ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2015

Can Drive: Active Stability Control with ABS and Crash Location Sensing without GPS for Bikes

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ABSTRACT: In earlier days, due to several accidents in several parts of the world and also to the development of Electronic Systems form last few decades this had made an impact over the vehicles due to which the safety features for the four-wheeler's of ABS technology has been introduced. Especially in four-wheelers there are devices that are electronically controlled by near-far or inside the vehicle but when compared to the two-wheelers the devices use in this are less due to the less space. This type of technology has become mandatory for high end cars and trucks of vehicles in countries like US and Europe.But in countries like India two wheeled vehicles are more when compared to the four wheeled vehicles. So, we are proposing a project that designs an innovative controlarchitecture which allows us to enhance the active safety and stability of the vehicle for a good driving feeling.

KEYWORDS*:* Anti-lock breaking systems(ABS), CAN controller, Degree of freedom (DOF), Electronic stability control (ESC) and Micro Electro Mechanical system/sensor(MEMS).

I. INTRODUCTION

In order to increase the stability and safety of the vehicles a well-known vehicle control system like ABS and ESC are used because vehicle's in everyone's life play an vital role, more over safety is considered to be primary of all, According to statics over 40% of the accidents are occurring due to the long braking distance, unbalanced slipping off and brake deviation due to this the braking efficiency became an important factor for the safety of driving.

In the present days bikes are enhanced with advanced acceleration and breaking systems.one such effective design in the breaks of the two wheeler is anti-lock brake system(ABS) that induces pressure on the break by making the vehicle to halt with in some fraction of seconds and avoids collision with other vehicles or skidding on the road [5]. Already this system has introduced and has been running in cars before introducing to the bikes it has given a lot more effect on the breaking control and also there is an another feature was available with this ABS that provides Active Stability Control using a device known as Electronic Stability Control (ESC) but this system was no introduced in bikes, as it constitutes a quite challenging task due to the complexity of the two wheeled vehicles.

Adding to that there is an additional feature in this project during a crash situation a message will be sent to the nearest hospital/home/Emergency service with the Embedded vehicle location data using 6-DOF Digital MEMS compass which consists of 3-axis MEMS accelerometer and 3-axis MEMS Magnetometer[8],[3],[6].

II. OVERVIEW OF ABS AND ESC

Safety is the key factor in any type of automobiles, all the automobile manufacturers are adapting new technologies to provide best safety for their customers. The most common safety feature in present day's vehiclesare ABS and ESC.

The main objective of ABS is to provide the best control of the vehicle to the driver during the barking operation. Generally when are applied on a skid surface, the wheels locks and the vehicle starts skidding [5]. This disable the steering control for the driver. So the ABS is used to provide the full control of the automobile [7]. The behavior of the vehicle with and without ABS is shown in the figure 1.

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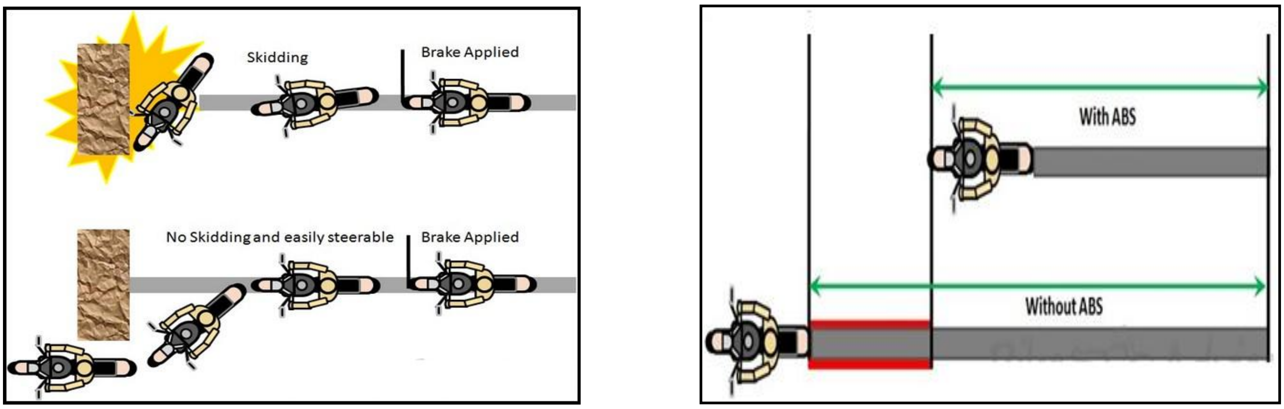

