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MODELING AND RECOGNIZING DRIVER BEHAVIOR BASED ON PREDICTIVE CONTROL APPROACH

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Abstract: Recent statistics show that a large number of traffic accidents occur due to a loss of control on vehicle by the driver. This is mainly due to a loss of friction between tire and road. Many of these accidents could be avoided by introducing ADAS (Advanced Driver Assistance Systems) based on the detection of loss of tire/road friction. Friction (more specifically the maximum coefficient of friction) which is a parameter of tire/road interaction, mainly depends on the state of the road (dry, wet, snow, ice) and is closely related to the efforts at the tire level. In this paper, propose a new method for the estimation of the maximum tire/road friction coefficient, to automatically detect possible state of loss of friction which results in an abrupt change on the road state. This method is based on an iterative quadratic minimization of the error between the developed lateral force and the model of tire/road interaction. Tire-road friction is the most important piece of information used by active safety systems.

Index terms: driver modelling, steering movement, obstacle detection, friction variation, ADAS technology.

I. INTRODUCTION

Many traffic-safety related investigations prove a correlation between the road condition and the number of accidents. An internal study at Volvo Cars claims that 15 % of all accidents occur owing to low tire-to-road friction sensing and actions, including the driver's knowledge and skill. To maximize the performance envelop of the driver–vehicle system, the research direction of improved driver behavior modeling is of special interest Monitoring of the road conditions is, among vehicle manufacturers, seen as an increasingly important element to support traffic safety. This paper presents an estimation method that can detect tire-road friction information during normal driving and to estimate the driver skill and steering conditions. In recent years, demand for automobile safety has increased, thereby promoting research and development of anti-lock brake systems (ABSs), collision avoidance systems, etc. Tire-road friction is the most important piece of information for these systems. However, most conventional friction estimation/detection methods are accurate only within the non-linear region. In addition, such methods require numerous sensors, such as yaw rate sensors, acceleration sensors, and steering angle sensors. The main features of our method are friction condition can be estimated when the vehicle is still in the linear regions. The steering conditions can be validated. To control the speed of the vehicle in direct accidents. The main approach of this system is to overcome the drawbacks of the existing method. In this system we can implement a system for automatically detecting the road state to allow the calculation of risk indicators of exit route (accident), and thus be able to warn the driver. Following this work, we plan to validate the method embedded on a real vehicle, and to integrate the multi-model approach to estimate the maximum lateral friction coefficient. The experimental results show that, when applied to a free-rolling tire, the proposed method detects friction change from dry asphalt to iced road while the vehicle travels at constant speed without braking, accelerating, or cornering. And we used the ultrasonic sensor to detect the objects in front of the vehicles if any object found suddenly the vehicle can stop.

A. Adaptive Control Behaviour

The human driver is the ability to adapt to not only different controlled vehicle dynamic plants but to altered operating conditions. Within the nonlinear realm, similar observations have been noted regarding driver adaptive control behavior. It was observed that drivers can stabilize and control such directionally unstable vehicle plants – primarily through use of slow, oscillatory, counter-steering behavior. Associated analyses using a driver model noted that the presence of a nonlinear internal vehicle model (within the driver model structure) was an important ingredient for reproducing that distinctive steering behavior suggesting that drivers can identify and internalize even nonlinear controlled vehicle dynamics as part of their adaptive control behavior.

B. Driver Assistance Systems

Roadside units can provide drivers with information which help them in controlling the vehicle. Automatic braking is a technology for automobiles to sense an imminent collision with another vehicle, person or obstacle; or a danger such as high brakes or by applying the brakes to slow the vehicle without any driver input.

C. Advanced Driver Assistance Systems

In the systems to help the driver in the driving process. When designed with a safe human-machine interface they should increase car safety and more generally road safety. Advanced driver assistance systems (ADAS) are systems developed to automate/adapt/enhance vehicle systems for safety and better driving. Safety features are designed to avoid collisions and accidents by offering technologies that alert the driver to potential problems, or to avoid collisions by implementing safeguards and taking over control of the vehicle. Tire-road friction is the most important piece of information used by active safety systems.

