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Dynamic Stability Program for E-Bicycle Provide For Safety Characteristic

M. Sathis Kumar[1], G. Ganesha Perumal[2]

Centre for Electrical and Electronics Engineering, Kalasalingam University, Krishnankoil, India[1]

Department of Electrical and Electronics Engineering, Kalasalingam University, Krishnankoil, India[2]

Abstract: - The proposed system has Dynamic Stability Program (DSP) combined design to Electronic Stability Control (ESC) associated with Antilock Braking System (ABS) for E-bicycle provide for safety characteristic. The ABS is used to prevent wheels from locking up and provided the shortest stopping distance on slippery surfaces and Sudden Braking condition. During steering on ice, black ice, snow, dirt or gravel roads, emergency avoidance manoeuvres on regular dry roads, due to going too fast around a curve[2]. In these circumstances the vehicle can spin out, drift out, become unstable and respond in a highly non-intuitive manner to the driver steering[2]. An ESC system can control the yaw rate of the vehicle under these circumstances making it's respond in the way the driver expects and drivers intention in order to stabilize the vehicle by understeering or oversteering.

Keywords:-Antilock Braking System, Electronic Stability Control, Reduce Brake Pressure; Reduce Stopping Distance, Controller Area Network.

I. INTRODUCTION

Antilock braking system (ABS): ABS for two wheeled vehicles are existing, the design of a two wheeled vehicle stability control system constitutes somewhat a challenging task due to the sophistication of two-wheeled vehicle dynamics and to the physically powerful interaction between the vehicle and the driver. For this reason, there is no solution commercially available for two wheeled vehicles that have a dynamic stability control system[1][3]. The ABS working theory based on speed sensors to find out the rotational speed of each wheel. If a wheel risk locking due to deep braking or slick conditions, this system uses its longitudinal braking control and senses vehicle dynamics and drivers intention in order to steady the vehicle by avoiding rolling, skidding and loss of traction. Anti-lock brakes benefit in two ways: the vehicle stops faster, and the driver able to steer while vehicle stop.

Electronic Stability Control (ESC): The ESC systems are marketed under various names Different company's design in four wheelers the systems names such as Dynamic Stability and Traction Control in Volvo, Dynamic Stability Control in BMW, Electronic Stability Program in Mercedes-Benz, StabiliTrak in GM's brands, Vehicle Stability Control in Lexus and Toyota. While they're not similar, these trade-named systems all illustrate the same basic technology. But all of these systems, no theme their names, use high-tech sensors, the vehicle central processor and mechanical actions to assist in driving security.

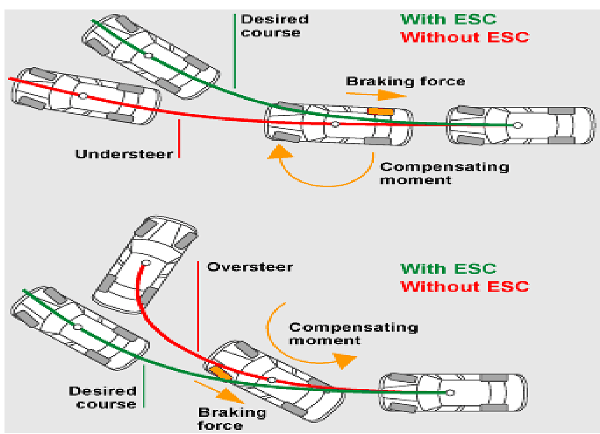

Fig. 1, Examples of ESC performs understeer and oversteer condition.

We frequently study about high performance vehicle having a tendency to understeer or oversteer. But the truth is, any vehicle can turn off course, especially if the road is slippery[1][2]. Our aim is to design such ESC in the case of two wheelers. Understeer fig (1) happens when the front wheels don't have enough traction and the vehicle continues moving forward rather than turning. Oversteer fig(1) is just the opposite the vehicle turns farther than the driver intended causing the rear wheels to slide and the vehicle to spin. ESC, as electronic stability control is often known, can help to correct both of these situations.

In the next section, system architecture and component description of DSP developed in Section 2 and in Section 3, respectively. Front wheel ECU Simulation results are provided in Section 5. Some concluding remarks make in section 6.

II. SYSTEM ARCHITECTURE

The DSP consists of steering angle position sensor, front and rear brake position sensor, acceleration position sensor, CAN Bus, and a Controller. The front wheel ECU consists of DC motor, rotary encoder, CAN Bus and a controller. The location of these devices within a vehicle is shown in Figure 2 and 3.