(a) Steering control (b) Braking distance

Fig. 1 Vehicle behavior with and without ABS

In an ABS fitted vehicle the sensors which will be sensing the wheel speed will be present. When the brakes are applied these sensors send signal to the ABS control system. These system calculates the braking force required to enable the safety braking and sends the signal to the brakes. The brakes will be applied with calculated barking force at equal intervals of times until the vehicle is fully stopped instead of applying brakes suddenly. So this provides steering control during barking also [4]. As shown in the figure 1(a) the vehicle without ABS loses the steering control during the braking and hits the obstacle, but the ABS fitted vehicle avoids the obstacle with the help of control provided by ABS to the steering. Similarly as shown in figure 1(b) the braking distance will be reduced for the vehicle with ABS fitted system than a normal vehicle.

Fig. 2 Generalized block diagram of ESC

ESC feeds as a memory unit to an ABS system. ESC is a computer program which calculates the accurate braking pressure required to ensure the safety operation. The ESC acts as a bridge between ABS system and vehicle wheels [2]. The wheel speed is calculated by the wheel speed sensor if there is any skidding or losing control of the steering the speed difference between the two wheels will be changed then the ESC becomes active then the ESC system will calculate the brake pressure applying according to speed of the bike. If the vehicle is moving in a fast then the brake pressure apply will be slow similarly when the vehicle is moving in slow condition appliedbrake pressure will be high.Due to this Active Stability Control or Electronic stability control the vehicle stability will be improved by sensing the Yaw Rate and Roll Rate of the vehicle [4], [1]. Yaw Rate of the vehicle is calculated by the Yaw Rate Sensor which measures the rotation of the bike then it will be calculated by the ESC by how much the steering should be maintained in the uncontrolled condition [1]. The Roll Rate sensor will calculates the speed of the wheels for the previous rotation and the next rotation this whole process will be handled by ESC [1].25 times a second, it compares whether the driver’s input is according to the actual direction in which the vehicle is moving. The driver can give inputs according to his driving skills on a trial surface in the main dash board unit. ESC not only initiates braking control, but also manage on the engine side to accelerate the driven wheels.

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III. OPERATION

The entire design phase of the system constitutes of totally three Electronic control unit of which one is the main dash board unit and the other two ECU are one for the front wheel and the other is for the rear wheel [4], [8]. In the main dash board unit driver can give the inputs according to his driving skills.

