

Ultrasonic Mass Positioning & Wireless Data Collection



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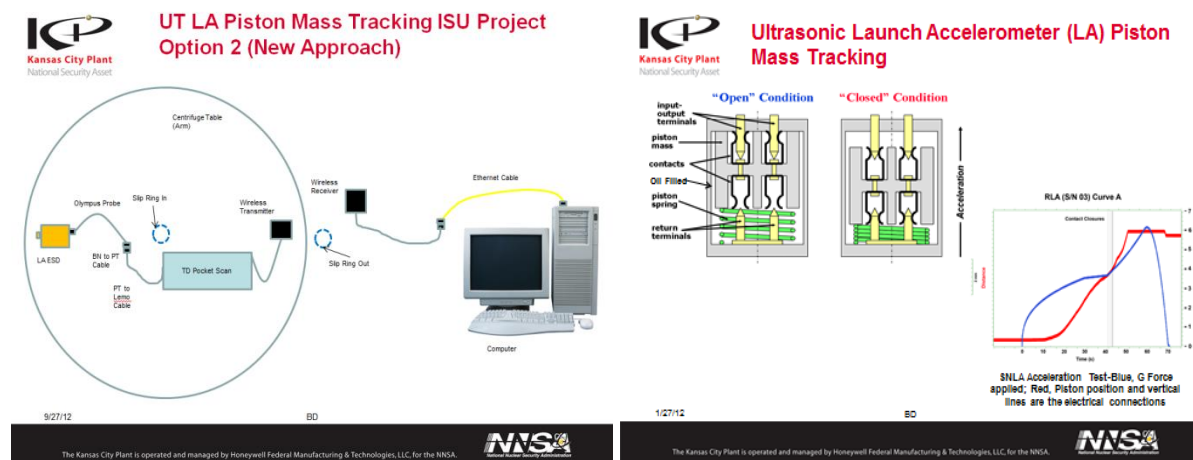
ACKNOWLEDGEMENTS

Our group would like to thank those who have helped us so far in formulating our wireless transmission system design. This of course means our advisor and source of knowledge, Dr. Aleksander Doganzic. We would also like to thank the graduate student who has assisted us in enhancing our knowledge of the topic and purchasing of our components: Renliang Gu.

PROJECT DESCRIPTION

ABSTRACT

At Honeywell FM&T (Federal Manufacturing & Technologies), a major portion of engineering related time is spent testing their products. High levels of testing accuracy insure that they are producing a premium product that will be reliable for years at a time. One of the testing procedures that they utilize is Ultrasonic Testing on each of the Launch Accelerator (LA) Pistons. By use of the software and hardware provided by Honeywell FM&T we have developed a test setup that will monitor and test these probes with a wireless application. We have also created a program for eavesdropping on the wireless signal. This was accomplished by use of the C language and C libraries and a MATLAB environment was used for graphical interface. This set up will allow Honeywell FM&T to monitor their LA Pistons during testing in a centrifuge. When the piston has reached it's closed the position it causes an electro-mechanical connection.



PROBLEM STATEMENT

Honeywell FM&T have been experiencing a large amount of noise in their testing signals with a wired test set up due to the centrifuges. The lack of accuracy that can occur with these noise signals on a wired signal could be eliminated by use of a wireless testing application

OPERATING ENVIROMENT

The goal of our project is using ultrasonic probe to test the moving mass during a centrifuge test. The centrifuge is a close system and normal signal can be brought out through brushes. The probe can read through a 0.125 inch 304 stainless steel end cap and monitor the movement of a slug of 304 grade stainless steel in a cylinder. The probe can read through the steel cylinder to monitor a slug during the centrifuge.

The operating environment of this project is in a closed cylinder where it is doing the centrifuge test. It will give the analog sign of the slug during its rotating which is from 0 to 120rpm. This project will be simulated and tested using the above concept design.

FUNCTIONAL REQUIREMENTS

In our projects we have some functional requirements. The first functional requirement is the probe. The probe our client used is Olympus probe XMS-310-B which is cost \$813, which has been provided by Honeywell FM&T. The second functional requirement is the implementation of the TD pocket scan. The third requirement is the wireless. Our client has the wire to transform the signal from the probe, but the signal is noisy. They want us to use wireless to transmit the signal. The fourth requirement is the microcontroller. We need use embedded system to make it happen.

NON-FUNCTIONAL REQUIREMENTS

Our project has several non-functional requirements.

- Data rate of the wireless.

We are looking for the Wi-Fi that can reach 300Mb/s, but it is too expensive. Then we try to get 2 or 3 Wi-Fi paralleled to transmit and receive data from the TD pocket scan.

- A/D and D/A Converter.

The A/D and D/A Converter we are looking for is can convert the data form the probe in time and easily connect with the MCU.