D. Technology of ADAS

ADAS technology can be based upon vision/camera systems, sensor technology, car data networks, Vehicle-to-Vehicle (V2V), or Vehicle-to-Infrastructure systems. Next-generation ADAS will increasingly leverage wireless network connectivity to offer improved value by using car-to-car and car-to-infrastructure data. The Automotive Coalition for Traffic Safety and the National Highway Traffic Safety Administration has called for a Driver Alcohol Detection System for Safety (DADSS) program to put alcohol detection device. Adaptive features may automate lighting, provide adaptive cruise control, automate braking, incorporate GPS/ traffic warnings, connect to smart phones, alert driver to other cars or dangers, keep the driver in the correct lane, or show what is in blind spots.

II. PROPOSED BLOCK DIAGRAM

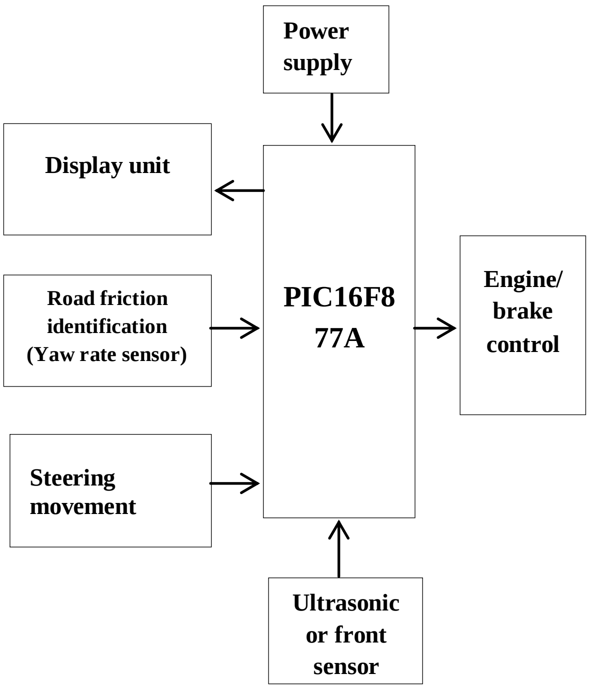


Fig: 1 block diagram of proposed system

A. Block Diagram Description

The proposed block diagram is consists of friction identification, steering movement, ultrasonic sensor, PIC microcontroller unit, display unit, engine/break control, power supply.

B. Friction identification

Tire friction based on measurement of vehicle motion and then determines friction. The algorithms for tire/road friction-model parameter identification. It is assumed that the vehicles are moving on a flat surface and their vertical-position changes are neglected. However, this simplification may yield notable errors in some cases. The methods that were developed to deal with such situations are examined. The tire/road friction force is indirectly measured via the resulting vehicle motion.

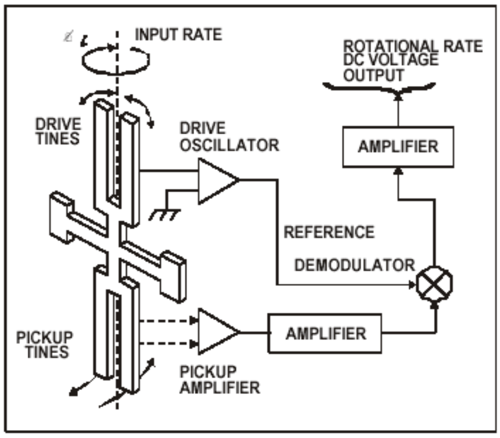


Fig: 2 working principle of yaw rate sensor

Steering systems contribute to improved driving safety and agility. The vehicle's sub-systems all utilize the sensor signals and the centrally calculated information on the vehicle's driving status, e.g. on speed, sideslip angle and movement of the vehicle body. This ensures consistent system behavior and the economically efficient implementation of functions. Vehicle by coordinating the steering and brake intervention. In most situations a steering intervention is sufficient without reducing the vehicle speed. When steering round a corner, the ideal steering movement is progressive, smooth and controlled. Applying and taking off steering lock should be done in a fluid movement, without taking either hand off the wheel where possible. 'Pushing and pulling' the wheel may be fine for general road driving, but this does not allow the smooth motions needed when driving near the limits of grip. Try not to let the steering wheel slide through your fingers when letting off steering lock, and then adjust your hand position accordingly for the next corner or straight. In some situations when you need to take the lock off very quickly - you may find it easier to let the wheel slide through your fingers slightly, but this should be avoided where possible.