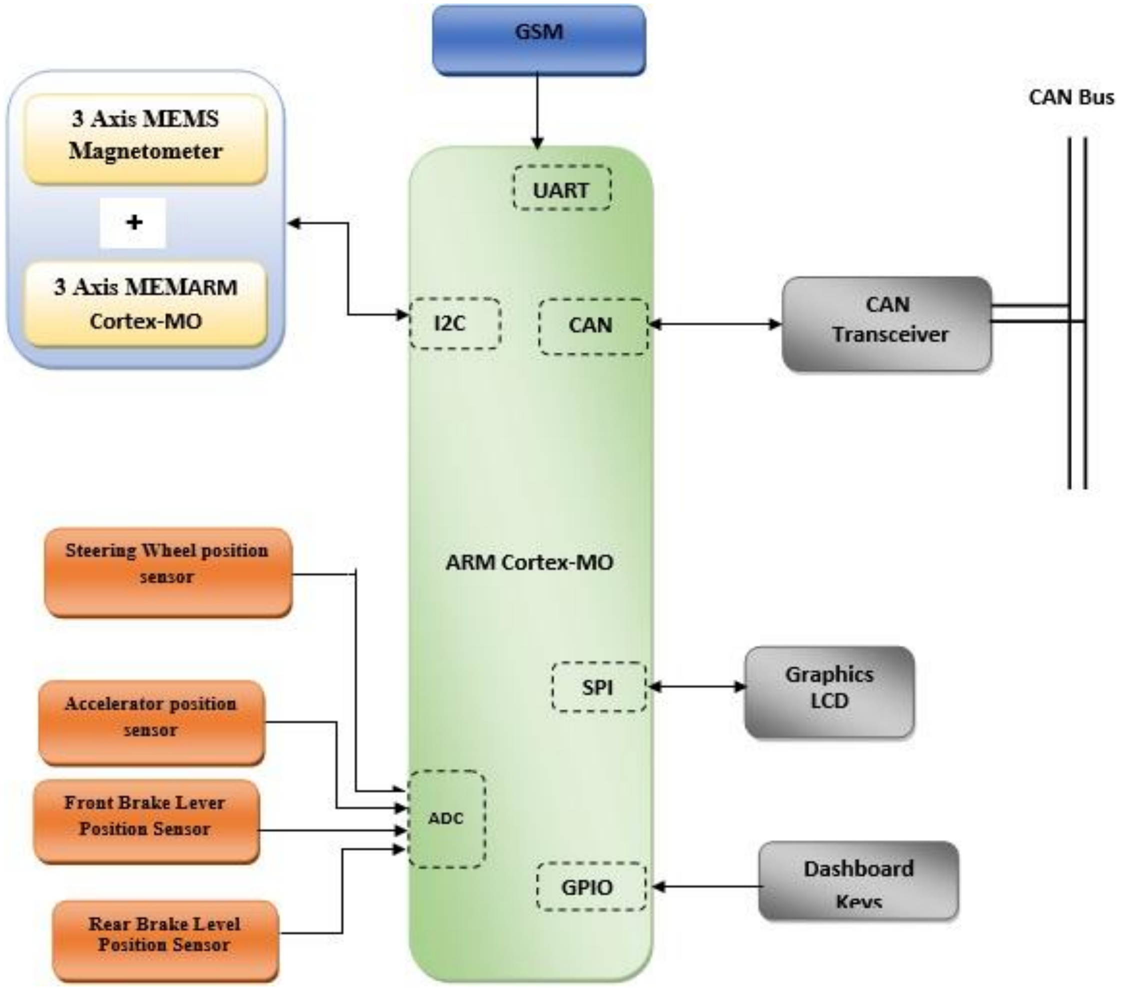

Fig.3 (a) Block diagram of main dash board of ECU

The above figure 3 represents the main dashboard unit to which all the sensors are given to the ADC unit for which to convert the signals analog to digital and the dashboard keys are used for the driver to give inputs according to his driving skills on a trail surface, these can be displayed by the graphics LCD unit so that driver can see the values that has been set by him and also 6-DOF magnetic compass in which it consists of 3-axis MEMS accelerometer and 3-axis MEMS magnetometer it will sense the location of the vehicle during crash situation ,sensed via the 3-axis MEMS accelerometer ,the system will send an emergency message to the home/hospital/emergency service before that the driver has to assign the numbers in the GSM modem the message will be sent using GSM through UART protocol and the (3-axis MEMS accelerometer + 3-axis MEMS magnetometer) sensed through I^2c protocol [4].

The above figure 3(b) & figure 3(c) are dedicated for front wheel and rear wheel control. The wheels are controlled by a couple of DC motors one for front and the other for rear wheel. . The ECU interfaces with the rotary encoders to measure the speed and the direction of the wheels. If there is any slip occurs or during over steering and under steering the rotary encoders will take that uncontrolled situation and will be sent to the main dashboard unit then the pressure

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apply for the wheels is calculated by the brake level position sensor and the brake will be applied through the DC motors.