STANDARDS

IEEE 802.11n

As the project we were tasked with was for industrial application our standards must be in line with current industry standards. This includes the wireless transmission of our system. Due to the speed of our signal being generally 100 MHz we must utilize a wireless system fast enough to process this signal. The only real option available in mass quantities to the industrial world is the IEEE 802.11n protocol for signal transmission. The channel for this wireless protocol has the following parameters it must maintain:

- Operation width of 40 MHz
 - Dual channels of 20 MHz
- Operation speed options of 5 GHz or 2.4GHz pending on number of channels being used
- Data transmission rates
 - Industry Maximums
 - 2.4 GHz channel – 72.2 Mbits/s
 - 5.0 GHz channel – 150 Mbits/s
- Must maintain backwards compatibility with past 802.11 protocols (802.11g, 802.11b, and 802.11a)
- Signal range
 - Indoor
 - 230 ft
 - Outdoor
 - 820 ft

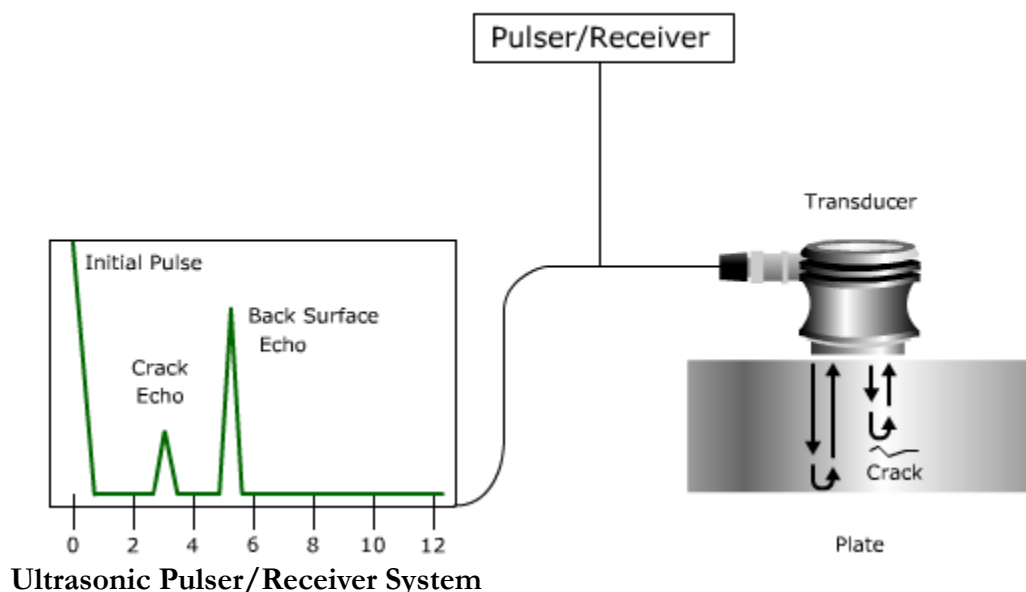
OLYMPUS XMS-310 ULTRASONIC TRANSDUCER

Our system also contained an ultrasonic transducer, which was provided to us by Honeywell FM&T. They gave us the Olympus XMS-310 Ultrasonic Transducer as that is what they are using for their testing procedure. The ultrasonic transducer must maintain the following parameters:

- Operation frequency of 10 MHz
- 2mm element size
- Immersion transducer
 - Allows for the transducer to be immersed for up to 8 hours

TD-PS45 POCKETSCAN

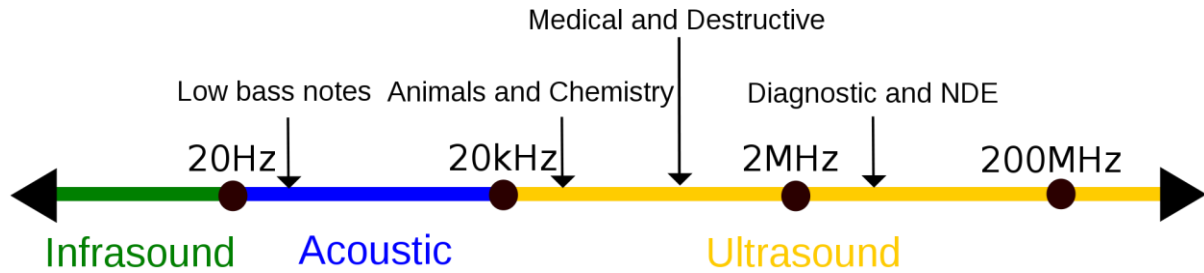
Utilize the TD-PS45 Pocketscan in our testing environment as to the request of Honeywell FM&T. This is another component they chose for use by us as it the actual equipment they are using. This piece of equipment as no necessary standards alongside it as it is a piece of equipment that is just responsible to sending a pulse at a user specified speed and digitizer with a user specified sampling frequency. It just must operate at a fast enough speed necessary for each individual customer. Which is generally around the frequency of 20 MHz pending on the system, ours will operate at 100 MHz sampling and pulsing frequency.



