Importance of Microcontroller in Automobiles

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Abstract

Technology has become an inevitable part of the human life, hence, automobiles are no exception. The use of microcontrollers to automate the automobile industry is increasing with every passing decade. Increasing use of Microcontrollers has not only led to automation but simpler construction of the subsystems and reduced use of wires for interconnection leading to increased portability. Microcontroller is dedicated for a specific task and their use in the automobile industry has led to automation in incredible areas ranging from Electronic Stability System(ECS), Automatic Parking to Smart Phone controlled car security. Hence, due to greater customer expectations regarding fuel economy, safety, comfort, performance, maintenance and ease of operation, in the future microcontrollers will be increasingly involved in our day to day lives to eventually get better performing automobiles.

Keywords - *Automobile, Embedded System, Microcontroller, Intelligent automobile, Smart vehicle*

I. INTRODUCTION

Nowadays, automation has also become essential in order to combat environmental issues. Emissions from conventional automobiles has contributed largely to global warming which has become a matter of huge concern for the present and future generations. Hence, the automation industry must consider several performance and global emission norms. All the integral systems of an automobile including fuel injection, break, navigation etc. are required to be monitored continuously by digital controllers such as microcontrollers/microprocessor.

With increasing developments in technology, consumer expectations have also increased. As a result, the face of automobile industry has completely altered. Concepts such as power seat, power steering, automatic transmission have evolved. In fact, driverless cars are also on the pipeline due to such sophisticated concepts, research in various incredible areas have been taken up which has revealed completely new face of automation. Accident Inference systems installed in automobiles, better brake and automobile exhaust testing, Carbon Monoxide alarm in indoor parking are few such areas. All these enthralling ideas and their implementation in the automobile industry is possible only due to the ever so increasing use of microcontrollers. Preprogrammed Microcontrollers are embedded in the automobile to achieve implementation of these concepts.

Automation in automobile industry is a consequence of the increasing technological developments. All the interesting ideas and concepts have been devised and designed to implement for practical purposes only due to the availability of microcontrollers. Initially, 8-bit microcontrollers were used for engine control. However, more efficient microcontrollers were required for faster and accurate functioning of various subsystems. With the manufacture of 16-bit and 32-bit microcontrollers, better performance has been achieved in the automated subunits of the automobile. Use of microcontrollers has eventually led to lesser number of components and better performance for less money [8]. Hence, innovation in the automotive sector has become easier and cheaper due to the availability of such high performance, powerful microcontrollers with more non-volatile memory.

It is worth mentioning all the fields in which recent research have been taken up regarding use of microcontrollers for automation in the automobile industry. Firstly, one of the major concerns for any automobile manufacturing company as well as the customer is passenger safety. Hence, a lot of research has been done in this area. One of them is implementation of Electronic Stability Control (ESC) using microcontrollers. ESC in vehicles provide safety of life and property by triggering control action whenever the vehicle is detected to have lost traction. It is responsible to stabilize the vehicle once again under such circumstances and bring the vehicle back to linear motion. Basically, Differential Braking System is employed in ESC. This involves applying brakes on one of the four wheels when the car enters into a spin motion. The two situations which arise under this condition are:

i) Understeer

ii) Oversteer.

In the understeer condition, the front wheel does not turn as much as required. Thus, ESC applies right brake of the rear wheels to generate a clockwise effect.

Again in the oversteer condition, the vehicle turns more than required. Hence, if ESC is activated, it applies brake on the left front wheel to produce a counter clockwise movement to stabilize the vehicle. Moreover, ESC involves large number of sensors which constantly send signals or information to microcontrollers to initiate the control mechanism on risk detection.

Implementation of Adaptive Front Light system using microcontrollers [1] is another interesting area of research. It is based upon steering wheel angle and speed changes to adjust the light axis angle to improve driver's security vision. When a vehicle encounters a corner, the microcontroller collects information of the speed changes and steering wheel angle to determine the dimming of the headlights and adjustment of angles between the left and right headlights. These information are used to calculate the stepper motor's control parameters by the microcontroller.

A lot of research have been done to increase the consumer's comfort. For instance Power Seat [3], which focuses on automatic seat adjustment which has a toll on the body of the person while adjusting the seat to a comfortable position. This is tiresome as well as time consuming. Hence, automatic adjustment of the seat using microcontrollers has been focused upon in this [3] research paper. Smart Phone controlled car security is another interesting research in this area. In this research, objectives like locking of the car, unlocking of the car, switching the car ON and OFF along with finding the location of the car via an SMS sent from the user mobile phone to the GSM modem set in the car have been achieved. These objectives provide solutions to problems like waiting before starting the car to let the engine attain temperature for its normal operation to obtain better performance of the car and to increase its life. Moreover, if a car gets stolen and is used for illegal purposes then the owner has to tackle several legal issues. Thus for such situations, smart phone controlled security system has been implemented on a real car.

