Design of Stability Control Motorbike with Abs and Crash Location Sensing

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Abstract: ***The development of Electronic systems in the last few decades have some impact over which it is concerned about vehicles especially four wheeler's as they possess with devices that are electronically controlled by near-far or inside the vehicle, but the availability of two wheeler vehicles are very less with such counterparts, especially the necessity among the safety of passengers, when it comes to two wheeler's, they lag more as safety becomes a major issue which needs a through solution. As an engineer it is easy to guess that the dynamic control of two wheeler's are very difficult than four wheeler's. In four-wheeled vehicles, stability control was introduced in the recent past to improve passengers' safety in critical driving conditions and it is now familiar with most commercial cars. For two-wheeled vehicles, designing such a stabilized system is quite challenging, and it deserves a huge effort because of its complexity and most important that for two-wheeled vehicles dynamic it is necessary to have a strong interaction between the vehicle and the one who drives. The Proposal of this paper proceeds as such resulting an over-all idea protecting the bikers from risk and smooth riding.***

Keywords: Antilock Breaking System (ABS), Electronic Stability Control (ESC), Degree of freedom (DoF), Micro Electro Mechanical System (MEMS).

1. Introduction & Motivation

In the Present Generation, every human will have a dream of affording vehicles especially two wheelers, as they are easy to ride consuming less time to reach the destination. But no one realizes how much it is risky when riding at high speed, thus it becomes an open issue among the younger generation [5], [6]. Whereas those who afford four wheelers doesn't need to worry about the risk involved, as its risk is very low when compared to that of two wheeled vehicles. It's because not everyone can afford to buy cars and as per the statistics manufacturers of bikes are comparatively more than cars, According to some statistical. Survey more than 40% of people end up with accident due to unstable and skidding due to over speeding and breaking [1], [2], [8]. E-Bikes will be supposing guaranteed to be the future of two wheeled motorbikes in the fore coming decades as measures are taken to make the world greener and free

From pollution. I feel the present day safety features integrated within these two wheeled vehicles are inadequate and so I turned to technology to look for ways to make the bike riding into a much safer experience and most effective part of travel.
Four wheeled vehicles have a strong support along its body and as a result, they experience less precaution in case of any cause [3], [4], and [6], whereas two wheeled vehicles are open aired and experiences a high security threat when riding at high speed. [1],[8]Cases like chances of steering, skidding, slipping or rolling over are very rare in four wheeled as compared to two wheeled counterparts, also its more costly for the manufacturers to provide such safety aspects in two wheelers. Even though some two wheeled vehicles are evolving with ABS, designing the stability system is quite complex due to vehicle dynamics and the way of interaction with vehicle and its driver. Due to this reason there is no commercial solutions for two wheelers that have stability control [9], [10].

2. Overview of Systems

The proposed system is focused on Designing of ESC in the existing ABS fitted E-bike, one important safety technology used in high end cars and trucks are called ABS (Anti-Lock Braking System) which has already become a mandatory feature for vehicles in countries such as US, Europe, Russia, etc. As a matter of fact, it is an electro-mechanical system that helps reduce wheel skid in automobiles by controlling the brake force applied to each wheel, making it easier to stay in control while riding. ABS equipped bikes are still evolving. The figure below shows bike fitted with ABS.

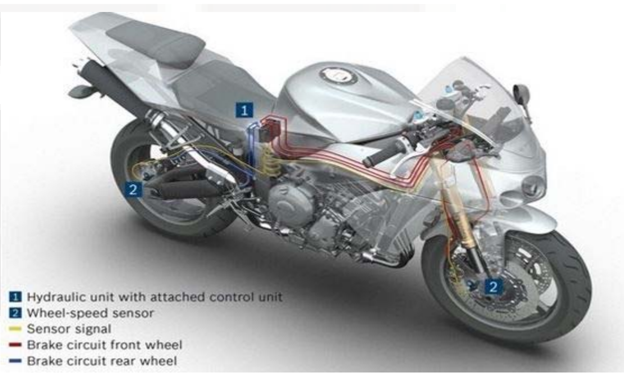


Figure 2.1: ABS Equipped Bike

Active Stability Control or Electronic Stability Control (ESC) is a safety feature that improves the vehicle stability by sensing yaw rate and roll rate in order to improve steering control in four-wheeled vehicles. It was first introduced in passenger cars in 1995 and it has been hailed by manufacturers, suppliers and road safety advocates as the most important safety technology since the seat belt. With skidding being the main cause of traffic accidents that result in serious injuries or deaths, this anti-rollover and anti-skid technology senses when the driver is losing control of the car and autonomously applies braking pressure to individual wheels to help stabilise the vehicle.