BACKGROUND INFORMATION

ULTRASONIC WAVEFORMS

The Ultrasonic wave is a sound pressure wave with frequency greater than the upper limit reaches of the human ear. It behaves similar to all sound waves only without the ability to be heard. The wave frequency limit that human beings can here is about 20 kHz, with ultrasonic waves operating from this frequency to up near several gigahertz. Ultrasonic have sensed branched out of this area for use of imaging, detection, and measurement.



Sound Wave Spectrum

WHY WE USE ULTRASONIC WAVES

In the application provided by Honeywell the TD Pocketscan will be using ultrasonic to detect movement in a system. This will focus around the 2 MHz range as shown in the figure above. This speed is necessary to collect the resolution of signal we wish to process. This same system can be used to detect cracking in the testing system as well.

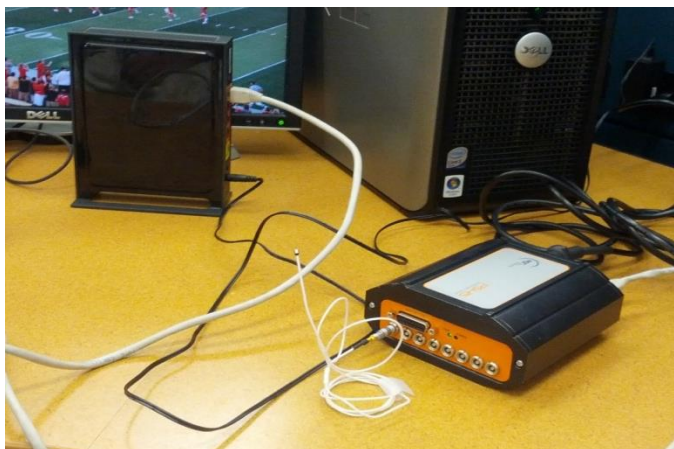
TEST APPLICATION

In order to test our system we developed a simple way to simulate the centrifuge environment using water and a ball bearing. By using piping we can simulate the movement of the metal ball through water to have the TD Pocketscan output the graph of the movement. This can in turn be listened to by the C and MATLAB program.

HARDWARE USED

Hardware was provided to us by Honeywell FM&T for use in our test system. The main components are as follows:

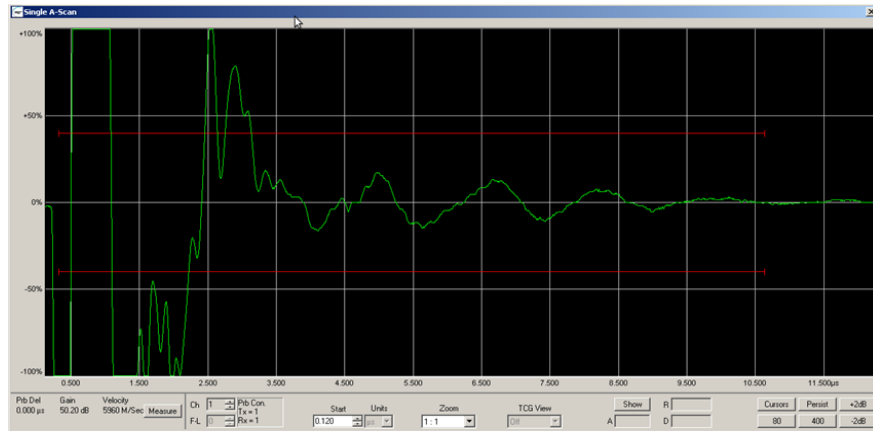
- AGR Field Operations PS45 TD Pocket-Scan
- Olympus Transducer XMS310
- NETGEAR Wireless-N WNR2000 Router



Wireless System Design

SOFTWARE USED

The program used in our system was built and designed by AGR Field Operations. It is called TD Scan 19.00. We had originally planned on designing our own system using Lab VIEW or MATLAB to process and synthesize our code; however when the TD Pocket Scan was provided to us our only option for massaging and processing of the signals was the AGR TD Scan Software. We also built and designed our own C code to eavesdrop on the signal for wireless monitoring from remote locations.



TD Pocketscan Generated A-Scan

MATERIALS

Materials will be needed to construct a mechanism which we can use to simulate the setup Honeywell is testing. Aluminum or steel will need to be purchased to machine the device we are measuring with the probe and PVC pipe to simulate our system.