C. Steering through a corner

When taking a corner, aim for the apex and turn in a smooth controlled arc - don't use aggressive steering unless you're deliberately trying to unsettle the car (e.g. for a handbrake turn). Once you've clipped the apex, unwind the steering lock progressively as you increase the throttle. If you find you have to tighten up mid-corner you've hit the apex too early, and if you find you don't need to use the entire width of the track on the exit you've probably left your cornering too late.

D. Driving position:

When getting ready for the track you should adjust your seat to a much more upright position than you may use when driving on the road. You should be able to rest your wrists comfortably on the top of the steering wheel while keeping a slight bend in your arms. This may mean moving closer to the wheel than you normally would which can feel strange at first, but will give you maximum control.

E. Hand position

When driving on a stretch of straight or gently curving tarmac, the default hand position is quarter to three (Figure 1). When taking tighter corners it will be necessary to adjust hand position accordingly. Grip the wheel with a firm but relaxed grip, but not so hard that your knuckles turn white! Try to maintain this position unless it isn't possible to take the corner in this way, as this gives you the advantage of instantly knowing exactly where the straight ahead position is, and the ability to steer rapidly yet smoothly. For a tight right hand hairpin, a suggested hand position . This will allow the lock to be applied and taken off without either taking hands off the wheel or adjusting the hand position until after the corner has completed. If your car has a large number of turns from lock to lock, you may need to start with your right hand further anti-clockwise.

F. Display unit

Liquid Crystal Display (LCD) consists of rod-shaped tiny molecules sandwiched between a flat piece of glass and an opaque substrate. These rod-shaped molecules in between the plates align into two different physical positions based on the electric charge applied to them. When electric charge is applied they align to block the light entering through them, where as when no-charge is applied they become transparent. Light passing through makes the desired images appear. This is the basic concept behind LCD displays. LCDs are most commonly used because of their advantages over other display technologies. They are thin and flat and consume very small amount of power compared to LED displays and cathode ray tubes (CRTs).

G. Ultrasonic Sensor

To measure the distance the sound has travelled we use the formula: Distance = (This popular ultrasonic distance sensor provides stable and accurate distance measurements from 2cm to 450cm. It has a focus of less than 15 degrees and an accuracy of about 2mm this sensor uses ultrasonic sound to measure distance just like bats and dolphins do. Ultrasonic sound has such a high pitch that humans cannot hear it. This particular sensor sends out an ultrasonic sound that has a frequency of about 40 kHz. The sensor has two main parts: a transducer that creates an ultrasonic sound and another that listens for its echo. To use this sensor to measure distance, the robot's brain must measure the amount of time it takes for the ultrasonic sound to travel. Sound travels at approximately 340 meters per second. This corresponds to about 29.412µs (microseconds) per centimeter. Time x Speed of Sound) / 2. The "2" is in the formula because the sound has to travel back and forth. First the sound travels away from the sensor, and then it bounces off of a surface and returns back. The easy way to read the distance as centimeters is to use the formula: Centimeters = ((Microseconds / 2) / 29). For example, if it takes 100µs (microseconds) for the ultrasonic sound to bounce back, then the distance is ((100 / 2) / 29) centimeters or about 1.7 centimeters. Connect the VCC and GND pins to a 5V power supply, the trigger input (Trig) pin to a digital output and the echo (Echo) pin to a digital input on your robot's microcontroller. Pulse the trigger (Trig) pin high for at least 10us (microseconds) and then wait for a high level on the echo (Echo) pin. The amount of time the Echo pin stays high corresponds to the distance that the ultrasonic sound has travelled. The quicker the response, the closer your robot is to an obstacle.