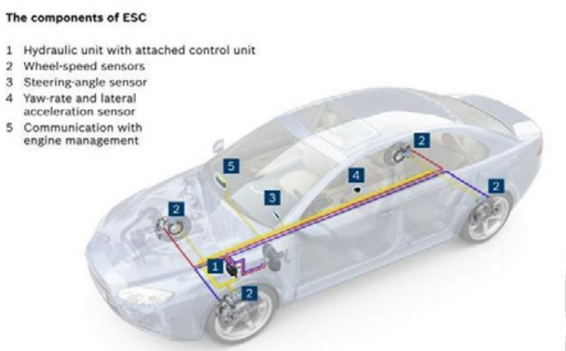


Figure 2.2: Four wheeler (Car) fitted with ESC

The components used in bike ABS and car ESC are almost looking similar, but varies lot in their protocol with wheels and dynamic control units as ESC requires more control systems. The Electronic Stability Control ESC integrates ABS and Traction Control System, but has the added feature of a yaw torque control, a functionality that prevents skidding. It is designed to help drivers maintain control of their vehicles in sudden manoeuvres such as rapid steering and counter steering, sudden lane changes and obstacle-avoidance manoeuvres. ESC is always active. 25 times a second, it compares whether the driver's steering input is corresponding to the actual direction in which the vehicle is moves. If the vehicle moves in a different direction, either understeering or over steering, it detects the critical situation and reacts immediately. To do this, the vehicle's braking system is used as a tool for controlling the vehicle back to its track. Specific braking intervention is directed at individual wheels, such as the inner rear wheel to counter understeer, or the outer front wheel during over steer. This control will give a strong interaction on selective braking interventions that generates the desired counter force, so that the car reacts easily as the driver intends. ESC not only initiates braking control, but can also manage it on the engine side to accelerate the driven wheels. ESC substantially reduces the complexity of the steering process and lows down the demands placed on the driver the rate at which the ESC installation is hiked in terms of percentage/year since 2006 is monitored as such.

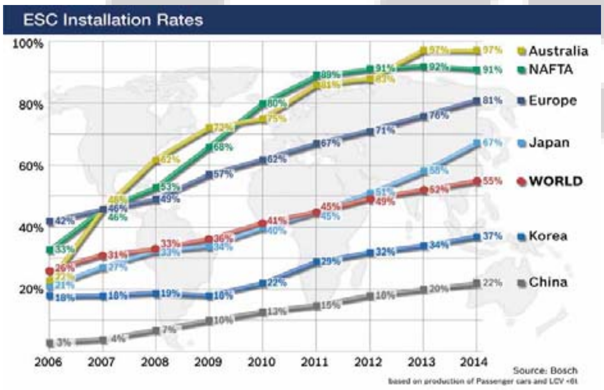


Figure 3: ESC Installation Rate Worldwide.

3. Block Description

The design of stability motorbike comprises of three different Circuit Units and their corresponding circuit description. Antilock Breaking System alone cannot have the full impact on the safety divine, it needs the support of Electronic stability Control to access throughout the drive with long breaking and bear with deadly curves which creates tragic steering such as understeering and over steering. The location of a stationary vehicle or that which is in movement can be identified without the help of GPS too, which reduces the burden of spending more penny compared to this small and simple device known to be the Digital MEMS 6-DOF magnetometer which is highly used in vehicles with stability Control, which makes emergency calls/alarms in case of Roll over detection, crush detection, anti-theft.

