**Introductory Description**

Many people in their spare time try to find interesting activities to do to keep them occupied. One of these activities is a remote controlled hobby. This hobby involves many vehicles including cars, boats, helicopters, and airplanes. I myself am an introductory hobbyist in the remote control airplane field. As technology increases, so does the ability to add new movement and new technologies to the remote controlled vehicles. When I was thinking about my senior project, I looked at my plane and brainstormed ideas that would add to the fun of my hobby experience. For this project, I propose to build an airspeed indicator for my R/C airplane. The system will monitor the planes’ airspeed and display the speed to the pilot on a liquid crystal display (LCD) in M.P.H.

**General Description**

The major hardware components are shown in Figure 1 and 2. The system has two separate hardware blocks: Figure 1 for onboard the airplane and Figure 2 on the ground next to the pilot. As you can see, two separate portable power supplies will be needed. In Figure 1, the components include a wind sensor, Hall Effect sensor, power supply, RF transmitter and antenna. A magnetic strip on the wind sensor (Figure 3) will trigger the Hall Effect for sensor every revolution of the wind sensor. The resulting digital signal will then go into the transmitter, which will be transmitted to the receiver antenna on the ground. In Figure 2, the components include; an antenna, RF receiver, HC12 microcontroller, 2 x 16 LCD display, and power supply. The signal from the transmitter will go into the receiver, be sent to the microcontroller for speed calculation, and then the speed will be displayed on the LCD.
Figure 1. System Hardware on Airplane

Power Supply

Rotational Fan → Hall Effect Sensor → RF Transmitter

Antenna

Figure 2. System Hardware on the Ground

Power Supply

Antenna

RF Receiver

M68HC912B32 Microcontroller → 2 x 16 LCD Display
The maximum dimensions of the project components are shown in Figures 3 and 4. The critical parameter in Figure 3 is that the wind sensor must not be in the path of the wind kickback of the airplane’s propeller. If the sensor were in that path, the sensor would provide inaccurate readings of the airplanes’ speed because the sensor would be spinning due to the propeller wind, not the true airspeed. The power supply and RF transmitter will rest in the cabin of the airplane. The antenna on the aircraft, which is the link to the transmitter, will be a piece of wire running down the length of the plane not exceeding 91cm in length. Figure 4 depicts the components ground. The components will be housed in a plastic casing, with the LCD visible on the top. The dimensions of this casing will not exceed 20cm length x 8cm height x 10cm depth. The casing will house the power supply, RF receiver and microcontroller. The antenna will extend no further than 18cm from the top of the casing.

Figure 3. Plane Diagram
Figure 4. Display diagram
**Functional Description of Hardware**

The detailed hardware block diagram is depicted in Figure 5. The main components include M68EVB912B32 (HC12) microcontroller, LCD, RF transmitter module, RF receiver module, Hall Effect sensor, and portable power supplies. The HC12 will be used to calculate the speed of the airplane, and output that speed to the LCD module. Port T (PT7) of the Pulse Accumulator on the HC12 will be the link to the RF receiver. The receiver will pulse PT7 every rotation of the wind sensor, and the Pulse Accumulator (in Event Counter Mode) will count the rising edge of the pulse. The microcontroller will then calculate and output the speed to the LCD, which will be connected to PortA (0-7) and PDLC (4-6). Memory for the program code and variable storage is sufficient on board the HC12. The main program will be stored in the 32k bytes of Flash EEPROM. The 1k byte of RAM will be used for variables in the program.

As I mentioned earlier, there will need to be two separate power supplies. The elements in the plane consume the least power, so I am going to use a 9V battery rated at 655mAh for the Hall Effect IC and the RF transmitter. 5V regulators will be used on the RF transmitter and Hall Effect IC. The power supply on the ground needs to power the HC12, LCD, and the RF receiver. These devices consume more power, so I am using a 7-cell, 8.4V NiCd battery pack (rated at 1500mAh). I will use 5V regulators on the HC12, LCD, and RF transmitter. The RF receiver and RF transmitter modules are made by Laipac. They contain an LC type oscillator tuned to operate at 418 MHz. The pair is good to use for this project because they both operate with digital signals, which makes it possible to avoid A/D conversions at the processor level.
The final element is a Panasonic Hall IC. It will sense the magnetic field given by the wind sensor (Figure 3) and produce a digital pulse. I chose this IC because its output is a digital signal, making it directly drivable to the digital input of the transmitter.

