International Journal of Electrical and Electronics Engineers
Vol. No.8 Issue 01, January-June 2016
www.arresearchpublication.com
IJEEE
ISSN 2321 - 2055

SAFETY AUTO BRAKE SYSTEM FOR VEHICLES IN HILL STATION USING MEMS SENSOR

Shankarappagari Girish[1], Chandu Lalith Nandan[2], K.V.N. Kavitha[3]

[1,2,3]School of Electronics Engineering, VIT University, Vellore, (India)

ABSTRACT

This paper outlines the design and construction of a module suitable for driving the vehicles in hill station. Auto braking system is used for vehicles going in upward direction. This construction includes of two phases. In first module, slope of the vehicle is observed using micro-electromechanical system (MEMS) Sensor and in second phase, motor speed is controlled based on the data from sensor. Sensor is interfaced to the microcontroller using I2c Protocol where the controller receives the information from the sensor and processes it according to the desired decisions. This can also be used in applications like Refrigerator, microwave oven, operation theaters etc.

***Keywords*: I2c protocol, MEMS Sensor, Speed control, SAB.**

I. INTRODUCTION

Now-a-days the accidents at the hill stations are increasing and most of the accidents are due to the skidding of the vehicles. When a vehicle is moving on increasing inclination road, there is a chance that at certain point the vehicle skids. The Safety Auto Brake System is used to prevent the skidding of the vehicle. This system works when the vehicle is moving upward direction. Basically atcertain angle of inclination where the vehicle is about to skid, the Safety Auto Brake System (SAB) applies brakes to prevent the skidding of the vehicle.

SAB System model includes, MEMS Sensor, ATMEGA32 Microcontroller, LCD display, Power Supply, Drivers, Motors. The MEMS Sensor is interfaced to the Microcontroller using I2c protocol, microcontroller receives the data from the MEMS Sensor and process it according to the data the sensor appliances are operated.

II. SYSTEM MODEL

The system model that represents the Safety Auto Brake System used in this work is given below in figure 1.Each section is explained separately as follows.

2.1 MEMS Sensor

MEMS-based sensors are a class of devices that builds very small electrical and mechanical components on a single chip. MEMS-based sensors are a crucial component in automotive electronics, medical equipment, smart portable electronics such as cell phones, PDAs, and hard disk drives, computer peripherals, and wireless devices. These sensors began in the automotive industry especially for crash detection in airbag systems. Throughout the 1990s to till today, the airbag sensor market has proved to be a huge success using MEMS technology. MEMS-based sensors are now becoming pervasive in everything from inkjet cartridges to cell phones. Every major market has now embraced the technology.

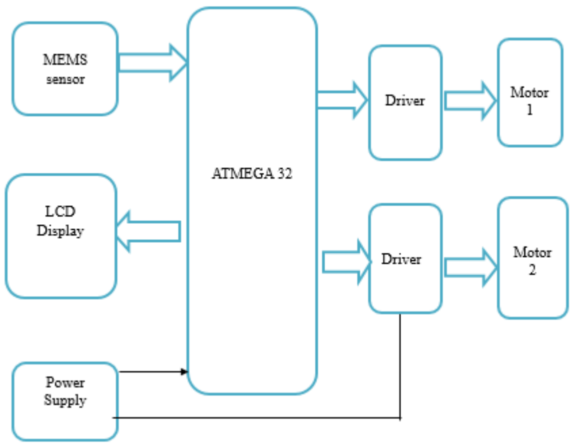

Fig. 1 System Model

Inertial sensors have been used in aircraft and navigation systems for a long time. It is not until recently that new technology has caused the price and size of gyroscopes and accelerometers to make them available in consumer electronics. Of particular importance is the MEMS technology have enabled inertial sensors to become available on the small size and price scales associated with such common place devices as consumer appliances. Accelerometers measure the transactional force encountered due to their acceleration. To convert this into a velocity, this need to be integrated once and to convert this to a position.

2.2 Atmega32 Microcontroller

The ATmega32 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega32 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed.

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega32 provides the following features: 32K bytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 1024 bytes EEPROM, 2K byte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes.

2.3 Adxl335

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*. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.