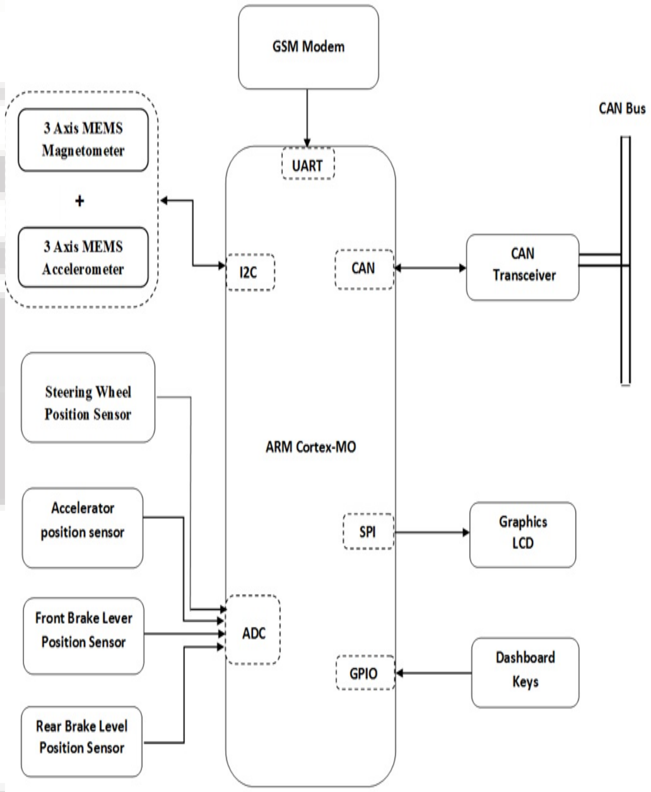


Figure 3.1: Main Dashboard unit with ABS and ESC

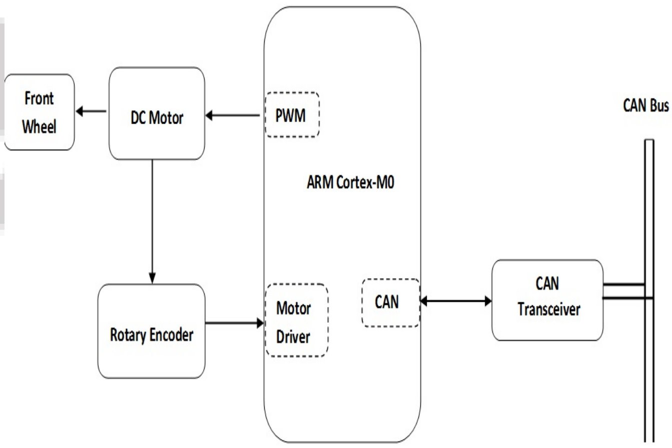


Figure 3.2: Front wheel Unit

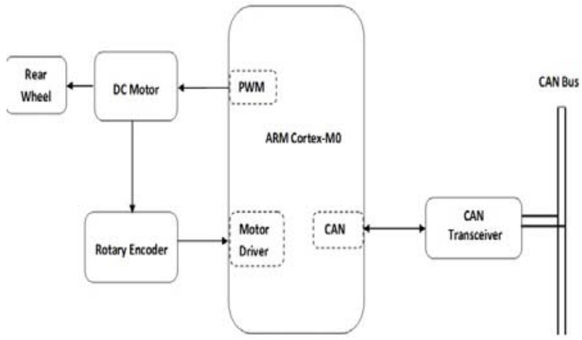


Figure 3.3: Rear wheel Unit.

4. Components description

4.1 LPC 11C00

The LPC1100 is the world's first Cortex-M0 based microcontroller series offering users a cost effective, very easy to use 32-bit MCU which is code and tool compatible with other NXP ARM based MCU products. With 32-bit performance combined with multiple power modes and very low Deep sleep power, the LPC11xx offers industry leading energy efficiency greatly extending battery life. The LPC11xx sets new benchmarks in performance efficiency with dramatically improved code density enabling longer battery life and lower system costs. It has some additional features such as Serial Wire Debug and Serial Wire Trace Port, High-current output driver (20 mA) on one pin, High-current sink drivers (20 mA) on two pins, Integrated PMU (Power Management Unit) to minimize power consumption during Sleep, Deep-sleep, and Deep power down modes, Single 3.3 V power supply (1.8 V to 3.6 V), 15 GPIO pins can be used as edge and level sensitive interrupt sources, Cock generation unit with divider that can reflect the main oscillator clock, IRC clock, CPU clock, and Watchdog clock, Processor wake-up from Deep-sleep mode via interrupts from various peripherals, Power-On Reset (POR), Crystal oscillator with an operating range of 1 MHz to 25 MHz, PLL allows CPU operation up to the maximum CPU rate without the need for a high-frequency crystal. May be run from the main oscillator, the internal RC oscillator, or the Watchdog oscillator, Available as 48-pin LQFP package and 33-pin HVQFN.