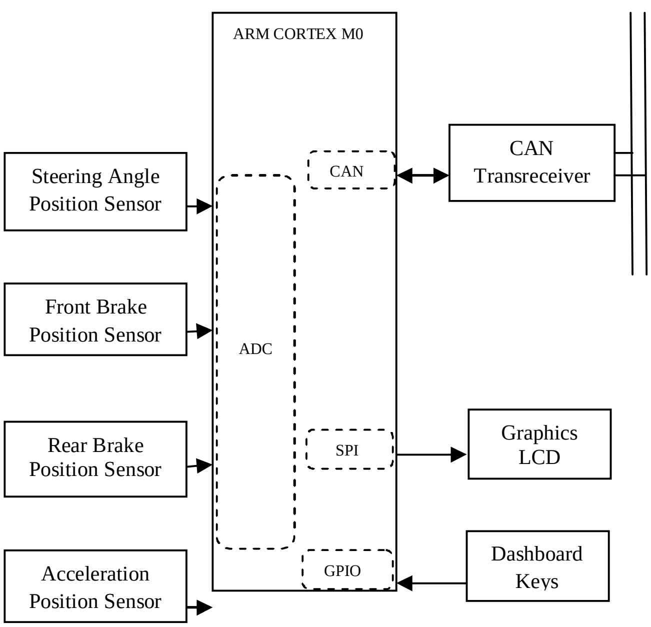

Fig. 2, Example of Dashboard DSP

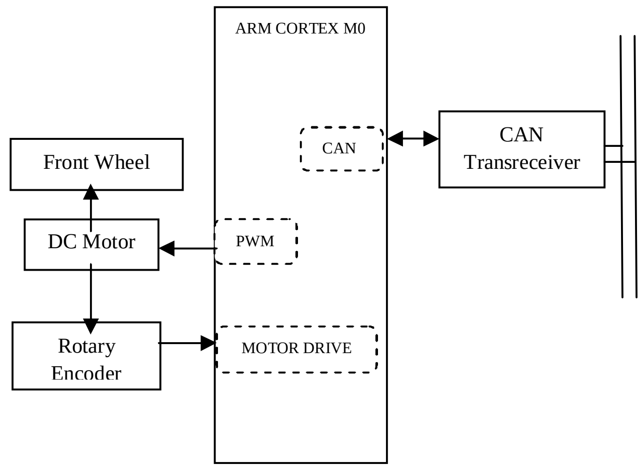

Fig. 3, Example of Front wheel ECU

A. Controller unit

The LPC11C14 is 48 input output pins an ARM Cortex-M0 is designed for economical, low-power CAN-based application. On-chip CAN and CANopen drivers provide design engineers with easy-to-use API commands to the CANopen protocol. The controller looking for when a wheel locks up, the wheel would stop much more quickly.

B. Sensors unit

The ABS and ESC information is fed into the vehicle controller through four sensors. The anti-lock braking system needs some way of knowing when a wheel is about to lock up [4]. The speed sensors, which are located (front and rear wheel) at each wheel, provide this information. And the electronic stability controls needs some way knowing when a steering angle is about understeer or oversteer. The steering angle position sensor has to provide the information about steering angle.

C. Front and rear brake position lever sensor

The front and rear brake position sensor has measure the driver applied brake pressure for each wheel.

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D. Acceleration position sensor

The speed sensor located at each wheel (front wheel and rear wheel) has measures the speed of the wheel which the controller can then control the speed of motor. A rotary encoder, also called a shaft encoder, is an electro-mechanical implement that converts the angular position or motion of a shaft or axle to an analog or digital code.

E. Steering-angle sensors

The sensor measures the direction of the driver intends to seek the vehicle. If it's different than direction the vehicle is essentially traveling, the ESC system will boot in. A steering angle sensor in an automobile measures changes in the steering geometry between the steering wheel and the road wheels. Steering angle sensors measure the revolution angle, angle velocity and track of the steering wheel, only if information on the direction in which the driver needs to go. Steering angle sensors are necessary for systems such as ESC and are also used in electric power steering and active steering systems (DSP) as well as parking support systems and curve lights.

F. Data Communications

The interactions between the controllers, sensors are performed through high-speed CAN bus. The two electronic control units which are present in dashboard, front wheel are communicated through CAN protocol. This CAN protocol is basically an automotive protocol which is widely used in automobile industry. CAN bus is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other within a vehicle without a center computer. CAN bus is a message-based protocol, considered in particular for automotive function but now also used in other areas such as aerospace, maritime, industrial automation and medical equipment.