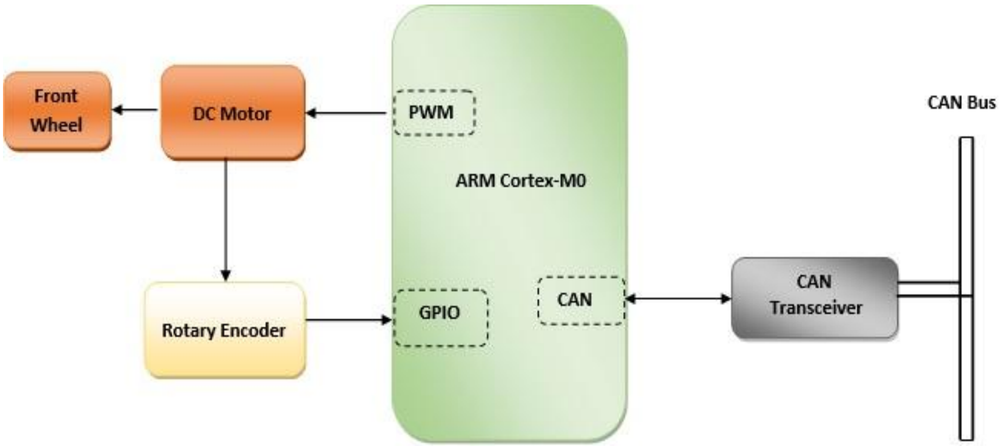

Fig 3(b).Front Wheel ECU Unit

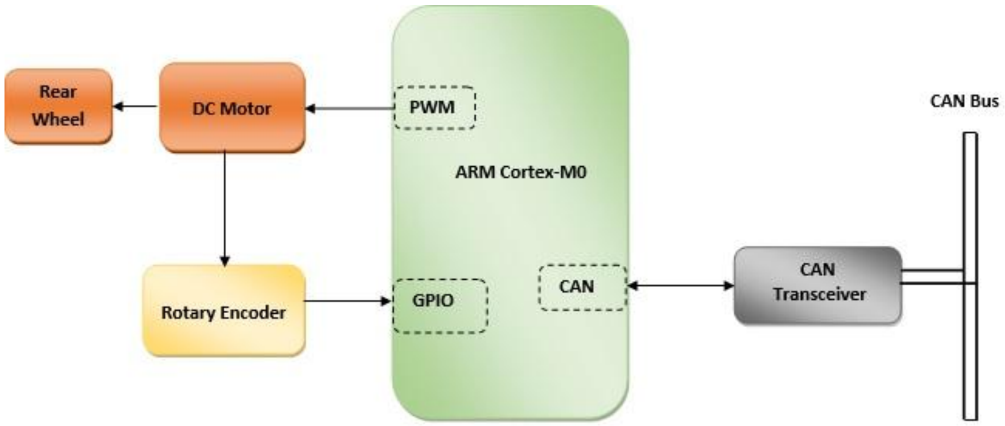

Fig 3(c). Rear Wheel ECU Unit

All three ECU are connected through the most known vehicular network called CAN (Controller Area Network).CAN is an event-driven protocol which will be reliable for the automotive applications. In order to meet the real time deadlines, and to make the system robust, the software runs under the Free RTOS, the most open source real time kernel in the world [4].

IV. COMPONENTS DESCRIPTION

A. LPC 11C14:

The LPC1100 is the world's first Cortex-M0 basedmicrocontroller series offering users a cost effective, veryeasy to use 32-bit MCU which is code and tool compatiblewith other NXP ARM based MCU products. With 32-bitperformance combined with multiple power modes and verylow Deep sleep power, the LPC11xx offers industry leadingenergy efficiency greatly extending battery life. TheLPC11xx sets new benchmarks in performance efficiencywith dramatically improved code density enabling longerbattery life and lower system costs. It has some additionalfeatures such as Serial Wire Debug and Serial Wire TracePort, High-current output driver (20 mA) on one pin, Highcurrentsink drivers (20 mA) on two pins, Integrated PMU(Power Management Unit) to minimize power

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consumptionduring Sleep, Deep-sleep, and Deep power down modes,Single 3.3 V power supply (1.8 V to 3.6 V), 15 GPIO pinscan be used as edge and level sensitive interrupt sources,Cock generation unit with divider that can reflect the mainoscillator clock, IRC clock, CPU clock, and Watchdogclock, Processor wake-up from Deep-sleep mode viainterrupts from various peripherals, Power-On Reset (POR),Crystal oscillator with an operating range of 1 MHz to 25MHz, PLL allows CPU operation up to the maximum CPUrate without the need for a high-frequency crystal. May berun from the main oscillator, the internal RC oscillator, or the Watchdog oscillator, Available as 48-pin LQFP package and 33-pin HVQFN.

