

FINAL PROJECT

THE TIMING MEASURE OF STROBE LIGHT BY FREQUENCY

EENG 3910: Project V – Digital Signal Processing Design

Due: 05/05/2014

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INTRODUCTION

This project is a small part of the larger project by Dr. Garcia to measure stimulus response in the human brain (evoked potential response). We will be using Labview and various Labview accessories. The project is to design a system to measure electrical response of a given part of the body in a series of samples initiated by an outside “trigger” source. The samples are then averaged, to reduce noise, and produce a visible waveform of the response. The larger project is aimed to measure the body’s response to external stimuli which is helpful for future (and more complicated) experiments and research.

This project was pursued because of a real-life possibility of implementation. We did not want to create another project that has no applicability to others for the sake of achieving a grade. We hope this project will help Dr. Garcia and others in their efforts to take measurements of the human body.

RESULTS AND DISCUSSION

Inputs

This project has two forms of electrical input. First, the signal from the human body that is in response to an external stimuli. Second, the signal from a circuit that measures the external stimuli. For the purpose of creating a prototype we used a strobe light as a stimulus. This strobe light would flash at around two to ten times per second. For the “bodies” signal we used a microphone to record the sound that was emitted from the strobe light. This was used for testing purposes because we did not have access to an abundant supply of bodily probes and we already had a sense of what signal should be returned.

For the purpose of clarity for the rest of this report the stimulus signal that is acquired from the strobe light will be called the Light Input and the signal that is acquired from the microphone to represent a collected response from a body is called Sound Input.

Design Constraints

To design a functioning system that can take a signal from a microphone as well as a signal from the body we needed to determine a fair sample size and rate that would be sufficient to collect data. Based on discussions with Dr. Garcia a default sample rate of 8000 Hz would be sufficient for his research. Additionally, it was discussed that 25 or more samples would be desired to ensure good results.

Class requirements dictated that we must use a software package on a computer with a reasonable amount of digital signal processing.

Theory

The primary purpose of this project is to automate a signal averaging system and to collect and display such information. In practice, collection of electrical samples of “real world” events will introduce a certain amount of noise into the sample. The following formula describes this phenomenon:

$$S(n) = R(n) + N(n)$$

Where $S(n)$ equals the actual signal acquired; $R(n)$ equals the real signal that is desired; and $N(n)$ equals the noise that is added spontaneously.

$N(n)$ in our measurements will primarily be randomly distributed around a value of zero. Therefore, if we average an infinite set of samples of $S(n)$ we will have:

$$S(n) = R(n) + 0 = R(n)$$

In practice we cannot measure an infinite set of samples, but a limited sample size is acceptable in most circumstances. Because we, as designers of the measuring system, do not know all the conditions that may determine an adequate sample size we choose to design a system that will allow for as many samples as desired.

The averaging technique that we will use is:

$$\text{Average}_n = (\text{Average}_{n-1} * (n - 1) + \text{Sample}_n) \div n$$

Where Average_n is the average of the 1st through nth samples.

Implementation

To implement we first decided to use the Labview software suite. Labview was chosen because we had fresh experience with it in-class, we had a readily available was to bring analog signals to the software (MyDAQ), and it has a built in GUI that allows us to create whatever graphical outputs that are desired.



Figure 1: MyDAQ

We then needed to build a circuit to acquire the two input sources (Light Input and Sound Input). Together with MyDAQ, which served as our analog to digital converter, we were successfully able to bring in the sample data.

In this Figure, instead of using LED we used MyDaQ to display the waveform of the impulse in the Lab View waveform.

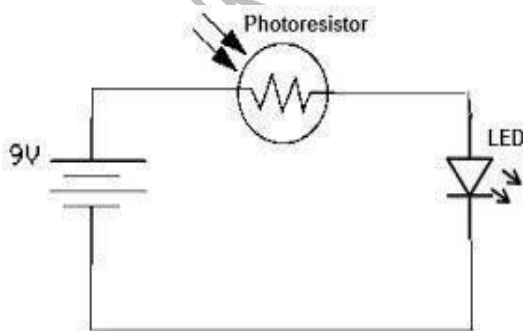


Figure 2: Photo Resistor to Capture the Impulses

Our third development phase was designing a suitable code structure that would manipulate the data as well as store and display it as needed. This phase became our lengthiest task. On paper, the design of the code seemed straight forward, we needed a way of determining when to start sampling from the Sound Input and storing that information so that it could be averaged later, then averaging that information when needed. Our problem was that the way Labview and MyDAQ bring in information. Rather than it be a constant stream of information at the given sample rate (8kHz) it was sent as buffered sets of 8k samples. This 8k set of samples was manipulable through the settings so it could be expanded if necessary.