III. COMPO4NENTS DESCRIPTION

G. Arm Cortex M0

The ARM Cortex M0 processor is the minimum, lowest-power and the majority energy-efficient ARM processor available. The particularly minimum code, low power and small silicon area footprint of the processor achieve 32-bit performance at an 8-bit price point, bypassing the step to 16-bit devices. Serial communication module available in the series is fully software-configurable to handle SPI, UART and I2C communications to enhance interface flexibility.

The Cortex-M0 processor promises substantial savings in system cost while retaining tool and binary compatibility with feature-rich processors such as the Cortex-M3 processor. It consumes as little as 85 µW/MHz (0.085 mW) in an area of typically below 12 K gates, enabling the making of ultra low-power analog and mixed signal devices. The project described on this page demonstrates the FreeRTOS ARM Cortex-M0 GCC port. It is configured to run on the LPC1114 version of the LPCXpresso board, using the free Eclipse based LPCXpresso IDE

B. LPCXpresso.

LPCXpress0 is the low-cost development platform available from NXP. It supports NXP's ARM-based LPC controllers. The platform is comprised of a basic Eclipse-based IDE and low-cost target boards which include an attached JTAG debugger. Intended for simplicity and ease of utilize, the LPCXpresso IDE (powered by Code Red) will provide software engineers a quick and easy way to develop their applications.

The LPCXpresso target boards are together developed by Code Red, NXP and Embedded Artists. Three LPCXpresso boards have been released. The first features the LPC1343 with integrated USB 2.0 Full Speed Device, while the following features the LPC1114, which is the opening Cortex M0 controller released to marketplace. Future LPCXpresso boards among further LPC microcontrollers are planned. LPCXpresso is an end-to-end solution enabling embedded engineers to develop their applications from initial evaluation to final production. The LPCXpresso development platform is jointly developed by NXP, Embedded Artists and Code Red.

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IV. SYSTEM FUNCTIONALITY

Stopping a vehicle in a hurry on a slippery road can be very challenging. On slippery surfaces the professional drivers can stop the vehicle as quickly without ABS as an average driver can with ABS[5]. Anti-lock Braking system (ABS) is does not provide for full safety while driving, so it has to be assist with Electronic Stability Control (ESC) for efficient working in longitudinal braking as well as in curves vehicle oversteers (or) understeers. The system has used for four sensors that are front brake lever position sensor, which is used to provide information of braking force in front wheel[1][6]. Acceleration position sensor is used to provide information of acceleration applied. The steering position level sensors are used to give details of steering angle respectively.

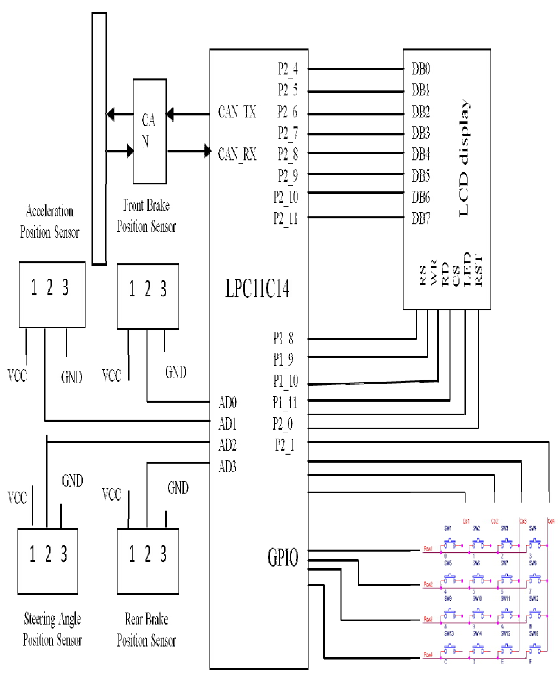

Fig. 4, Circuit diagram for dash board DSP

ABS works with both the front and rear wheels to prevent lock-up. During piece of information, in favor of most riders who brake most heavily with the front brake in wheel-lockup situations, the knowledge is most likely more effective with the front brake [5].

The DSP has working on when the driver apply brake hard during an urgent situation, the ABS is able to avoid the brakes from locking up allowing the driver to maintain steering wheel operation to minimize the feasible of losing control of the vehicle's steering. The ESC reduces the skid of vehicles in the conditions of under steering or over steering tendency[2].

