Model based Development of an Adaptive Vehicle Stability Control System

Prof. Tarannum Shaikh¹ Aamir Khan² Arsalaan Thakur³ Shazaib Shaikh⁴
¹²³⁴Department of Electronics Engineering
¹²³⁴Mumbai University M.H Saboo Siddik C.O.E,Mumbai-08, India

Abstract— An approach for vehicle safety and better control is presented in this project, using adaptive vehicle control we are making an effort to make vehicle itself aware of conditions surrounding it. This can also be used for collecting uniform scientific data needed to make vehicle and highway transportation safer and reduce fatalities. This project gives an affordable and a very cost effective platform for vehicle to have an onboard data recorder which can be used to improve road safety which also can be used for vehicle forensics which would reveal the law enforcement authority about the failure that caused accident, and give vehicle manufacturer an idea for improvement.

Key words: Model, Adaptive, Control, Vehicle, Sensors, Accelerometer, Rs232, Lm 35, Ldr, Led, Relay

I. INTRODUCTION

This project implements an electronic MCU based computing unit, with an ADC based data gather and storage system. This project will primarily be designed to be used in a 2-wheeler to 4- wheeler vehicle. It has a MCU unit, an ADC and several other components as mentioned later.

The main purpose behind this project is to acquire the data which are represented as various physical quantities such as Velocity, Temperature (engine, passenger compartment etc), distance covered, acceleration, time etc.

The unit converts up to 8 parameters, and this is expandable by adding additional ICs. We have used total 8 parameters namely x,y,z acceleration, temperature(Lm 35), light intensity(ldr) and collision warning(distance).

The main objective of the project is -

1) Gather and make the data available in case of emergency
2) This data can be shared with police and court in case of any emergency etc
3) This data can be used by the vehicle manufacture to improve the safety and other design factors
4) This can be used by the R&D engineers to understand the dynamics of vehicle in better ways.

The basic features are:
1) Vehicle itself should be made aware of conditions surrounding it, to enable it with smart-decisions.
2) Vehicle should advice/warns users about abnormal conditions.
3) In case of unfortunate accident, it should tell the law enforcement authority about the failure that caused accident, and vehicle manufacture can use this idea for improvement.
4) In case of an accident can record whether the vital safety features were working or not
5) It should warn if important systems are about to fail.
6) Since this is based on essentially a micro-controller and sensors, feature can be kept on added.

II. DESIGN PROCEDURE

A. Block Diagram:

1) Sensor Array Unit:
A sensor array unit is a unit where the sensors are attached to measure any changes going around its environment of it. It detects any temperature or radiation or any gas leakage in the vehicle to which it is attached. It will address the Microcontroller about it and Microcontroller will forward it to data recorder, which will be recorded in the in the Data storage and retrieval unit. Now here data recorded is in analog form which is converted to digital signal by IC MCP 3208 and then given to the Microcontroller.

2) Data Storage and Retrieval Unit:
This unit actually is a data recorder and data retrieval unit which record the data of the event happening to the reading out the data which has been recorded while data was occurring. This unit holds IC AT24LC256 which is 256kb Serial EEPROM used for serial data storage; data retrieve would be through serial line to computer for display purpose by using RS232 to the computer.

3) RS232 Data Channel Unit:
This unit is an interface unit used for communication between computer and Microcontroller. IC RS232 is used for serial data transmission to computer using a serial data cable from RS232 unit to computer port. Now this device has an output pin serial data transmit and receive which is useful for communicating the microcontroller and computer by microcontroller giving the data to computer and displaying on it using VB program.

4) Data Gathering and Processing Unit:
This unit is a Heart of the instrument; it controls the elements and properly synchronizes with its other unit to each other. The microcontroller decides which signal to be
transmitted or received from other devices or to other devices respectively. Here Microcontroller used is IC P89V51RD2 which is a 5V low power 64kb Flash Microcontroller with 1kb RAM. This device will log the data and retrieve at time of data displaying. Now Microcontroller have a pin 2.4 which decides whether data is being recorded or data has been displayed or to be retrieve for displaying. Now Microcontroller will see whether it is LOG mode or RECORD mode. If it is LOG mode then whatever the sensor data is to be measured is converted to digital signal and being serial stored at data storage in memory of the IC AT24LC256. Now if it is in RECORD mode then it will retrieve the data serially to the RS232 device and to computer by serial data link under control of Microcontroller. Then from RS232 the data to the computer is displayed through VB software by plotting a graph versus time. Microcontroller controls the operation of the data from ADC to be stored and written on memory device or to be retrieve serially and read out at the computer.

5) Display Unit

The display unit basically is nothing but a computer which is used for viewing the output of all the sensors to the computer by means of a serial-line-to-USB-connector which takes the serial data from the Microcontroller device through a memory device and transfers it on serial-line-to-USB-connector. The computer receives the data at COM1 port and it displays it using VB by simulating it VB and showing the output temperature, radiation, gases and fumes from the environment or internal in the device itself.