2.4 L293,L293d(Quadruple Half H-Drivers)

The L293 and L293D quadruple high-current half-H drivers are used. The L293 is designed to provide bidirectional drive currents of up to 1 amp at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo- Darlington source. When an enable input is high, the associated drivers are enabled, and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications.

2.5 Power Supply Unit

Power supply is a reference to a source of electrical power. This power supply section is required to convert AC signal to DC signal and also to reduce the amplitude of the signal.

A Transformer is used to convert the 230V AC Signal to 12V AC Signal.

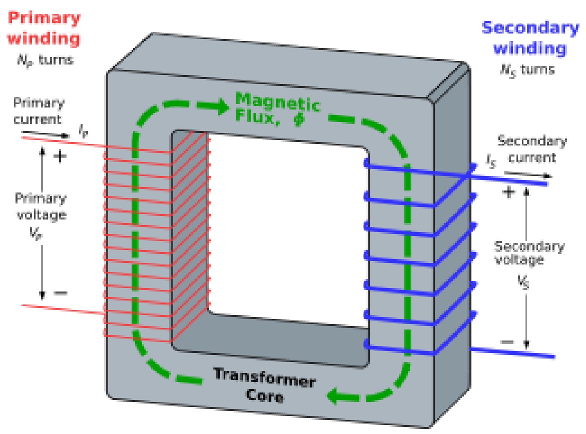

Fig. 2 Transformer

Equation of a Transformer

$$\frac{V_S}{V_P} = \frac{N_S}{N_P} \quad \text{. . . . . Eq(1)}$$

Ideal Power Equation of a Transformer

$P_{incoming} = I_P V_P = P_{outgoing} = I_S V_S$. . . . . .Eq(2)

2.6 Pulse Width Modulation

Pulse-width modulation (PWM) of a signal or power source involves the modulation of its duty cycle, to either convey information over a communications channel or control the amount of power sent to a load. Pulse-width modulation uses a square wave whose pulse width is modulated resulting in the variation of the average value of the waveform.

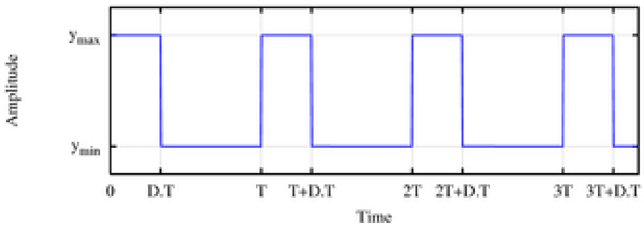

Fig. 3 Square Wave, Showing the Definitions of y_{min}, y_{max} and Duty Cycle

If we consider a square waveform $f(t)$ with a low value y_{min}, a high value y_{max} and a duty cycle D (see figure 3), the average value of the waveform is given by:

$$\bar{y} = \frac{1}{T}\int_0^T f(t)\,dt. \qquad \text{………………..Eq(3)}$$

As $f(t)$ is a square wave, its value is y_{max} for

$0 < t < D \cdot T$ and y_{min} for $D \cdot T < t < T$.

The above expression then becomes

$$\begin{aligned} \bar{y} &= \frac{1}{T}\left(\int_0^{DT} y_{max}\,dt + \int_{DT}^{T} y_{min}\,dt\right) \\ &= \frac{D \cdot T \cdot y_{max} + T(1-D)y_{min}}{T} \\ &= D \cdot y_{max} + (1-D)\,y_{min}. \qquad \text{….Eq(4)} \end{aligned}$$

Thislatter expression can be fairly simplified in many cases where y_{min} = 0as $\bar{y} = D \cdot y_{max}$. From this, it is obvious that the average value of the signal ($\bar{y}$) is directly dependent on the duty cycle D.