4.2 CAN Controller MCP2515

Microchip Technology's MCP2515 is a stand-alone Controller Area Network (CAN) controller that implements the CAN specification, version 2.0B. It is capable of transmitting and receiving both standard and extended data and remote frames. The MCP2515 has two acceptance masks and six acceptance filters that are used to filter out unwanted messages, thereby reducing the host MCUs overhead. The MCP2515 interfaces with microcontrollers (MCUs) via an industry standard Serial Peripheral Interface (SPI).

4.3 Graphics LCD PCD8544

The PCD8544 is a low power CMOS LCD controller/driver, designed to drive a graphic display of 48 rows and 84 columns. All necessary functions for the display are provided in a single chip, including on-chip generation of LCD supply and bias voltages, resulting in a minimum of external components and low power consumption. The PCD8544 interfaces to microcontrollers through a serial bus interface. The PCD8544 is manufactured in n-well CMOS technology.

4.4 MEMS Sensor LSM303DLH

The LSM303DLH provides three-dimensional heading accuracy within buildings, automobiles, and at high latitudes in such places as the northern US, Canada, and northern Europe, where the declination angle of the earth's field is difficult to measure with Hall-type sensors. In combination with software drivers for heading, auto calibration, and soft-iron/hard-iron compensation—available for a variety of popular mobile phones' operating systems—the LMS303DLH six-dimensional sensor gives system designers a powerful instrument for implementation of navigation functions. The LSM303DLHC features two data-ready signals (RDY) which indicate when a new set of measured acceleration data and magnetic data are available, therefore simplifying data synchronization in the digital system that uses the device.

5. Software Tool used

5.1 LPCXpresso IDE

LPCXpresso is a new, low-cost development platform available from NXP. The software consists of an enhanced, Eclipse-based IDE, LPCXpresso is an end-to-end solution enabling embedded engineers to develop their applications from initial evaluation to final production.

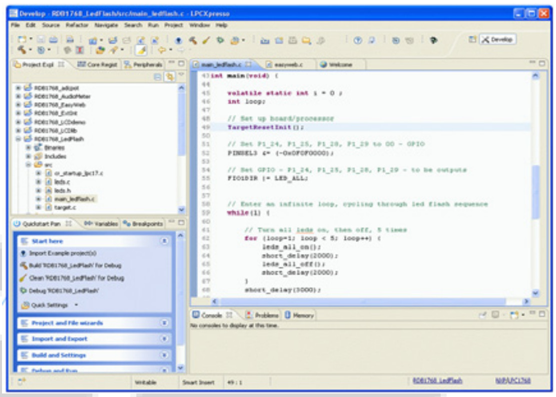
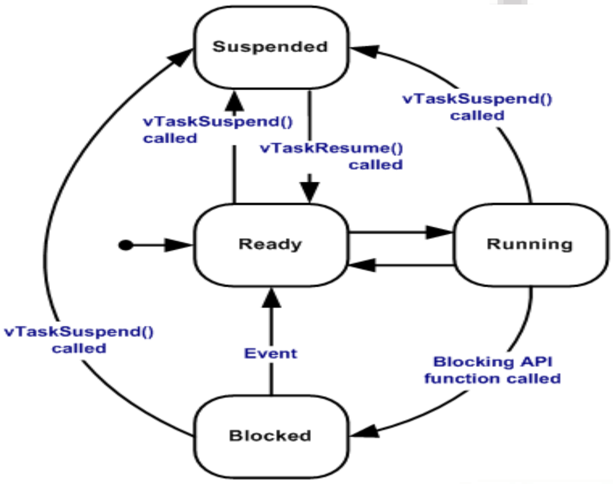


Figure 5: LPCXpresso IDE

The hardware consists of the LPCXpresso development board which has an LPC-Link debug interface and an LPC ARM-based microcontroller target. The C programming environment includes professional-level features. The LPCXpresso IDE can build an executable of any size with full code optimization and it supports a download limit of 128 kB after registration. Features are more such as LPCXpresso is a complete tool chain for LPC1000 series of Cortex-M microcontrollers, eclipse based IDE, GNU Compiler, Linker and Libraries, Enhanced GDB Debugger, Supports LPC-Link Programmer and Debugger, Developed by NXP Semiconductors and CodeRed Technologies.