B. CAN CONTROLLER:

Controller Area Network (CAN) is a serial network that was originally designed for the automotive industry, but has also become a popular bus in industrial automation as well as other applications. The CAN bus is primarily used in embedded systems, and as its name implies, is the network established among microcontrollers. It is a two-wire, half duplex, high-speed network system. It is well suited for high speed applications using short messages. Practically it can link up to 110 nodes on a single network.

In the above Fig 3(a),Fig 3(b),Fig 3(c), CAN bus is used to communicate between the ECU units, it is the best standard design to the microcontrollers and the devices to communicate with the each other applications without a host computer. The CAN bus will have both the transceiver and the receiver.

C. I2C (INTER INTEGRATED CIRCUIT)

It is a low bandwidth; short distance bus protocol. It provides a simple way to talk between IC's by using 2 wires SCL (Serial Clock) and SDA (Serial Data). Both the lines are bidirectional. It is a true multi-master bus including collision detection and arbitration to prevent data corruption if two or more masters simultaneously initiate data transfer.

D. ADC (ANALOG TO DIGITAL CONVERTER)

An analog-to-digital converter (abbreviated ADC, A/D or A to D) is an electronic integrated circuit, which converts continuous signals to discrete digital numbers. The reverse operation is performed by a digital-to-analog converter (DAC).An ADC is an electronic device that converts an input analog voltage (or current) to a digital number.

E. GPIO (GENERAL PURPOSE INPUT / OUTPUT)

ARM Provides GPIO Ports. Every Peripheral must interact with outside world through these GPIO. The basic Peripherals like buttons, LEDS, Switches and other components are easily get connected to GPIO. A GPIO pin is a pin that can be configured through software to be either a digital input or a digital output. A microcontroller will have a number of these GPIO pins, organized into one or more ports.

V. ALGORITM ANDFLOW CHART SYSTEM FOR CRASH LOCATION WITHOUT GPS

A. Algorithm Of System Working:

1) Start.
2) Include all necessary library files.
3) Initialize MEMS compass and GSM peripherals of Microcontroller.
4) Accelerometer Sensor senses the Movement of bike.
5) Magnetometer sensor senses the direction of bike.
6) When the accelerometer value is above 60, then crash location get indicate in the MEMS compass.
7) The Message is sent through GSM to the particular person.

B. Flowchart of the system:

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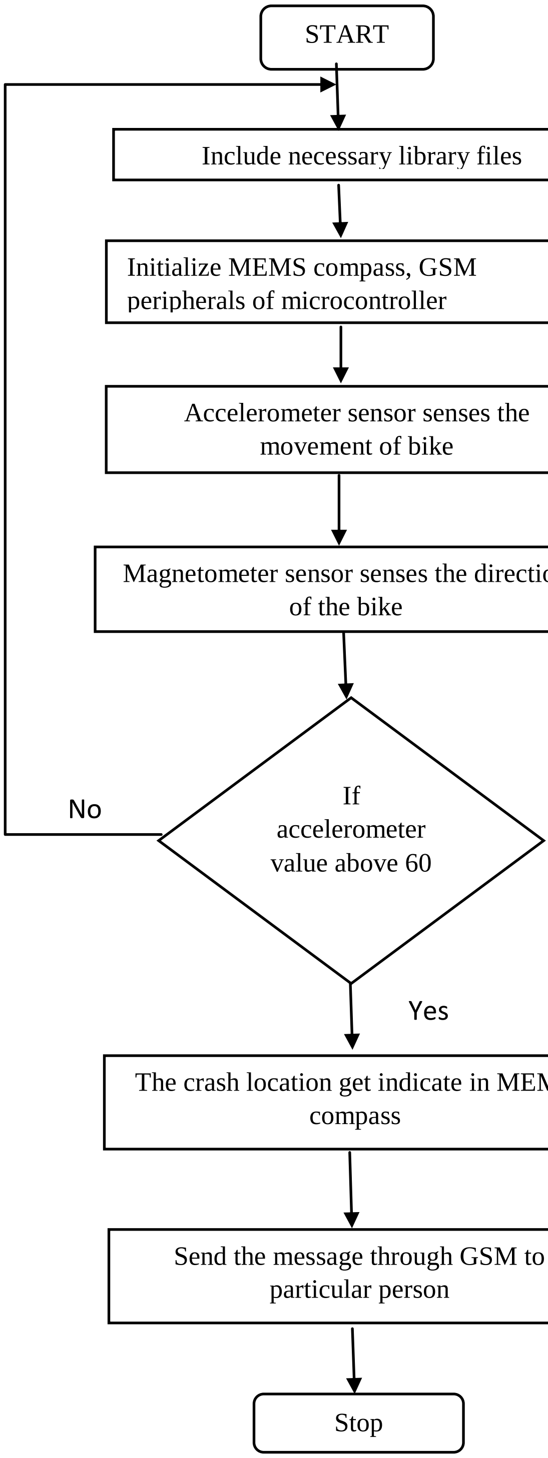