Ultimately we devised a code structure that would use feedback variables within an “in-place” structure. Within the “in-place” structure we would get pair of 8k arrays of subsamples (which is the buffer size as mentioned previously) that we could manipulate in a loop. As the loop concluded we could take the portion of the averaged data as well as some useful indicators and use them as an input on the next iteration of the “in-place” structure.

And lastly GUI design and testing.

The GUI was very simple. We use a waveform display of the current data stream from the Light Input and Sound Input. This is to help in later testing but also for creating a more interactive looking output.

To test, frame by frame analysis was applied in the math script to determine the peaks of the impulses since the impulses are within few milliseconds. The frame by frame analysis was not used because the voltage often starts from negative value instead of zero. Therefore, it was not ideal for us to reduce the amplitude of the noise under certain value. Figure 3 shows the approximation of a noise less signal using the averaging technique.

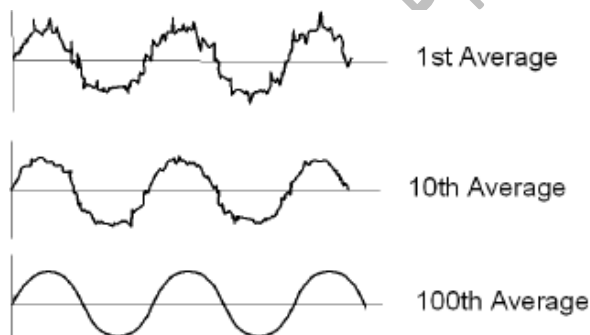


Figure 3: Averaging Technique

Overall, the project contains:

- Amplifiers and other analog circuitry - for data collection
- MyDAQ (hardware to software tool) - for data conversion from analog to digital
- Labview (software) - for data manipulation and display

Software Code

The following are screenshots of various views of our Labview code:

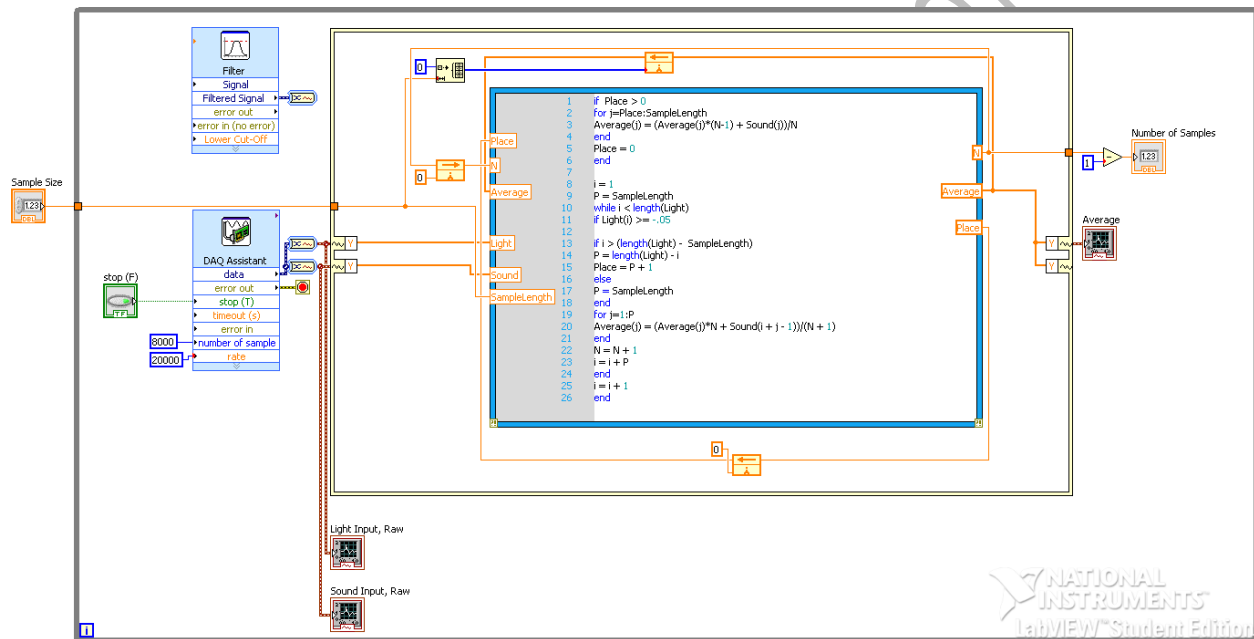


Figure 4: Lab View (Block Diagram)

```

1  if Place > 0
2  for j=Place:SampleLength
3  Average(j) = (Average(j)*(N-1) + Sound(j))/N
4  end
5  Place = 0
6  end
7
8  i = 1
9  P = SampleLength
10 while i < length(Light)
11 if Light(i) >= -.05
12
13 if i > (length(Light) - SampleLength)
14 P = length(Light) - i
15 Place = P + 1
16 else
17 P = SampleLength
18 end
19 for j=1:P
20 Average(j) = (Average(j)*N + Sound(i + j - 1))/(N + 1)
21 end
22 N = N + 1
23 i = i + P
24 end
25 i = i + 1
26 end

```

Figure 5: Math Script

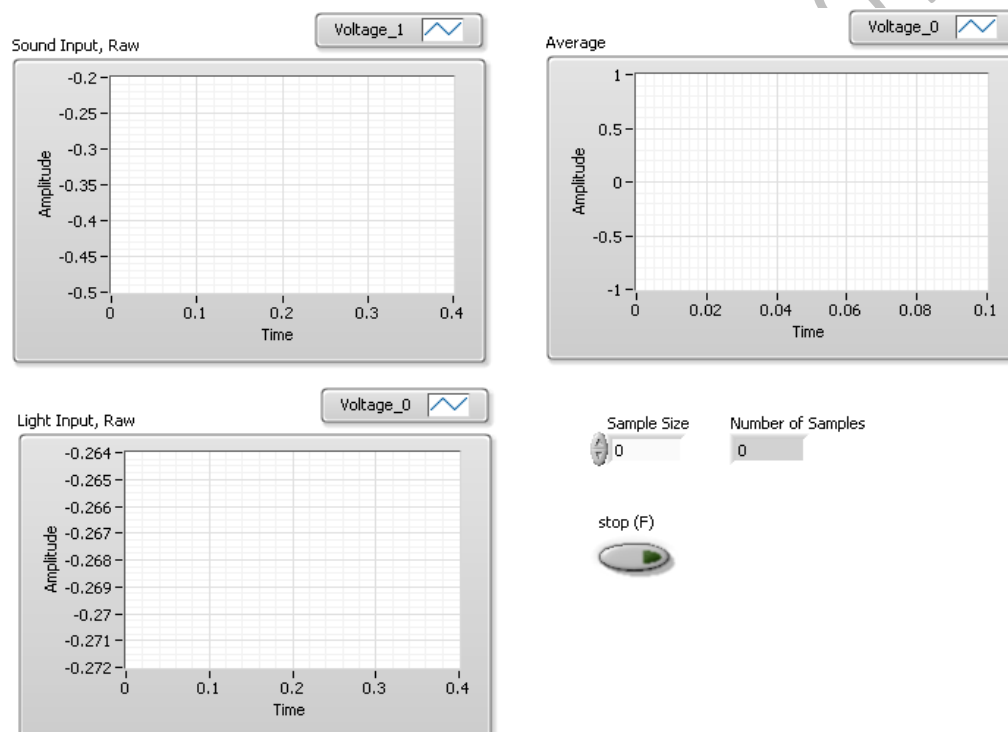


Figure 6: Lab View (Front Panel)

Work Load Distribution

The project was established by consent of the member on the group, each one of the members has some type of knowledge about specific topic which is the reason why we decided to work on this project. In order to be successful as a team we decided to take different roles and divide the workload into three different sections.

Zachary Heil was in charge of writing down the critical MatLab codes to gain the data from the signal using myDAQ and MyDaQ assists. He investigated different functions needed to make the signal analysis work. He would be in charge of proof reading the documentations.

Shabuktagin Photon Khan was in charge of working with the implementation using labview and NI myDAQ. He investigated the different functions needed. He will be in charge of the organization of the project. He will be in charge of the documentation towards the final project and putting together a power point presentation.

Other Considerations

Connect to Human Body

After we had successfully finished the design and implementation of the project using the sound from the microphone as an input we decided to get Dr. Garcia to help us with testing the project on its original intended purpose - acquiring signals from the brain. In testing, we found that we would need an additional amplifier in order to produce a signal large enough for the myDAQ to acquire. The instrumentation amplifier we were suggested to use did not give us sufficient results on preliminary testing. This may have been due to bad wiring our part or a (several) damaged amplifiers. Unfortunately, we were not able to finish our project as specified by Dr. Garcia by the deadline for class because of time constraints with each of our schedules. We will continue to work on it after the report date to continue to assist in Dr. Garcia's research.

