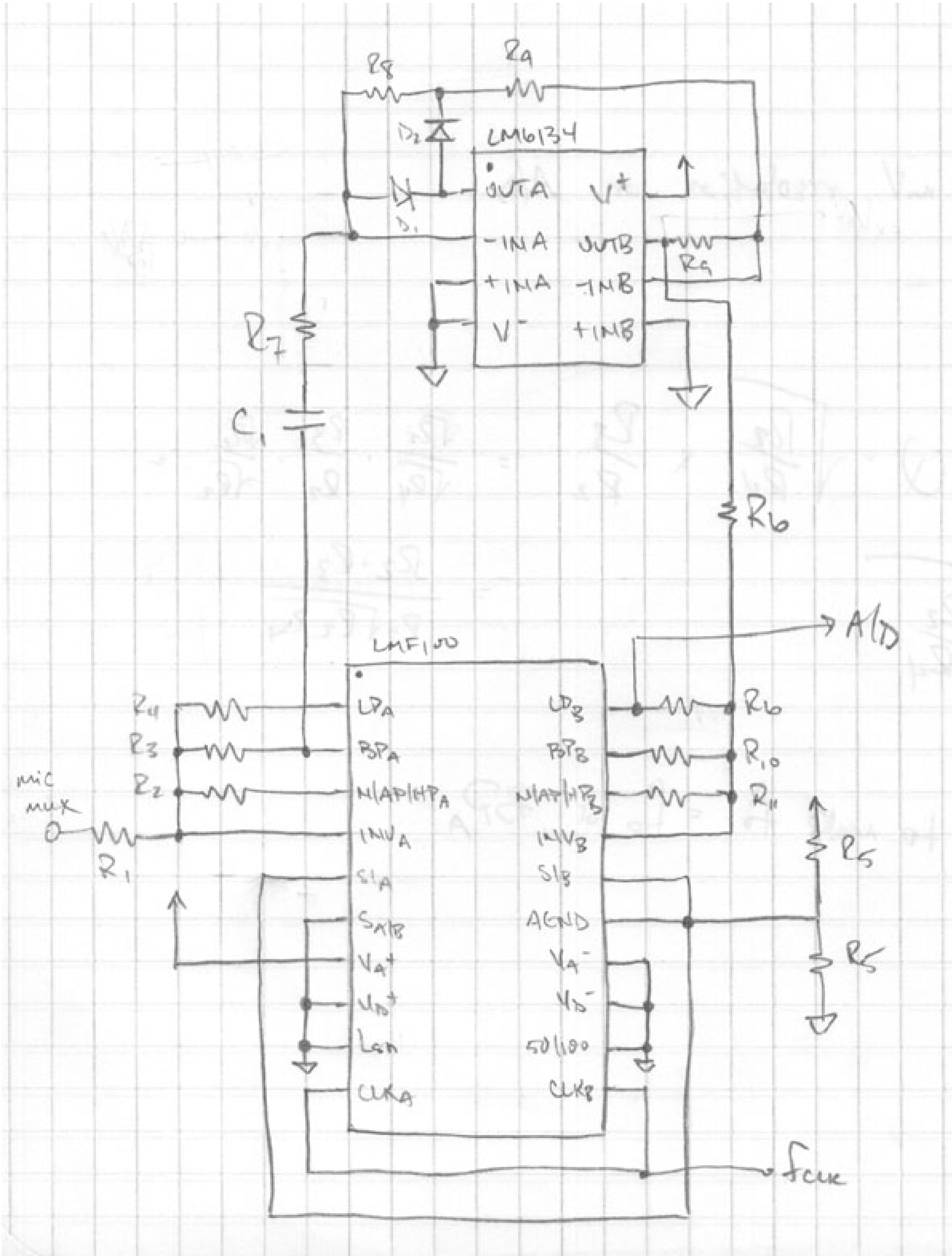

Figure 4 – Filter

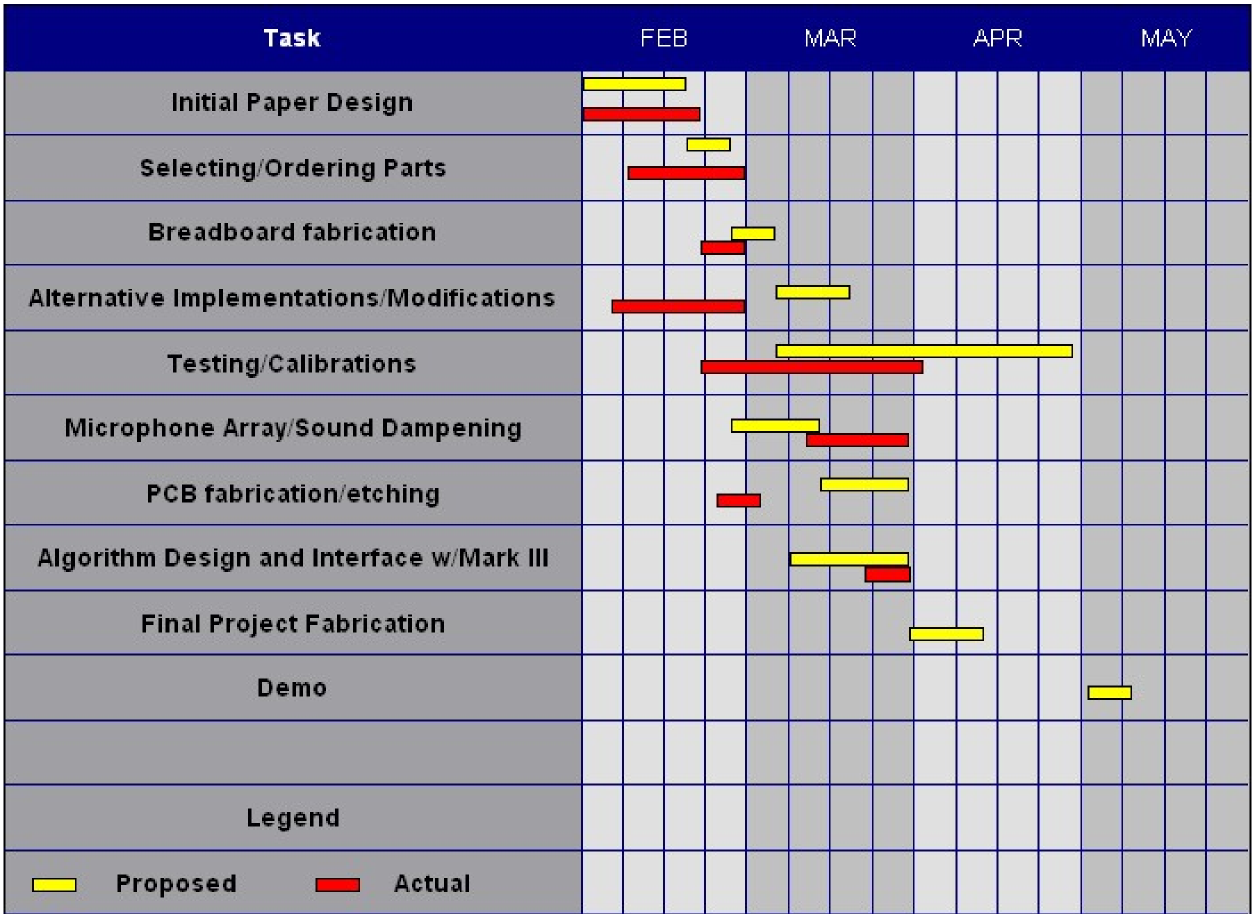

Figure 5 – Updated Gantt Chart