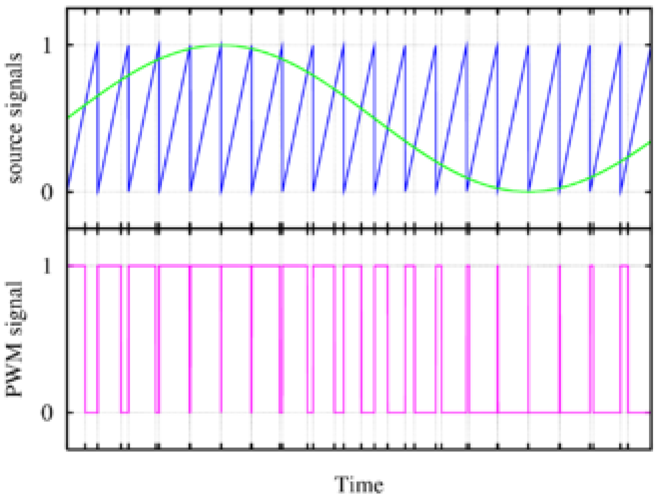

Fig. 4 Pulse Width Modulation Signal Graph

2.7 LCD

One of the most common devices attached to controller is an LCD display. A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other. A program must interact with the outside world using input and output devices that communicate directly with a human being.

III. MATHEMATICAL RELATION BETWEEN X-AXIS ACCELERATION AND SPEED

X-axis	Speed (rpm)
X<282	00 rpm
X>283&&X<299	25 rpm
X>283&&X<320	50 rpm
X>321&&X<330	75 rpm
X>331&&X<345	100 rpm
X>345&&X<365	75 rpm
X>365	50 pm

IV. WORKING

The Power Supply is given to the System through the step down transformer that converts 230V AC supply to 12V AC supply, which is then sent to bridge rectifier that converts the 12V AC to a pulsating 12V DC supply. This 12V DC supply is then sent through a filter that converts pulsating DC to a pure DC supply and then using a voltage regulator the 12V DC supply is converted to 5V DC supply. This 5V DC supply is given to 40th pin of the Microcontroller that is Vcc, 9th pin for the RESET button, LCD segment and driver IC (L293D).

The port C of the microcontroller is connected to a pull up resistor and interfaced with LCD display. Port A is given to the MEMS sensor and port D is connected to the L293D driver IC. MEMS sensor is interfaced to micro controller using I2c protocol, microcontroller receives the data from the MEMS sensor and process it according to the data from the sensor appliances are operated. The output from the MEMS sensor is given to the Microcontroller which converts it into digital data. The output from the microcontroller is processed and shown in the LCD display and accordingly the motor is driven with the help of the driver IC. The driver IC is connected to the port D of the microcontroller and it controls the dc motors. The direction of the motors and the speed control of the motors are controlled by the driver circuit. The motors are connected to the wheels of the vehicle and as the speed changes the vehicles starts moving

The MEMS sensor senses the acceleration of the vehicle and it is displayed in the LCD screen. As the vehicle moves the MEMS sensor displays the difference in the acceleration.As the vehicle climbs up the hill the speed of the motor speed changes as there is a change in the acceleration of the values in the X and Y plane. This speed is changed as it is already mentioned in the source code and accordingly the braking system is applied by decreasing the speed of the vehicle when the given acceleration values are reached.

The hardware setup used in this project is given in figure 5.