Additional Applications and Code Modifications

In retrospect, this project could be used for many more applications. If the Light Input and Sound Source Input were derived from different sources than a wide selection of sampling options are available for researchers. Modifying the Labview code to make each hard-coded variable user controlled can make this project more convenient for others to use and is potentially a goal we will look into.

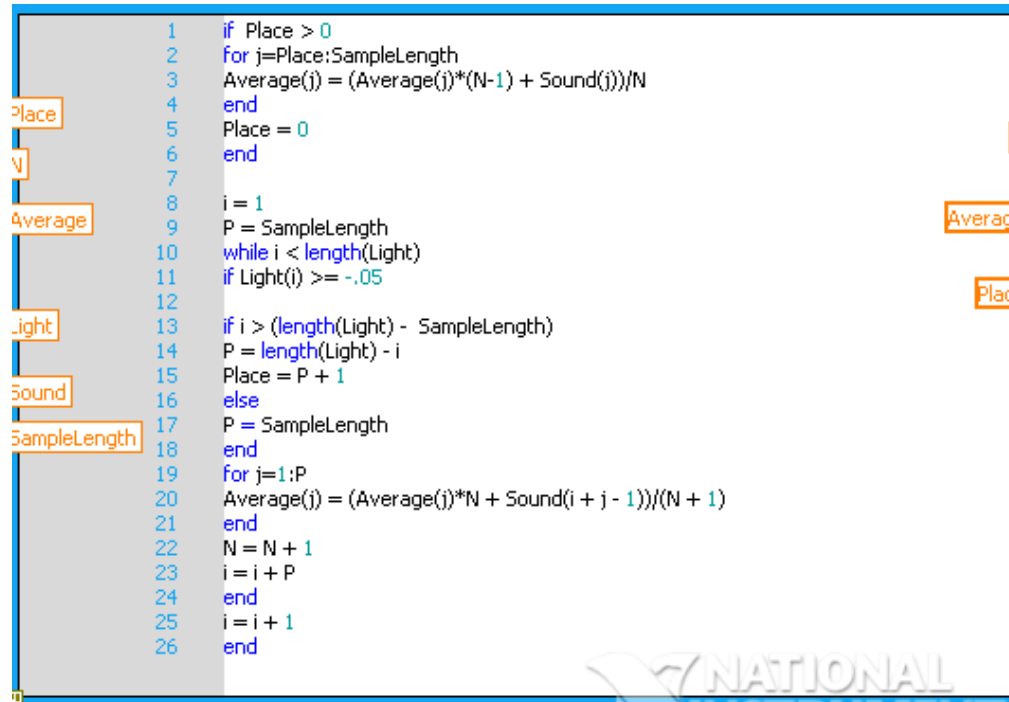
SUMMARY AND CONCLUSIONS

This project will help us to understand the concepts of digital signal processing and gain more experience with Lab View. With this project, we actually learned the importance of working as a team. First we decided to understand the abilities and skills of one another and how could they be applying into the project. We all knew something better at one topic than one another. With that being said we combined everything we knew at our best making the project a lot easier to work. Then we learned each other's schedule to see when meeting up was more appropriate for everyone on the team. Meeting up together was quite hard as we all had very busy schedules so we decided to work on it separately, so whenever we would meet up we could exchange ideas and experiences. We also learned that communication is a key for success, as we were in contact with other at all times by using web programs such as email and Google drive so we could share information and ideas with each other.

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APPENDIX

```
1  if Place > 0
2  for j=Place:SampleLength
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4  end
5  Place = 0
6  end
7
8  i = 1
9  P = SampleLength
10 while i < length(Light)
11 if Light(i) >= -.05
12
13 if i > (length(Light) - SampleLength)
14 P = length(Light) - i
15 Place = P + 1
16 else
17 P = SampleLength
18 end
19 for j=1:P
20 Average(j) = (Average(j)*N + Sound(i + j - 1))/(N + 1)
21 end
22 N = N + 1
23 i = i + P
24 end
25 i = i + 1
26 end
```



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REFERENCES

Book

Real-Time Digital Signal Processing from MATLAB® to C with the TMS320C6x DSPs, Second Edition by Thad B. Welch (Author), Cameron H.G. Wright (Author), Michael G. Morrow (Author)

Websites

http://en.wikipedia.org/wiki/Signal_averaging

[http://en.wikipedia.org/wiki/Noise_\(signal_processing\)](http://en.wikipedia.org/wiki/Noise_(signal_processing))

http://en.wikipedia.org/wiki/Evoked_potential

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