Microcontrollers are widely used in automobiles because of the ease of control electronics provides as compared to any other methodology. Faster and accurate operation of engine to optimize the use of fuel, monitor and control the performance of vehicle and diagnosis of malfunctions in onboard systems [12] must be controlled to maximize the benefits with regard to fuel emissions, fuel economy and engine performance[8]. Usually, separate modules performing major functions in the automobile were separately automated. However, with development in technology, integration of these modules have been taken up. Integration is achieved via involvement of computing power which will eventually lead to reduced number of cables between various electronic components

On the other hand partially automated automobiles[9] have also been researched upon. Thus, the use of microcontrollers along with intelligence of the driver can be witnessed in such automobiles, i.e., the automobile gives automatic response only if the driver is unable to take appropriate actions when alerted. This can be achieved by interfacing the microcontroller with the basic systems of an automobile such as braking, steering and acceleration [9]. Consequently, automation in automobiles has also become essential for road safety.

Keeping in mind all the constraints like environmental issues, global warming and passenger safety, the automobile industry is gradually moving towards electric driven vehicles[10]. This will be achieved eventually with the use of even more powerful microcontrollers.

These account for only a very few topics researched and innovations made in the automotive sector using Microcontrollers. However, it can be seen how easy it has become to achieve all these simple yet important innovations due to the availability of such cheap yet powerful microcontrollers.

II. WHY TO USE MICROCONTROLLER

As mentioned several times before in the paper, there are several other techniques that can be used for automation in the automobile sector. However, Microcontrollers provide equivalent or better alternatives to such methodologies and that too at lesser price. Hence, these are appropriate as well as feasible to be used for mass production. with the increasing advancements in technology. Automobile companies have experienced huge boost regarding introduction of automation in vehicles which eventually leads them to provide better and advanced features to the consumers.

The inevitable use of microcontrollers in the present day scenario of automation in the automobile industry can be justified by one such research which involves implementation

of Intelligent Cruise System [15] via microcontrollers. This intelligent system basically involves moving away from the obstacle by slowing down or steering away from the obstacle to a safe spot to avoid collision. Overall, this system makes driving a safer experience and reduces the stress and attention required by the driver. This proposed system involves the use of several sensors and microcontrollers which are then connected to various subsystems of an automobile, such as Cruise control, Power steering and Power braking which helps in making appropriate decisions. To set various sensors, the surrounding regions of a car is categorized as:

i) The crash avoidance area
ii) The navigation area.

The crash avoidance area is the area in front of the car and all other spaces come under the navigation area. Fixed sonar are mounted in the crash avoidance area and mobile sensors are required for the navigation area. The mobile sensors are mounted on servos for better navigation. All the required information is sent to the main microcontroller. The main microcontroller is required for parallel processing. Also, some auxiliary microcontrollers are used for direct communication with the sonar modules. These measure time taken for the transmission and reception of pulses and report it consequently to the main microcontroller for further calculations and the final decision making.

Another research in which extensive use of microcontroller has been shown is " Simulation of Advance Ignition System for a Four Stroke Single Cylinder Engine using Photosensor and 8751H Microcontroller" [12]. Conventional ignition system includes ignition coil, resistor, distributor, rotor and spark plug. This conventional system is appropriate for low or medium paced systems . For systems with better performance, the fuel combustion and spark firing should occur at the same time [12]. It helps to obtain the maximum power with least consumption of fuel. A microcontroller has been used to replace the conventional mechanisms such as vacuum advance and centrifugal advance. Thus, engine has been replaced with a DC motor , photosensor has been used to detect the top dead point and a timer and counter in Intel's 8-bit single chip microcontroller 8751H are used to measure the engine's speed.

Hence, two extremely innovative and important research topics have been discussed in this section which clearly use Microcontrollers as the heart of all the processes.

III. IMPORTANCE AND WORKING OF SENSORS

Sensors are transducers which convert one form of energy to another. These form essential part of the automotive electronic control systems. Sensors are responsible for collection of all the required information from the surroundings and processing them to give information in the form of electrical signals to the microcontroller. It is impossible for microcontrollers to work without sensors.