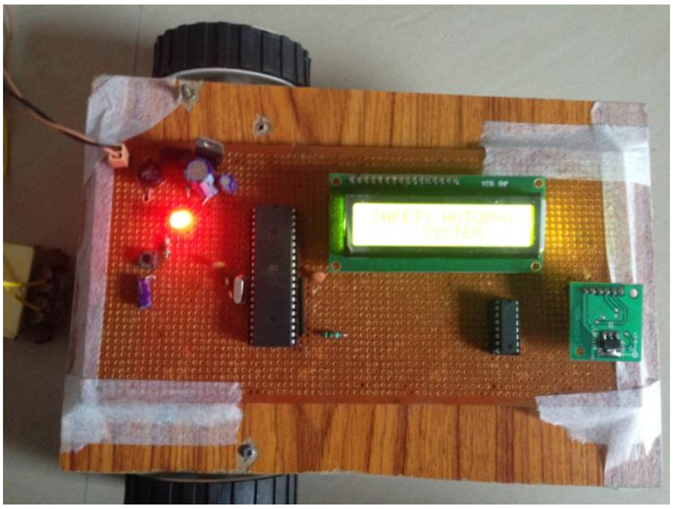

Fig. 5 Hardware Setup

V. RESULTS AND OBSERVATION

The Safety Auto Brake System automatically applies brake when a vehicle that is moving upward direction is about to skid. The speed of the vehicle decreases as the angle of elevation of the road increases. The MEMS sensor sends the information of acceleration of the X-axis and Y-axis to the microcontroller and this information is processed and the speed of the motors is controlled using drivers IC. The MEMS sensor used is a Triple Axis Accelerometer and this project we ignore the Z-axis acceleration. The X-axis and Y-axis acceleration is used to calculate the angle of elevation. The output is displayed on the LCD screen that is the values of acceleration of the X-axis and Y-axis and the speed of the motors. The speed of the motors is displayed in RPM (Rotations per Minute).

The speed of the motors at different elevations are observed and given in figures from 3-7with speed indication on display.

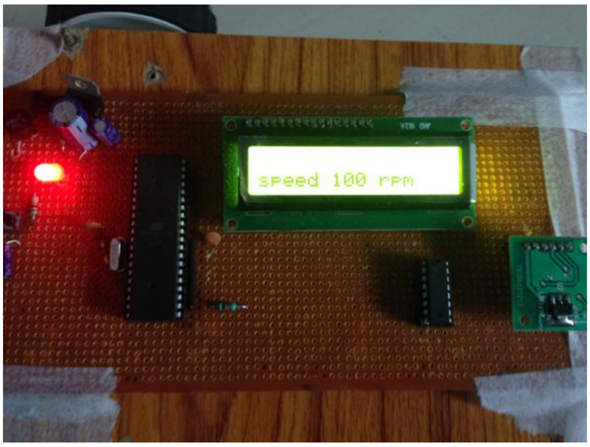

Fig. 6When the vehicle is moving on a flat road, the motor is running at a speed of 100 rpm.

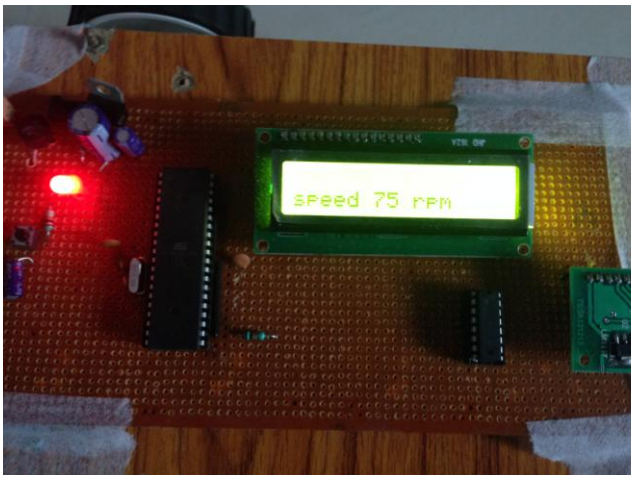

Fig. 7When the vehicle is moving on a road with a elevation of 100, speed restricted to 75 rpm

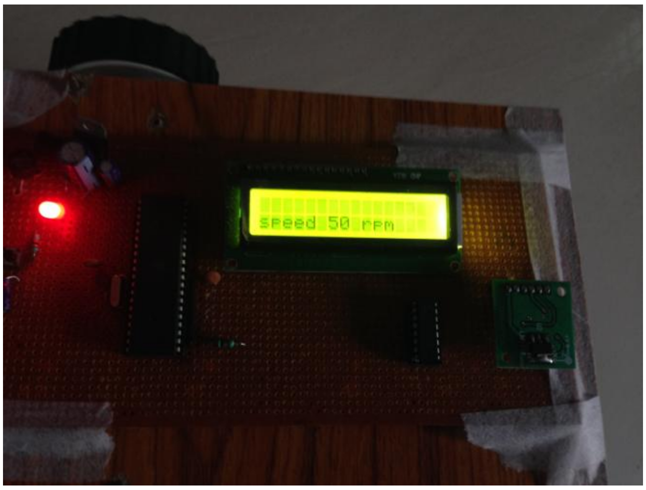

Fig 8. When the vehicle is moving on a road with a elevation of 200, speed is limited to 50 rpm