Figure 5. Hardware configuration
Software Description

The software portion of the Airspeed Indicator will be written in Assembly and C programming languages. The program will consist of the following modules:

1) LCD– This module includes routines for writing to the LCD from the microcontroller.
2) CONVERSION – This module will take the necessary data from the E-clock and the Pulse Accumulator and convert it into the corresponding airplane speed.
3) MAIN- This module is a cooperative kernel time-slice scheduler to handle the program flow. The decision to use a time slice was made because I don’t have very many tasks to be managing. My tasks will include counting, pulses, calculating the airspeed, checking for errors, and updating the LCD.
4) ERROR – This module will use software to detect if the plane is out of range or if pulses are missed at the receiver end.

User Interface

The user interface is very simple. The LCD is simply there to indicate the airplane’s speed or if the plane is out of the RF range. The LCD will be updated with the current speed every second. The LCD will have only two states will be either displaying the speed or telling the user that they are out of range.

Development Plan

I have spent most of fall quarter looking for components that would work for this project. The biggest struggle was to come up with a sensor that would work in the air. I now have a list of all the components that I believe will be necessary to complete the project. The remainder of
fall quarter will be spent getting the parts in my possession. Most of winter quarter will be spent on interfacing all of the hardware and to calibrate the wind and Hall Effect sensor. The interfacing task includes ensuring proper signals at the transmitter and receiver ends. I will be taking ETEC 454 Winter ‘03, so I plan to begin a preliminary program outline early as soon as I learn the material. The next step will be concentrating on getting a functioning program. Spring quarter will be spent writing a functional program for the system, and toward the end of the quarter, finishing up any loose ends or problems along the way. Here is a more detailed weekly list for the remainder of the fall, winter, and spring quarters:

Fall ‘02

Week 10: Order all hardware components except for the microcontroller and LCD
Week 11: Wait for parts, Final Exams

Winter Quarter ‘03

Week 1: Set up wind sensor and hall IC. Check for good signals and look into using the wind tunnel at WWU for calibration measurements (i.e.: wind speed vs. RPS).
Week 2: Make a calibration table in the wind tunnel for the Hall sensor. This relationship will be used later in the microcontroller program.
Week 3: Test RF transmitter and RF receiver to ensure proper operation.
Week 4: Interface the hall sensor with RF receiver and test all stages of signal.
Week 5: Make sure that the interface is working reliably to get ready to interface with the HC12.
Week 6: Work on interfacing the RF receiver with the HC12.
Week 7: Write a test program to that will count pulses and display on the terminal.
Week 8: Break down program into a general flow diagram.
Week 9: Design tasks and routines.
Week 10: Design time-slice scheduler kernel.
Week 11: Finals Week.

Spring ‘03

Week 1: Write the Conversion module.
Week 2: Continue writing program.
Week 3: Continue writing program.
Week 4: Continue writing program.
Week 5: Project Design Review.
Week 6: System tests.
Week 7: Final software development, revision, and testing.
Week 8: Final software development, revision, and testing.
Week 9: Code Review and final preparation of system for demonstration.
Week 10: Project demonstrations.

**Hardware and Software Development Tools**

The development hardware and software needed for my project to work will all be found in the Engineering Technology Building at WWU. Hardware development tools will include a portable oscilloscope to take into the wind tunnel for calibration measurements, digital multimeters, digital oscilloscopes, PC’s, programmable power supplies, and soldering irons for my hardware testing. Software development tools will include Introl Code program, Codewright Editor, and Norel Debugger.
Demonstration Prototype

The Airspeed Indicator system will be developed on the Motorola HC12 Evaluation Board (EVB). Although it will be developed on the HC12EVB, it will still be packaged in the plastic casing not exceeding 20cm length x 8cm height x 10cm depth. Again, the casing will hold the HC12EVB, power supply, and receiver. The LCD and antenna will be on the outside of the casing. Construction of the receiver end of the project will take place on the development area of the HC12EVB. For the transmitter end, wires will be soldered onto the Hall IC (mounted on the plane) and ran inside the plane. Inside the plane, the receiver, hall IC leads, and power supply leads will come together on a small breadboard (5.4cm W x 8.6cm L x .2cm H). Because the airplane will not be able to be flown for demonstration purposes, the project will be demonstrated in the ETEC 340 LAB using an electric fan as the artificial wind source.

Electrical Specifications

Project Specifications:

Range: 0 – 50 m.p.h

Resolution: 1 m.p.h.

Frequency: 418 MHz

Range: 500ft.

Power Requirements

On the Plane

9V battery, 655mAh

Total worst case power dissipation: 180mW

Estimated battery life: 17.7 hours
On the Ground

8.4 battery, 1500mAh

Total worst case power dissipation: 460mW

Estimated battery run time: 19.74 hours

Preliminary Parts Description

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