Fig 4: Flow chart for crash location without GPS

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VI. ALGORITM AND FLOWCHART SYSTEM FOR ELECTRONIC STABILITY CONTROL SYSTEM :

A. Algorithm of system working:

1) Start.
2) Include all necessary library files.
3) Initialize I2C, SPI, ADC, UART peripherals of Microcontroller.
4) Assume, the steering angle value is set at 45.
5) MEMS Compass checks the steering angle value.
6) If angle is greater than 45, operates at over steering condition and brake is applied at the Front Wheel.
7) If angle is less than 45, operates at under steering condition and the brake is applied at the Rear Wheel.
8) TheAngle position information is displayed in the LCD.

B. Flowchart of the system:

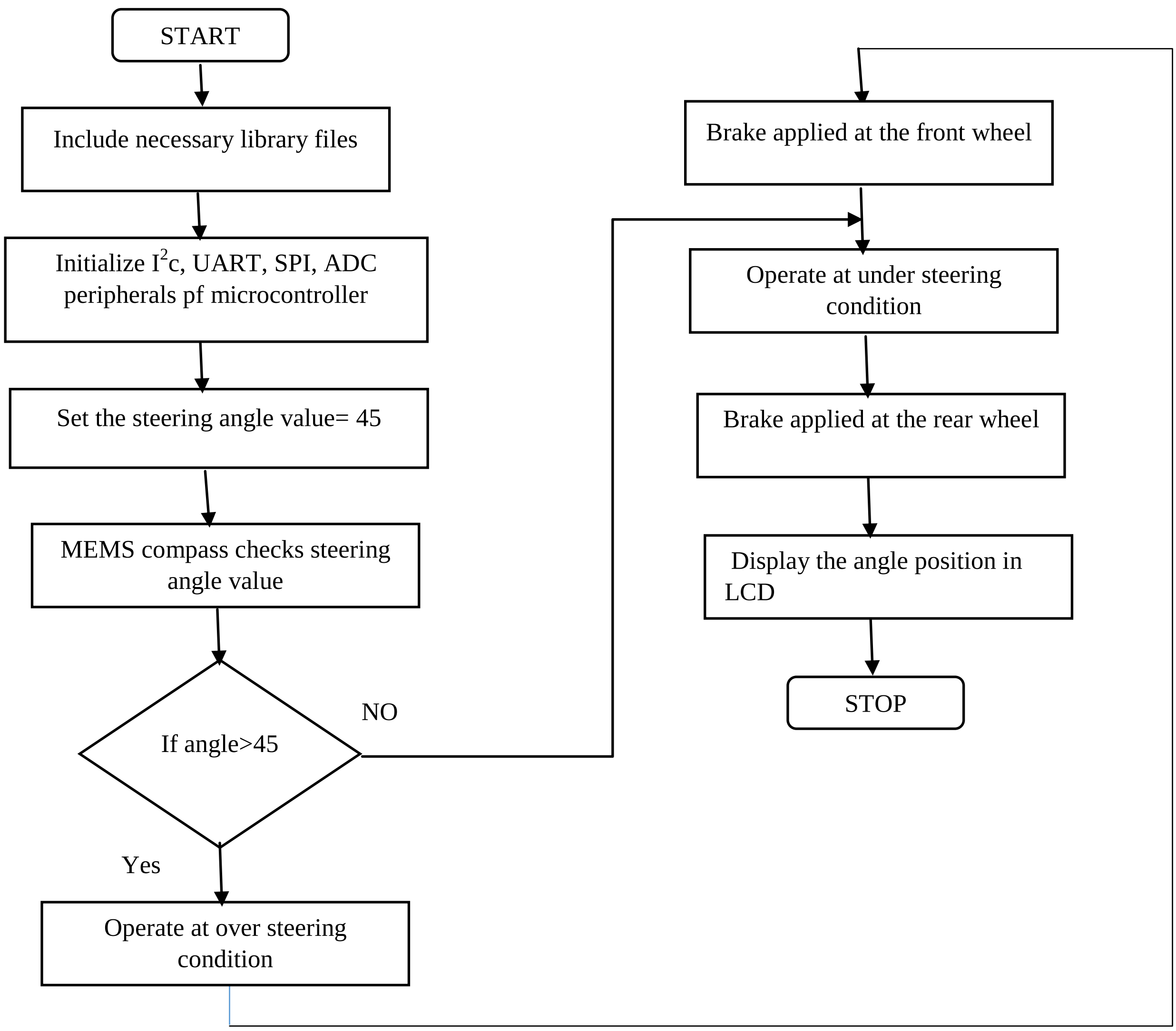

Fig 5: Flowchart system for electronic stability control

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VII. EXPRIMENTAL SETUP

The system setup is illustrated in this section. The below figure 6 gives the 32-bit ARM CORTEX Board-M0 which is the main control of the both front wheel and the rear wheel and also it consists of MEMS sensor, GSM module which sends the message during crash situation.