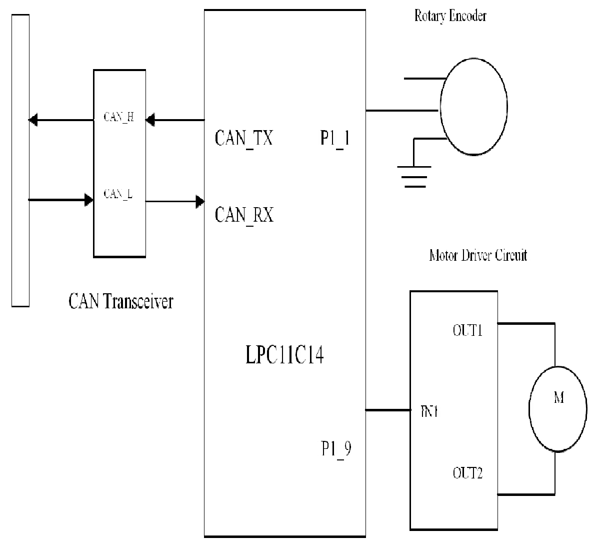

Fig. 5, Circuit diagram for rear wheel ECU

The ESC works concurrently with the ABS quickly adjust the brake force on a front wheel to ensure E-bicycle safety [8]. The electronic stability control system helps prevent the indirect skidding and loss of control that can go in front to rollovers. It can help drivers keep up control during urgent situation maneuvers when their vehicles otherwise might spin out (or) reduce vehicle speed to prevent running off the outside of a curve.

This fable is generally based on the suggestion that a locked-up wheel provides the most traction probable [9]. This isn't factual. A skidding tire has less traction than a tire that is not skidding. Speed sensors measure the rotational speed of each wheel.

If a wheel risks locking due to forceful braking or slick conditions, Not only does the system sustain the correct spot of maximum stopping force that occurs before lockup, however by avoiding lock-up, the inertial consequence of the spinning wheel is maintained,

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stabilizing the E-bicycle. By keeping the wheels from locking up and skidding when the driver takes the brakes, ABS not only allows you to maintain some control, however it allows driver to stop in a shorter distance.

V SIMULATION OUTPUT OF FRONT WHEEL ECU

The DSP system has designed to have three ECU (Electronic Control Unit) as dashboard, front and rear. The above each model has used to ARM cortex M0 processor, the simulation has obtained to the front wheel.

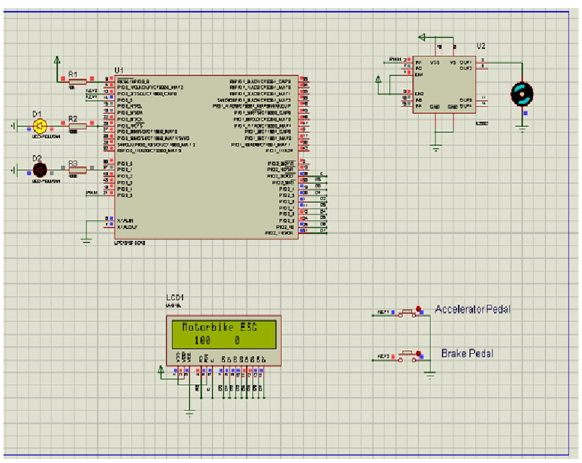

Fig. 6, Simulation for the activation of acceleration in front wheel.

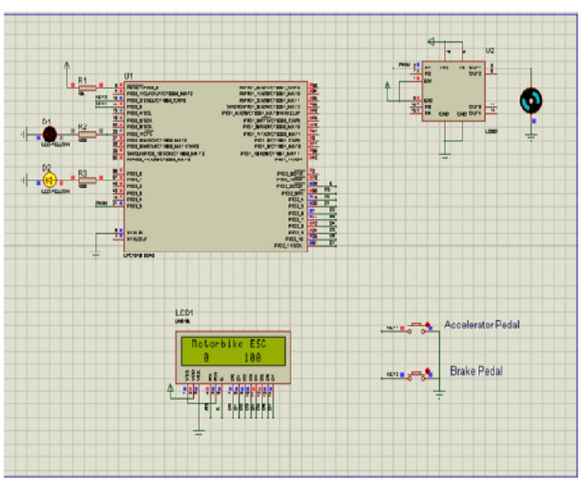

Fig. 7, Simulation for the activation of brake in Front wheel.

