CHAPTER 2

LITERATURE REVIEW

In this new millennium, new inventions with the latest technology and invention are being produced by engineers and scientists world wide. This is true by just searching any of the technology field in the internet and more than one hundred results will be display. Thus, to for the up coming technologies or inventions, it is wisely to study and understand these previous projects in order to gain knowledge on the overall system. For this project, the Wireless Data Acquisition has been developed not only undergraduate students but also design engineers in prominent companies.

2.1 Computer Aided Racing Statistics Project

In late 1999, the Department of Electrical and Computer Engineering Auburn University, Alabama has started a project entitled Computer Aided Racing Statistics (CARS). The project is conducted by twenty seniors from its Electrical Engineering course and completed on March 2000. The aim of this project is to design, develop and implement a wireless data acquisition system which capable to function in an hostile environment for example a race car or heavy machinery. To achieve this aim, the system is capable of to read sixteen difference analog signals and transmit the converted data in digital format by wireless communication in a minimum of 800 meters to a PC for monitoring purpose. In hardware configuration, this project used an ADC0816 analog to digital converter with a 16 channel analog multiplexer and an MC68HC11 microcontroller as the brain for the data acquisition unit where it monitors the switching between sensors and also formats the digital data before sending it to the wireless data-modem. A 7473 flip-flop chip is used to halve the 2MHz generated by the microcontroller so that the ADC0816 can be functioning. [3]

In this project, the wireless modems are used to transmit serial data obtained from a vehicle in real time. Some examples of this data are engine temperature, acceleration, and strain-gauge data. For the wireless data transmission, a format to transmit the data is being developed whereby each sensor will transmit a 16-bit packet for each sample with the format, 1HHHHDD1 0DDDDDD0, where H represent a header bit (the address of the sensor) and D represent a data bit. This format was chosen due it its capability of error detection (for example if a byte arrived which started with a 1 and ended with a 0, then the software daemon will detect an error). In this project, the wireless data-modem that implements the RF data link is selected based on the design parameters of:

a) Range of link, physical characteristics and output power
b) Frequency of operation, antenna requirements
c) User interface
d) Baud rate/link throughput ,robustness of the link and price

For parameter (a), these parameter defines the distance of data link between the transmitter side and receiver side. For this project, the range is not more than 800 meters. The required output power of each side is determine by this range and the physical characteristics of the surrounding environment. Based on the report, the range of RF data transmitter can be achieve by the Friis transmission equation. It is based on a free space propagation model and is used to predict received signal strength when the transmitter and receiver have a clear, unobstructed line-of-sight path between them.

$$\Pr(d) = \frac{\mathrm{Pr(d) = Pt * Gt * Gr} * \lambda^2}{4\pi^2 * d^2 * L} \qquad (2.1)$$

where Pr = power received Pt = power transmitted λ = wavelength in meters
Gr = gain of receiver Gt = gain of transmitter d = Tx-Rx separation (m)
L = system loss factor not related to propagation

As for this project, the transmitter is capable of producing 1W output power which it actually can travel 32 kilometers and greater depending on the antenna used. Thus, it would be any problem since this project aims only 800 meters of range. [3]

As this project requires a fixed platform and receives information from a moving platform, the operating frequency for this project is in low frequency and it also used omni-directional antenna type for parameter (b). The antenna type is selected due to its capability to radiate equally in all directions no matter what its orientation to the receiver is. For parameter (c), this project used the HyperTerminal from Microsoft® Corporation. And for the parameter (d), this project used the serial RS232 communication to link the modem and the PC. The best baud rate used is 9600. The link throughput which refers to velocity of data transfer in the air and can affect the system robustness directly which also known as Bit Error Rate (BER). Spread spectrum technology is being used in this project where the modem, Freewave use it to improve the robustness of the throughput link by reducing the modem's susceptibility to Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI). So, Freewave modem in this project reduces any likelihood of interference from the vehicle's other electrical system. The price for the Freewave modem is $USD1300 per modem which total $USD2600 for both transmitter and receiver modem where it being sponsored courtesy of one of the Auburn's senior design team. Meanwhile, the software development that involved in this project is the Redhat 6.1 Linux Operating System. The programming is done using the GNU C compiler and the GTK (Gimp Tool Kit) to create the GUI. [3]

2.2 Handheld Data Acquisition System Project

On 8 October 2001, a manuscript entitled 'A Handheld Data Acquisition System for Use in an Undergraduate Data Acquisition Course' by Greg Mason from the Mechanical Engineering Department, Seattle University has been published at the IEEE. This project is done to overcome the problem arouse where the available PC equipped with data acquisition cards in the Seattle University is limited for students to write computer programs and design or analyze simple interface circuits for various data acquisition and control assignments. Briefly, the system is based on a PocketPC computer and a low-cost serial DAQ card. The DAQ system runs under Microsoft WindowsCE, an embedded real-time operating system. The DAQ hardware is supported by a free development system and custom software that allows applications to be tested under emulation with simulated I/O before being downloaded to the DAQ hardware.[4]

The handheld computer is a Casio EM500 PocketPC. The device comes equipped with 16-MB memory, a 150-MHz RISC processor, VGA color touch-sensitive screen, an infrared (IR) port, USB/serial port, and a MMC/SD expansion slot. This choice was determined by price and availability. PocketPCs run Microsoft's WindowsCE 3.0 operating system. This operating system was designed with embedded real-time applications in mind. WindowsCE 3.0 is a preemptive multitasking OS. The OS includes short interrupt latency times; multiprocessing synchronization features, such as mutexes, semaphores, and events; and user-assignable thread priorities and time-slice lengths. The DAQ card is a model ADC-1 manufactured by Integrity Instruments. For the DAQ card, they used the ADC-1 which has 8 12-bit analog to digital converters, which can be used in a single-ended or differential mode; 16 digital Input/Output (I/O) lines with user-selectable directions; a 16-bit counter; and a Pulse Width Modulated (PWM) output. The ADC-1 communicates with the handheld computer via a 115–kb/s serial connection. The ADC-1 can theoretically collect and send data to the handheld at over 1000 samples/s. For the student projects, however, it is typically required sampling rates of less than 100 samples/s.[4]

The DAQ system is programmed using Microsoft's eMbedded Visual Tools.1 eMbedded Visual Tools consist of a Visual C++ compiler with the Microsoft Foundation Class (MFC) library and Visual BASIC. Programs can be compiled to run on any number of different processors, including MIPS, ARM, SH3, and SH4 architectures. Visual BASIC programs are interpreted and run unmodified on any system that has the appropriate Visual BASIC run-time interpreter. Completed programs can be downloaded from a desktop computer to the handheld using the serial/USB connection or the built-in IR port on the PocketPC. IR communication has the advantage of not requiring a physical connector. A key to the success of the handheld DAQ system in the laboratory is an emulator that lets students test their software without having to use an actual DAQ device. The emulator has two parts—theWindowsCE emulator and the ADC-1 emulator. The WindowsCE emulator is provided with Microsoft's eMbedded Visual Tools. The WindowsCE emulator is integrated with the development system and provides debugging capabilities similar to those found in most desktop development systems. When the software is working under emulation, it is recompiled for a specific processor and downloaded to the handheld computer. [4]