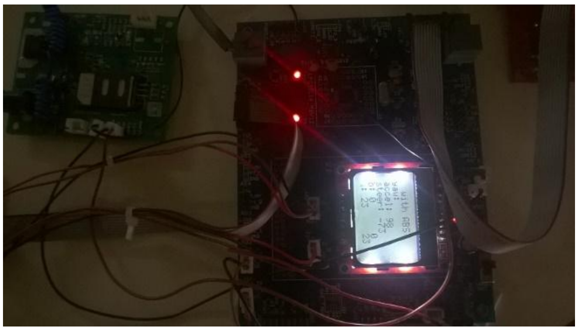

Fig 6: Main dash board unit of ECU

The above figure 6 is the main dashboard unit in which the acceleration, steering control, brake position can be displayed in graphic LCD. We can also see the message sending during crash situation through GSM that can be sensed through vehicle dynamics by MEMS accelerometer.

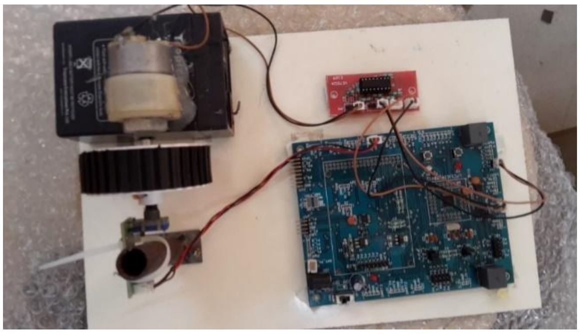

Fig 7: Rear wheel ECU unit

The above figure 7 is the rear wheel unit same as to the main dash board unit it consists of ARM CORTEX Board-M0,the wheel is connected through DC motor the supply of the rear wheel will be given from the main dashboard unit, near the wheel there will be sensor which will calculate the speed.

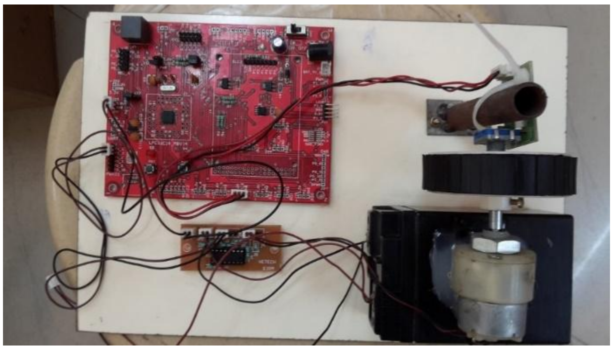

Fig 8:Front wheel ECU Unit

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The above figure the front wheel unit same as to the main dash board unit it consists of ARM CORTEX Board-M0, the wheel is connected through DC motor the supply of the front wheel will be given from rear wheel because the speed of the two wheels should be same, near the wheel there will be sensor which will calculate the speed.