B. Circuit Diagram:

The circuit given above is the data gathering and processing circuit which is used to gather the data from sensors and process and send to the RS 232 Com port. Now here circuit has a microcontroller AT89C51 which is a 40 pin microcontroller is 64KB Flash with 1KB RAM. Now this microcontroller has 40 pin with four ports from Port 0 to Port 3. Now at Port 2 we have connected a pin which is used for putting it LOG mode or RECORD mode. Now this pin is used for deciding if the data is to gathered or to be processed. Gathering and processing or displaying the data depends on this pin. Now if the data is to be gathered then we make use of sensors circuit. Now it will measure the data from sensors and will pass this data to ADC IC MCP 3208 which is a 14 pin 8 channels 12 bits converter serial interface which will collect the analog from the sensor circuit and will convert the data to digital format and will serially transfer that data to the microcontroller and through microcontroller will be stored in the memory device IC 24LC256 which is 256kb memory device which can store require data. Now when the circuit is switched on then microcontroller will check if the device in LOG mode or in RECORD mode, if it is LOG mode then the microcontroller will check the every reading of sensors and will be converted into the digital data and then will be serially given to the microcontroller from which microcontroller will forward the data into memory storage and will store the data for the time till the event or the mode has not being changes the data stored will change every time being put in the LOG mode erasing the previous data and starting with a fresh data. Now if we put the mode in RECORD mode then the data which is being stored in the can be retrieved from memory device and can be serially transferred to the RS 232 which is an interface between the computer and the circuit. Now the data from microcontroller is processed from the memory device which was recorded at the previously at time of logging the pin. Here microcontroller is used to both read the data and write the data, now if data to be written is the data which is sensor reading converted digitally and then written on memory and then read out at microcontroller. But when data requires to be processed then the data has to be
read by microcontroller to the serial line to RS 232 com-
port. Microcontroller becomes the heart of this project by
gathering and writing the data and processing and reading
out the data at the computer.

C. Flow Chart:

![Flow Chart](image)

D. Component Selection:

1) Accelerometer ADXL 330 which has 0.6g Accuracy and is 3 Axis Accelerometer with Low Cost. The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g.

2) The temperature sensor used is LM35. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It can be used to measure accurate temperature changes around the surrounding. The sensor converts the temperature changes to the analog signal and then it gives it to ADC. The sensors here can measure -55°C to 125°C.

3) A light dependant resistor is used to measure the luminous light intensity.

4) The proximity sensor consists of an infrared LED (IR LED) that sends light and a phototransistor.

The photo transistor conducts more current, if more of the output IR light is reflected back to the phototransistor. After the soldering of the proper resistors, the sensor can be used for short distances (<1 cm) to objects or color contrasts can be observed on surfaces to observe.

How: The sensor consists of an infrared LED and a phototransistor. By bringing voltage across the IR-LED sends light from the IR LED that a greater or lesser extent, is reflected back on certain surfaces, depending on the roughness and the distance to the surface. The photo transistor captures the reflected light, and will conduct current as a function of the amount of reflected light. The current through the IR LED must be limited by means of a resistor of 220 Ohm. The phototransistor can, just like the previously discussed light sensor are used as a voltage divider with a resistor of 10 kOhm.

E. Component List:

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Component Name</th>
<th>Specification</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P89V51RD2</td>
<td>8-bit 80C51 5 V low power 64 kB Flash microcontroller with 1 kB RAM</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>RS 232</td>
<td>Low Supply Current (.8mA Typical)</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>ULN 2003</td>
<td>5V TTL, CMOS</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>MCP 3208</td>
<td>2.7V 4-Channel/8-Channel 12-Bit A/D Converters with SPI™ Serial Interface</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>ADXL (accelerometer)</td>
<td>3axis, range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>LM 35</td>
<td>(temperature) (-55°C to +150°C)</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>LM 7805</td>
<td>(voltage regulator) 5V</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1: Component List

III. RESULTS

The end result of this project is as expected and as this is a futuristic concept, it is currently not available in the Indian market. Such projects are still in research and development phase, although some implementation exist, there is no full implementation. We have conceptualized the project by keeping the price, features and advantages in consideration. We can increase the memory capacity of the system thus providing us more data. We can also add extra features on it like camera. On giving more processing capabilities to the processor we can add features like skid control thus enhancing the safety of vehicles.
IV. CONCLUSIONS

The proposed circuit and algorithm of our project gives good results. This project thus gives a make the system smarter and gives it a sense of self automation. Advanced research in the same respect can lead to automatic vehicles in the near future. Using our system data can be stored and retrieved as and when required.

Our project ‘MODEL BASED DEVELOPMENT OF AN ADAPTIVE VEHICLE STABILITY CONTROL SYSTEM’, finds solution for vehicle safety and ease the work for automobile forensic studies by providing vital data

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