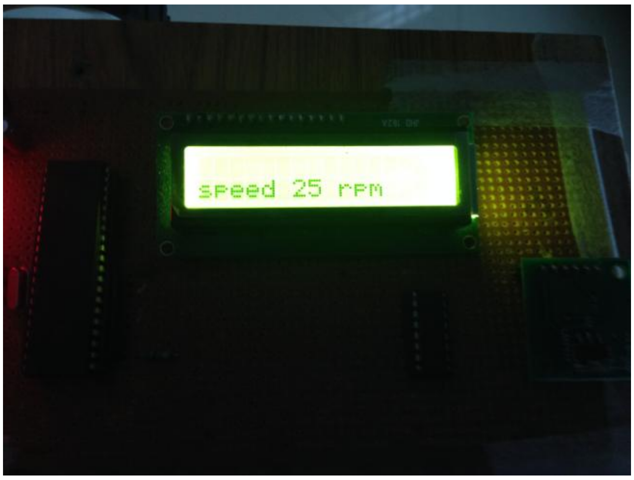

Fig. 9When the vehicle is moving on a road with a elevation of 350, speed is reduced to 25 rpm.

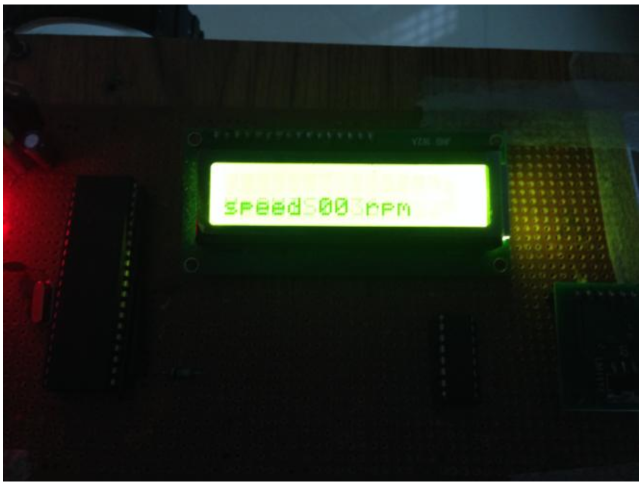

Fig. 10when the vehicle is moving on a road with a elevation of 45^0, motor is stopped.

VI. CONCLUSION

A prototype of Safety Auto Brake System is designed and tested. The prototype has been developed by the integrating features of all hardware components used. Presence of every component has been reasoned out and placed carefully thus contributing to the best working of the unit.

In future, the Safety Auto Brake System can be used in many vehicles to avoid collisions and accidents. Regenerative braking can be used in the vehicles and energy is saved and is stored in the batteries that can be used for further purposes. This type of braking can be used in any type of hybrid vehicles and we can reduce the use of fossil fuels.

REFERENCES

[1]. Liu Jun .Research on measurement system of vehicle motion attitude based on IMEMS sensors [J] .Transducer and Microsystems Technologies, November 2009.

[2]. Jiang Hai-tao. Inclination Indication System Based on MEMS Units [J]. Measurement and Controlling Technology, June 2010.

[3]. ATMEL Corporation. MAX1166 data sheet [Z] .2002.

[4]. Su Kuifeng. ATMEGA32 principles and development [M]. Beijing: Electronic Industry Press 2005.

[5]. SongTao Zhang. AVR microcontroller C programming language the essence of design examples. Beijing: Electronic Industry Press 2009.

[6]. J. L. Schmalzel, R. R. Krchnavek, F. Figueroa and W. Solano "Increasing density of data acquisition functions", ISS IV

[7]. J. L. Schmalzel, R. R. Krchnavek, S. Mandayam, F. Figueroa and W. Solano "Enhancing density, functionality and reducing costs of data acquisition", Sensors for Industry Conference (Sicon).

[8]. "ADXL335 Small Low Power,3-Axis ±3g Accelerometer", Analog Devices,2009.

[9]. Li Chang-an. The Dynamic angle detection device for vehicle driving simulator: China, ZL2010.

[10]. Wang Zhan-Ping .Technology Study of Aircrafts Attitude Identify Based on MEMS Accelerometer[J] .PiezoEctectrica& Acousto-optic, February 2007.