The above two figures (6,7) show the setup of front wheel and rear wheel these three ECU's are interconnected with each other through CAN bus. On the main dashboard unit there are keys for the adjustment to the driver upon his skills.

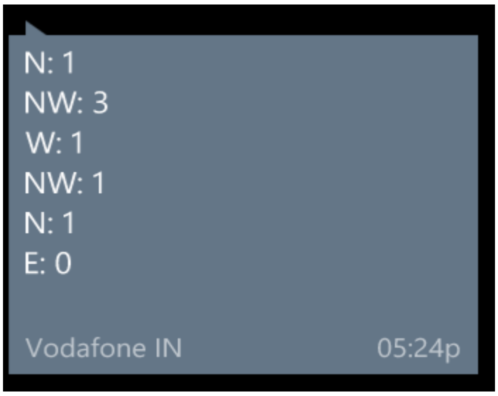

Fig 9: On crash detection

The above figure 8 show the direction when there is a crash situation occurred to the vehicle. This SMS will be sent to the number which is registered in the sim present in the GSM module [6].This will be tracked by MEMS compass.

VIII. CONCLUSION

In this system the stability control of the two wheeler is explained by using this method which is not available in two wheelers. Less costly vehicle tracking system not using GPS and also electronic ABS is superior to the currently available in mechanical models, less wire harness with the use of CAN communication network for which ARM Cortex-M0 microcontroller having with inbuilt CAN controller provides a next generation hardware platform, ideal for networking ECU'sEfficient real-time operation with the use of RTOS kernel in the main dashboard ECU. Due to this method there will less accidents in number during over steering and under steering of the vehicle.

REFERENCES

[1] P. Kachroo and M. Tomizuka, "An adaptive sliding mode vehicle traction controller design," in Proceedings of the IEEE International Conference on Systems, Man and Cybernitics , **1** , pp. 777–782, Vancouver, Canada, October 1995.

[2] Pierpaolo De Filippi, Mara Tanelli, Matteo Corno, Sergio M. Savaresi, "Enhancing active safety of two-wheeled vehicles via electronic stability control," 18th IFAC World Congress Milano (Italy), pp. 638-643 August 28 - September 2, 2011.

[3] Niklas Wahlström. Fredrik Gustafsson, "Magnetometer Modeling and Validation for Tracking Metallic Targets," IEEE TRANSACTIONS ON SIGNAL PROCESSING, **62(3)**, FEBRUARY 1, 2014.

[4] Rajesh Rajamani, Damrongrit (Neng) Piyabongkarn, "New Paradigms for the Integration of Yaw Stability and Rollover Prevention Functions in Vehicle Stability Control," IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS, **14(1)**, MARCH 2013.

[5] Pascal Cardinale, Camillo D'Angelo, Massimo Conti, "Traction Control System forMotorcycles," Hindawi Publishing Corporation EURASIP Journal on Embedded SystemsVolume 2009, Article ID 161373, doi:10.1155/2009/161373.

[6] B.Sulochana, B.A.Sarath Manohar Babu, " Monitoring and Detecting Vehicle Based On Accelerometer and MEMS Using GSM and GPS Technologies," International Journal of Computer Science Trends and Technology (IJCST), **2(4)**, pp. 55-59, July-Aug 2014.

[7] P. Kalaiselvan, K. Ramarethinam, P. Pandiaraj, "Design of Stability Control Motorbike with Abs and Crash Location Sensing," International Journal of Science and Research (IJSR), **3(3)**, pp. 281-285, March 2014.

[8] J.Jafnie Evangeline, Dr.J.Shekaina, "Anti-lock Braking System with ESC and Crash Location Sensing with GSM," International Journal of Emerging Technology and Advanced Engineering(IJETAT),**4(3)**,pp.291-295,Febrauary2014.