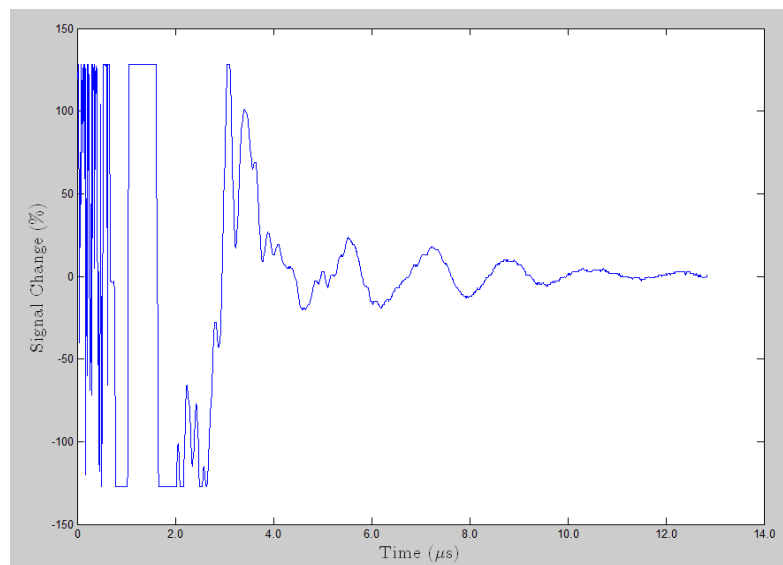
PROJECT SCHEDULE

These are the tasks that need to be accomplished in the following two semesters to complete the project successfully.

- 1) Research – Begin Understanding the System and How to Simulate it
- 2) Design of Project Website
- 3) Visit Honeywell Plant in Kansas City to Better Understand
- 4) Meet with CNDE to Discuss System Design and Probe Use
- 5) Design of System
- 6) Search and Purchase the Necessary WiFi and MCU Components
- 7) Testing the System and Programming Controllers
- 8) Repeated Design, Fabrication, and Testing for Creation of Optimal System

RESULTS

Using our router set up with our test application system we are able to transmit the wireless signal to the computer for use by the AGR TD Scan 19.00 Software. This also gives us the ability to monitor the signal using a few C libraries to output the same graph on another machine, as shown below. This will provide our customer with the ability to monitor the signals from a remote location. The application of this is invaluable when it comes to the troubleshooting of this system while in use.



Our MATLAB generated system

FUTURE OPERATIONS

For future projects it would be great to see our coding environment ported to Atmel designed Evaluation Kit boards for monitoring without the use of a computer. The implementation of such boards in a system could be highly desirable as it would allow for large amounts of cost savings for our customer. If this would be utilized we would recommend the use of the

SUMMARY

The project is to improve the current centrifuge testing system at Honeywell FM&T in Kansas City. The system must be created and simulated effectively to the liking and specifications of Honeywell. It should be a very interesting project to complete. We all continue to look forward to working with them as this is an excellent project for students in Electrical and Computer engineering to work with.

APPENDIX I: STANDARD OPERATING PROCEDURE

This Standard Operating Procedure will serve as a reference for the use to hook up the system correctly, not for the use of our testing apparatus.

The hook up of the TD-Pocketscan PS45 will follow the standard operating procedure as established by Honeywell at the current time. The primary portion of this documentation will serve to show the configuration of the system's wireless features.

ROUTER CONFIGURATION

This step will vary for all routers however the same basic steps will be as follows:

1. You will need to change the router's default IP Address from 192.168.1.1 to 192.168.0.1
2. Force the router to see the TD-Pocketscan PS45 IP Address as 192.168.0.200
3. Restart Router to save the Settings

COMPUTER CONFIGURATION

After setting up the router you must wirelessly connect to it. This can be done by the normal process within Windows. You will then have to fix the IP Address of the Wireless Adapter that the router is connected to. These instructions will be provided for Windows 7:

1. Press Window's <Start> button, and select <Control Panel>.
2. Switch the view to <Large/Small Icons>.
3. Select <Network and Sharing Center>.
4. On the left hand side of the window select <Change adapter settings>.
5. Right click the adapter that the PS45 is connected to.
6. In the dialog box press the <Properties> button.
7. Select <Internet Protocol Version 4 (TCP/IPv4)>
8. Press the <Properties> button
9. Select the option <Use the following IP Address :>
10. Set the IP Address to 192.168.0.199
11. Set the Subnet Mask to 255.255.255.0

CONNECTING TO THE TD-POCKETSCAN PS45:

1. Insert USB Key provided with the TD-Pocketscan PS45
2. Open the AGR 19.00 Scan Software
3. When system prompts you to input IP Address of TD- Pocketscan PS45 enter 192.168.0.200
4. System will now be functioning correctly
5. Conduct measurements on System