System Integration of an Electronic Monitoring System in All-Terrain Vehicles

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An electronic monitoring system (EMS) is designed for use in All-Terrain Vehicles (ATV) as a dashboard in an automobile. The system can display parameters such as tire pressure, speed, and fuel level, which provides safety to drivers during the operation of ATVs as well as maintenance information all the time. The monitoring system uses various analog sensors to collect signals and uses a microprocessor to extract parameters relating to speed, fuel level, rotations per minute (RPM), and tire pressure. Organic light-emitting diode OLEDs and light emitting diodes (LEDs) are is used to display the parameters to the ATV user. An input pad is utilized for user-input and customization to specific vehicles, allowing for the monitoring system to be applied to a wide variety of ATVs. Design concepts, with a focus on system integration, will be discussed based on extensive evaluation of efficiency and customer needs. Finally, testing methods and expected results are discussed.

Background and Application

The electronic monitoring system (EMS) for all-terrain vehicles (ATV) will be utilized like a dashboard in an automobile. The system will monitor engine revolutions per minute (RPM), ATV speed, fuel level, tire pressure, and which gear is currently active. The system will then display these levels on either a organic light-emitting diode (OLED) display, a light emitting diode (LED) display, or a liquid crystal display (LCD), mounted in the middle of the ATV's handle bars. These systems are standard on 2009 and newer models. Before 2009, however, ATVs were not equipped with systems. An estimated total number of new retail ATV's just in 2006 was 747,581 [1]. With that year alone, a huge market is established for our system. ATVs not equipped with a monitoring device do not allow the user to view certain parameters, such as speed, that are vital to safety. Also, knowing when maintenance is required on the ATV makes part failure less likely to happen. Since there are no such systems installed on ATVs prior to 2009, the potential market is relatively large. A system that is adaptable to any make or model of ATV is not currently available. This system as the first of its kind, could give us a competitive edge across the market.

The System integration problem

Why is system integration important?

Efficient system integration is essential for many reasons. System integration allows several different components to operate continuously without interruption. It is important because nearly all the systems in use today have many forms of operation. For example, in an automobile, there are several mechanical and electrical systems at work. In our electronic monitoring system, it is necessary to incorporate sensors to monitor four distinct values. Because of this, careful planning will be needed to create efficient system integration in order to display these values to the user.

Challenges with system integration

System integration is challenging in many ways. The biggest challenge is with receiving and analyzing electric signals for information. With four distinct signals being received at the same time, the biggest challenge is to continuously update the monitor with the correct values. Another challenge with system integration is physically being able to place all of the systems on the ATV. Since the ATV and the housing for the monitoring system are not very large, it will be difficult to arrange the systems so that they will not interfere with each other.

System integration in our electronic monitoring system

Our system is displayed using an OLED screen. The data is continually collected by the microcontroller (in this experiment the Cerebot Mx7ck is used). The microcontroller analyzes one signal at a time. To deal with the system integration problem, the time each signal is analyzed is varied for each parameter. In order to achieve this, a delay time is set up for each parameter. Figure 1 shows an example that deals with the integration problem. After the system is powered on, the OLED will display “welcome” and initialize the data. Next, the microcontroller will automatically collect data from each sensor depending on the delay time. In figure 1, the speed is set to be detected at the first, and then the RPM will be detected after it. Finally, the microcontroller will collect the fuel signal. Since the data that is collected forms a sequence, the loop will be able to update the data without interruption.