In order to show the importance of sensors, discussion of the paper" PIC Implementation of Carbon Monoxide Alarm for Indoor Parking Car" [14] can be taken up. CO emissions from car exhausts is a major contributor to Global Warming. Also, CO when inhaled causes asphyxiation. 15% of COHb level causes headache and dizziness, 25% causes severe headache and nausea, 30%-40% leads to vomits and collapse and more than 40% is lethal. Hence, control of CO emission is extremely important. The system is obviously designed with microcontroller as the core but MiCS-5132 manufactured by Micro-Chemical System is a sensor used for Carbon Monoxide detection[14]. The sensor requires two voltages: V_H and Vcc. V_H is the voltage applied to the heater to maintain specific temperature of the sensing element for its proper functioning. Vcc that is the circuit voltage is provided to measure voltage across the load resistor. The sensing resistor is connected in series with the sensor to measure the level of Carbon Monoxide in the atmosphere.

Also, when it comes to use of microcontrollers in automobile, the advancements can be made not only within the automobile for better performance, consumer safety and comfort, but also for various testing systems of automobiles. For instance, research has been done in the fields of " Automobile Braking Performance Test System" [4], "Variable Electronic Speed Governer"[5], " Dynamic Testing Technology of Automobile Exhaust"[7] and "Tire Pressure Monitoring System with Wireless Communication" [13] to name a few. All these Testing Systems require various sensors.

The Variable Electronic Speed Governer [7] uses a separate speed sensing unit in its design which is known as crankshaft/camshaft sensor. The magnet radiates a steady magnetic field. When the crankshaft rotates, the steel pins create obstruction in the magnetic field which results in the generation AC signal. This information is then used to calculate the speed and position of the camshaft.

The "Dynamic Testing Technology of Automobile Exhaust" [7] involves Data Collection Hardware system. It involves several sensors such as Oxygen sensors, Infrared sensors, Atmospheric sensors, Temperature Sensors, flow sensor, Gas sensor and Electrochemical sensor for various purposes.

Similarly, "Tire Pressure Monitoring System with Wireless Communication" [13] involves OMRON E8CC 10 Pressure Sensor in its design which is used to measure gauge pressure up to about 10 bar.

Now, in terms of present day automobiles, there are several sensors which are used for various purposes. Some of the popular car engine sensors can be listed as follows. The first one is the Mass Air Flow Sensor which calculates quantity of air consumed by the engine. The Engine speed sensor monitors the speed of the spinning crankshaft. The Oxygen sensor is used to measures the quantity of unburned oxygen present in the Oxygen Pipe. Spark Knock Sensor is a sensor used to ensure proper burning of the fuel. Fuel Temperature sensor ensures that the required amount of fuel is injected for smooth functioning of the car engine. Lastly, Voltage Sensor ensures that the car speed is controllable. There are several other sensors, however, these are the most common ones.

IV. HOW THE ELECTRONIC DESIGN AUTOMATION IS DONE?

For manufacturing considerations, usually system engineering approach is taken, wherein integrated designing incorporating electronic, mechanical and computational techniques are involved. Microcontrollers can be supported with software codes to perform desired tasks while considering all the constraints or conditions to achieve mechanical or physical tasks. Designing under such circumstances involves both hardware and software abstraction based on the mechanical task to be performed. Let us consider the very latest research topic "Microcontroller Based Automatic Parking System" which considers developing the parking assistance systems present in some of the automobiles into automatic parking system. It focuses on the implementation of an efficient parking algorithm using Two-Turn concept. The system architecture involves detection of vehicle location, parking space, turning control and parking algorithm being controlled by the Microcontroller AT89S52. The parking space detection checks if there is adequate parking space. The vehicle location detection is used to find the present location of the vehicle. Thus, these information along with the parking algorithm are used to implement automatic parking. Also, the hardware involves ultrasonic sensors which detect obstacles in the parking space and acts accordingly. The microcontroller continuously implements the parking algorithm until the parking action is finished or it is being suspended by the user themselves.

This shows that, both hardware and software is to be incorporated in a system for its designing based upon the mechanical considerations, in other words, the physical tasks to be achieved. Hence, this is how usually electronic system designing is done.

V. CONCLUSION

In this paper we have discussed ever so increasing importance as well as implementation of microcontrollers in automation of the automobile industry. We have discussed that microcontrollers are preferred over other techniques of automation due to several factors such as easier implementation, lower cost, portability, feasibility and simpler circuit to name a few benefits. We have also discussed various practical projects using microcontrollers that have been successfully applied on real life cars. Importance of sensors have also been discussed, wherein few very interesting projects have been talked about and the sensors used in them have been elaborated. Also, sensors which are usually found in car engines have also been mentioned. System designing is another task which we have touched in this paper. We have discussed that how the amalgamation of electronic, software and mechanics is essential to achieve a feasible design. Hence, with every passing day, the use of microcontrollers will only increase in the automobile industry to suffice the increased consumer demands and stricter environmental and emission regulations.

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