The ECU model has been interfaced with DC Motor using ULN2003 driver. If it detects a vehicle is going to be skid or roll or lock-up front wheel, the controller calculates the braking pressure needed for front wheel and the electrical motors. Motor turns on and the LED1 is blinking when the oscillation pedal is applied. Whenever the brake pedal is applied motor turns to off, the LED2 is blinking. Fig (6) Activation of acceleration pedal. Fig (7) Activation of brake pedal during the application of both brakes, the LCD display has displayed 100. The display value is not real time.

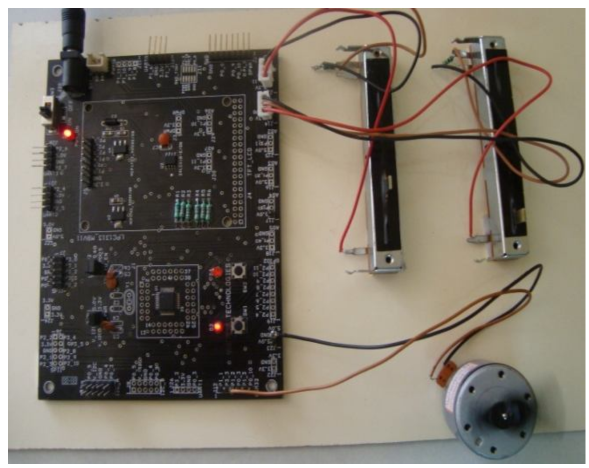

Fig 8, Hardware implementation on front wheel ECU

The roll of dynamic stability program gathers information about in sudden braking (or) slippery surface has measure applied for acceleration, braking force in front wheel and steering angle respectively. These values are converted analog into digital using ADC in the LPC11C14.These digital values are transmit dashboard DSP to front wheel ECU through CAN communication and the front wheel ECU has generate PWM pulse, run and control front wheel DC motor respectively.

VI. CONCLUSION

The stability control system can be implemented to the front wheel. This can be also implemented to the rear wheel which tends to increase the stability and safety of E-bicycle.

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REFERENCES

[1] Kanghyun Nam, Student Member IEEE Hiroshi Fujimoto, Member IEEE and Yoichi Hori Fellow IEEE, Lateral Stability Control of In-Wheel-Motor-Driven Electric Vehicles Based on Sideslip Angle Estimation Using Lateral Tire Force Sensors, IEEE Transaction on Vehicular Technology , vol. 61, no. 5, June 2012.

[2] Rajesh Rajamani, Senior Member, IEEE, and Damrongrit (Neng) Piyabongkarn, Member, IEEE New Paradigms for the Integration of Yaw Stability and Rollover Prevention Functions in Vehicle Stability Control , IEEE Transaction on vehicular technology , vol. 14, no. 1, March 2013.

[3] G. Cong, L. Mostefai, M. Denai, and Y. Hori, "Direct yaw moment control of an in-wheel-motored electric vehicle based on body slip angle fuzzy observer," IEEE Trans. Ind. Electron., vol. 56, no. 5, pp. 1411–14 19, May 2009.

[4] Grip, Havard Fjaer, Lars Imsland, Tor A. Johansen, Jens C. Kalkkuhl, and Avshalom Suissa. "Vehicle sideslip estimation." Control Systems, IEEE 29, no. 5 (2009): 36-52.

[5] Xu Shengming and Huitong Wu. "The research and analysis of the efficiency of automobile ABS brake based on fuzzy control." Consumer Electronics, Communications and Networks (CECNet) 2012 2nd Inter International Conference on. IEEE, 2012.

[6] Nam, Kanghyun, Yunha Kim, Sehoon Oh, and Yoichi Hori. "Steering Angle-Disturbance Observer (SA-DOB) based yaw stability control for electric vehicles with in-wheel motors." In Control Automation and Systems (ICCAS), 2010 International Conference on, pp. 1303-1307. IEEE, 2010.

[7] Roque, A., J. Esteves, J. Maia, and P. Verdelho. "Analysis and design of a traction control algorithm for an electric kart with two independent wheel drives." In IMACS, pp. III-257. 1999.

[8] Tseng, Hongtei Eric, Behrouz Ashrafi, Dinu Madau, T. Allen Brown, and Darrel Rockers. "The development of vehicle stability control at Ford." Mechatronics, IEEE/ASME Transactions on 4, no. 3 (1999): 223-234.

[9] von Vietinghoff, Anne, Marcus Hiemer, and Uwe Kiencke. "Nonlinear observer design for lateral vehicle dynamics." Proc. 16th IFAC World Congress. 2005.