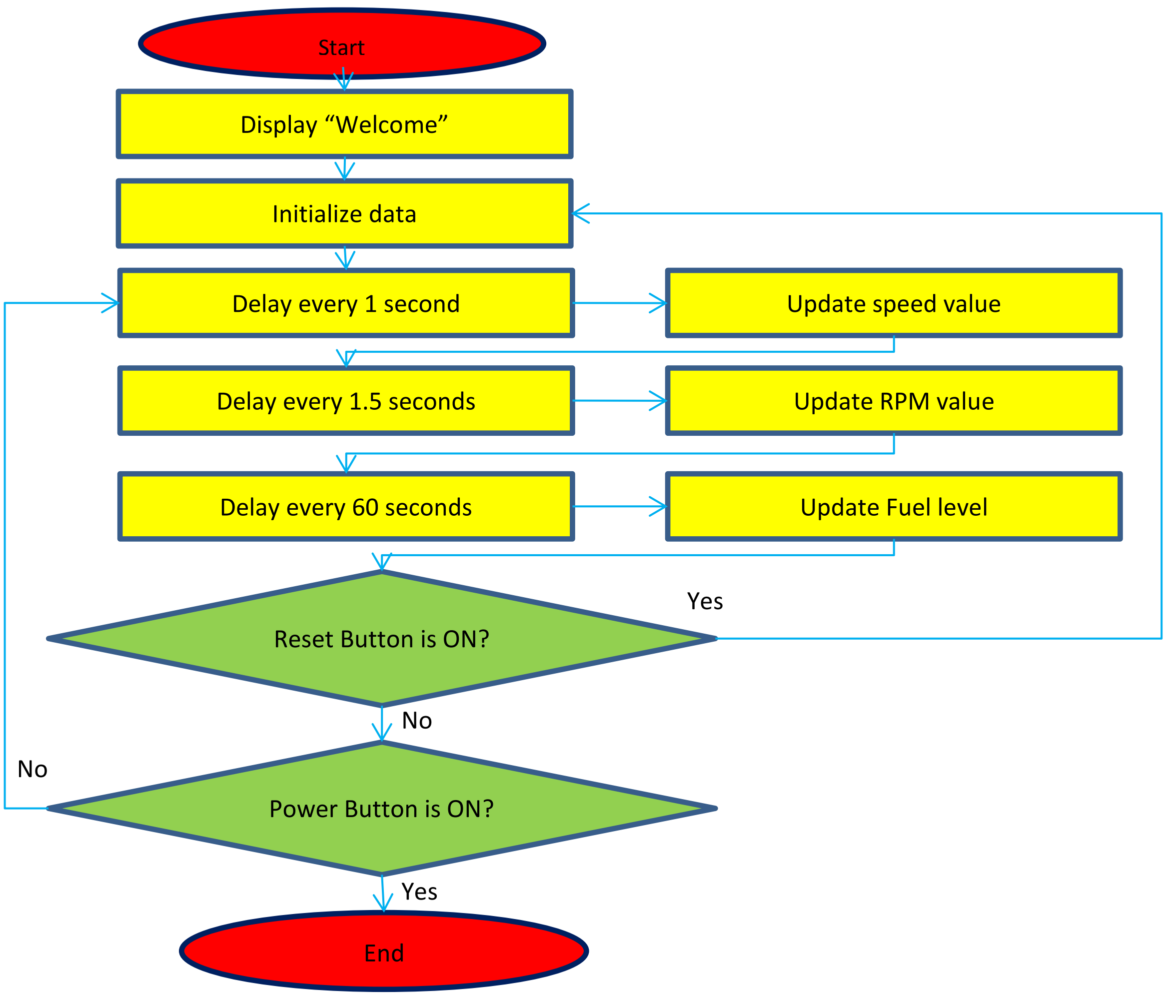

Figure 1. The flowchart for the electronic monitoring system.

Methods

Sensor descriptions

Tire Pressure

Tire pressure monitoring systems (TPMS) work in two very different ways; *direct* and *indirect* [3]. There are two methods in the *direct* category. One consists of a pressure sensor that is mounted inside the tire or on the valve stem of the tire. It is considered direct because it takes the pressure reading directly from where the pressure is being applied. For our system to use direct TPMS, a sensor needs to be mounted inside the tire in order to send signals wirelessly to a receiver on the microcontroller. Another way would be to mount a sensor on the end of the valve stem and calculate a pressure outside of the tire. This is considered direct because it is still taking a pressure reading directly from the tire. The system design worked best with *direct* TPMS. This was mainly from that fact that it will output a pressure value. Aftermarket systems could either be mounted directly inside the tire or just outside the tire by being threaded onto the valve stem. Since the (EMS) needs to be user friendly and easy to install the TPMS needs to be mounted outside of the tire. This narrowed down options because now the only *direct* TPMS would have to be threaded to the tire valve stem. The aftermarket system that best fits the EMS came with its own display. The TPMS system model number is TD1300A-X and manufactured by *Tyredog.* The aftermarket package included 4 wireless valve stem mounted sensor, one for each tire, and a small display with its own housing. This display can be disassembled and mounted inside the EMS housing. The only requirement of the aftermarket display is a 3 volt source for power. The sensors thread onto each valve stem and transmit an output through wireless communication with the display. An illustration of the tire pressure monitoring sensor is shown in Figure 2(a) and (b).

Fuel level

The fuel sensor that was chosen for the ATV Electronic Monitoring System measures the flow of fuel from the tank rather than the level of fuel in the tank. The sensor is the RS Components part numberV10980. The way the sensor works is the fuel traveling from the tank to the engine passes through the sensor. As it passes through the sensor it turns a turbine containing magnets. As the turbine spins it sends electric pulses representing the fuel that is flowing through the sensor. In order to calculate the fuel level the amount of fuel that has left the tank (determined by the number of pulses) is compared to the capacity of the tank. By performing a simple mathematical operation the fuel level can then be calculated and displayed for the operator. The sensor used to measure fuel level is shown in Figure 2(b).

Speed

The speed sensor used in this project is a magnetic speed sensor. The magnetic sensor offers more benefits as compared to an optical sensor. The magnetic sensor is easy to install to the wheel, and it has higher resistance to environment than the optical sensor. Optical sensors are able to measure the speed with a higher degree of accuracy, however, it is unstable when the car is vibrating or on a rainy day [2]. The optical sensor uses an additional power supply from the car or other accessory batteries, whereas the magnetic speed sensor is powered as the rotor turns. The sensor used to measure speed is shown in Figure 3.