H. Obstacle detection

Sensors to detect other vehicles or obstacles can include radar, video, infrared, ultrasonic or other technologies. Automatic braking by the system after sensing an obstacle can be executed in two modes. In collision avoidance, the collision is avoided by the automatic braking, but the driver will not be warned in this type of system. There is a very good chance of wrongly interpreting the signals, especially in the case of radars or lasers. So this is not so effective method of automatic braking.In collision mitigation system, the sensors detects the possibility of collision but will not take immediate action. A warning will be sent to the driver in the form of a signal or a voice message. There is a threshold safe distance calculated by the system and if the driver fails to respond even when the vehicle crosses that region, then only brakes will be applied automatically. Even if there is a mis-interpretation of signals, there is no problem because, the decision to apply brakes is left with the driver and the brakes are applied automatically only in the most emergency situations. Many vehicles are provided with the option of turning on or off the automatic system based on their surroundings. In some automobiles even though they cannot be completely disabled, they can be limited to warning the driver about coming obstacle.

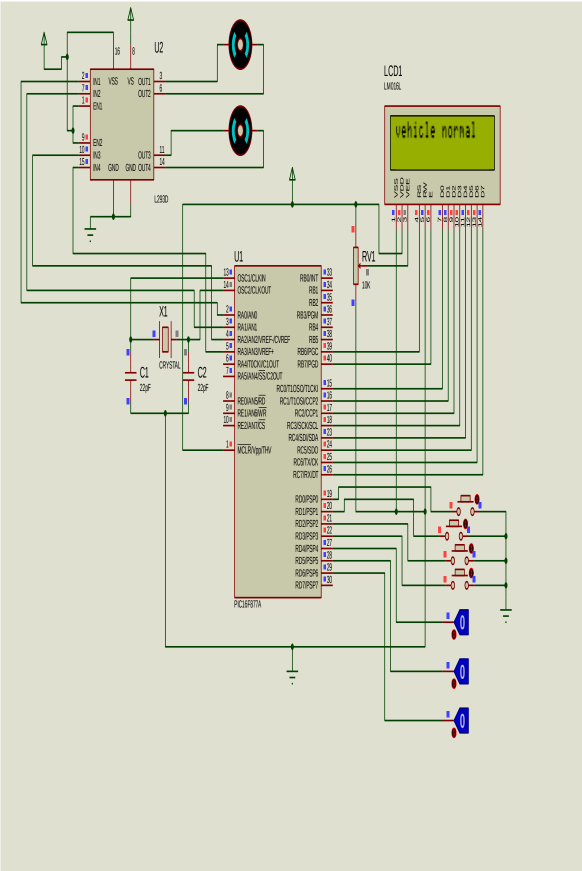
I. Engine Control Unit:

An engine control unit (ECU), now called the power train control module (PCM),is a type of electronic control unit that controls a series of actuators on an internal combustion engine to ensure optimal engine performance. It does this by reading values from a multitude of sensors within the engine bay, interpreting the data using multidimensional performance maps (called lookup tables), and adjusting the engine actuators accordingly.

J. L293D –Dc Motor Driver IC

We start with the L293D. L293D is a popular motor driving IC. It is a 16 pin IC. The IC has 8 pins on both the sides. It has 2 enable pins, 1 VSS pin, 1 VS pin, 4 ground pins, 4 input pins and 4 output pins. Though not required here, but in case you wish to learn how to interface L293D with a microcontroller. the enable pins, when are given true, (i.e. 1) then they enable the respective part of the IC. The enable 1 chip enables the Left part of the IC for inputs and outputs, and so does the Enable 2 does to the right part of the IC.

III. SIMULATION RESULT



IV. CONCLUTION

In proposed method, The ADAS based vehicle systems are used to identify the different obstacle, friction variation, and steering movement. The vehicle speeds are controlled by using the different type sensor to detect the above three case. The experimental results show that, when applied to a free-rolling tire, the proposed method detects friction change from dry asphalt to iced road while the vehicle travels at constant speed without braking, accelerating, or cornering. And we used the ultrasonic sensor to detect the objects in front of the vehicles if any object found suddenly the vehicle can stop. Finally In this project, Engine control unit is used to control the speed of the vehicle when it is passed on the any deviation are present in roadway. The experimental result and simulation results are verified by using mp lab and proteus software.

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