5.2 Operating System used- Free RTOS

FreeRTOS is professional grade, license free, robust, open Source Real-Time Kernel, Supports Mutex, Semaphores, Queues and C Configured for both Pre-emptive and Co-operative schedulers, Configured for both Pre-emptive and Co-operative schedulers, Configured for both Pre-emptive and Co-operative schedulers, Ported to Cortex-M0 (LPC1000), Works with LPCXpresso tool chain, Takes less than 4KB flash memory



6. Functional Description

In an Active stability system, multiple sensor inputs are used to determine the breaking force that needs to be applied as per the corresponding requirement. Acceleration is measured using acceleration position level sensor, front and rear brakes are measured with brake level position sensor, steering angle is measured by steering wheel position sensor which also calculates the break force along with driver accelerator input including wheel speed. If any situations such as vehicle skid or roll or even wheel lock on both wheels are detected, then the breaking pressure required for both wheels are calculated by the controlled and the pressure is applied differentially using electrical motors, which responds to the rider's lever squeezing force

Considering that ABS system is active while the driver applies sudden break, then the break pressure is calculated by the controller and applies on both the wheels differentially thus reducing the movement of wheel. The skidding threshold level is set to the rider which allows the Adjustment keypad during system activation, allowing different characteristics performances depending on the trail surface. loss of steering controls such as over steering(more than that required to steer) or understeering (less steering than that required) are detected using the steering position level sensor. in this case if the ESC is active then it will detect both understeering as well as over steering and controls the speed automatically

The location of vehicle is sensed by using 6-DOF Digital MEMS compass module, which as a 3-axis MEMS accelerometer and a 3-axis MEMS magnetometer inbuilt within the module, this providing direction without any use of GPS. In case of sudden crash situation the 3-axis MEMS accelerometer senses it and the system sends an emergency message automatically with the use of GSM to nearest Emergency service or to home with the help of embedded vehicle location data. The message sent will direct the location as well as the time at which the crash is detected.

The complete system consist of three Electronic Control Units(ECU's) interconnected with each other, where two of those are dedicated for front wheel control and rear wheel control, both the wheels are controlled by using 2 different DC motors, the rotary encoder interfaced with ECU measures the speed and direction of the wheels. Driver input unit sensors such as break level position sensor, acceleration level position sensor and steering wheel position sensor are interfaced with the main dashboard unit which is the third ECU. Other interfaces are also fixed on this ECU such as graphical LCD and GUI are provided which acts as dashboard display and vehicle status monitoring; also the MEMS compass is connected to this unit.

The whole system of three ECUs are connected each other through a closed network called as Controller Area Network (CAN). Each CAN has its own function as it is well known for its event-driven protocol, most often used in the automotive applications. To meet with the real time target and make this system long lasting, Free RTOS is most preferred to run, which is well known open source real-time kernel ever.

7. Benefits

Two wheeled vehicle with active stability control is attempted by designing for the first time, Without the need of GPS, the cost of tracking is very less, Comparing to the currently available mechanical models, electronic ABS systems are more superior, Since CAN network is used, excess wires are cut shorten, The real-time kernel being open source is most efficient, ARM Cortex-M0 microcontroller is used which has an in built CAN controller, which can be ideally used for networking within ECU's, Digital compass direction sensor provides 360 degree direction by sensing earth's magnetic field.

8. Conclusion and future works

Stability control in two wheeler is designed with ABS and all the sensor units have been monitored with corresponding inputs as per the rider's aspect. The basic feature that of four wheeler is quite accomplished and crashed vehicle tracking is done with digital compass by using GSM. This can be enhanced in future by using GPS or Mobile tracking systems or even more evolving techniques for more accuracy.

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Authors Profile

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