Rotations per minute (RPM)

The rotations per minute (RPM) will be measured using a magnetic sensor (the same sensor used for speed). The magnetic sensor is placed in the engine of the ATV and will directly read the rotations of the engine. As stated above, the magnetic sensor is superior to the optical sensor in this application because the magnetic sensor has a higher degree of stability and environmental resistance. The sensor used to measure RPM is shown in Figure 3.

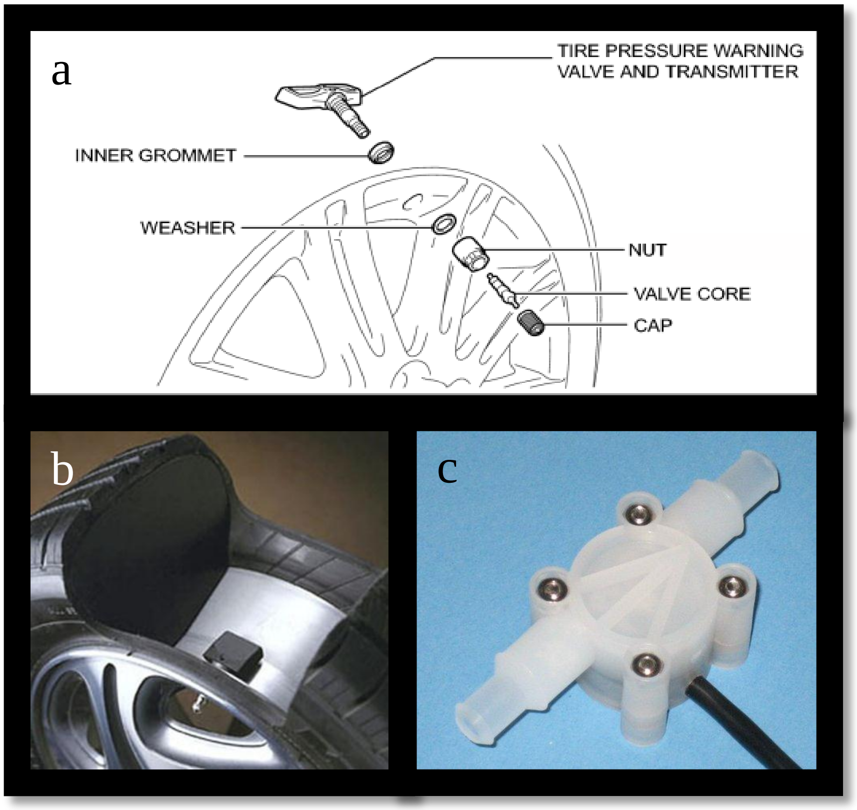

Figure 2. (a) The tire pressure sensor and (b) location. (c) The fuel level sensor.

Figure 3. The magnetic sensor used for the speed and RPM values.

Testing

The EMS is made to be installed on an all-terrain vehicle (ATV) but is not limited to just that platform. A new or used ATV was not in the budget so the Central Michigan Baja team was the perfect option. The team designs and builds a Baja vehicle every year for nationwide competitions. These vehicles are a cross between an ATV and go kart. The vehicles use many of the same components that an ATV does. The Baja vehicle is the closest platform available to test the EMS on. A picture of the actual Baja vehicle test platform is shown in Figure 4. The system will be installed to replicate installation on an actual ATV. The magnetic speed sensor will be mounted to one of the front tires, and read the rotations of the wheel. The RPM sensor will be mounted just behind the output clutch of the Baja vehicles and read rotations off the clutch that will be attached to the output shaft of the engine. The fuel flow sensor will be mounted in-line of the fuel hose before the engine and will be mounted horizontally per manufacture's requirements.

During the testing, it is anticipated that there will be some kind of electromagnetic interference (such as RF noise). If there is some noise, but that noise can be ignored because it is basically non-existent, no extra circuitry will be needed to cancel this noise. If there is a large amount of noise that cannot be ignored, the problem will be solved by shielding the connection wires or designing a filtering circuit.

Figure 4. The Baja test platform.

Discussion and Conclusion

The objective of designing and building this display for ATV's is to provide performance feedback to the operator to increase the safety of ATV's. The system will monitor important areas of the ATV's operation and display them for the operator to see. The areas that will be monitored are the speed, fuel level, rotations per minute of the engine (RPM), tire pressure, and engine run time. Because many ATV's manufactured before 2009 do not have any monitoring systems in place this device will provide the vital information to help operators maintain and operate their ATV's in a safer manner. The purpose behind the design and manufacture of this display is the fact that before 2009 ATV's did not have displays that came with them. The displays were an option that could be bought but was often not. There is not another unit on the market that can be attached to any ATV with all of these monitoring units in it. Currently each sensor would have to be purchased and installed separately. By monitoring the speed ATV operators will be able to keep their ATV's at a safer speed. With all of the engine and system monitoring the operator will be able to have a regular maintenance plan that can be tracked through the engine run timer. In addition to this problems that could arise with the ATV can be noticed before they cause an ATV to break down and become stranded.

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