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Simulation of Corner Skidding Control System

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***Abstract*—*Traction control system in automotive applications increases the stability and safety of vehicles. There are various types of vehicle control systems employed in internal combustion engine vehicles. The application of control system to motorcycles (two wheelers) is not so widely used as that of four wheelers, because of high cost of the control system. If one moves at high speed in motorcycles at the corners, the centripetal force exceeds the frictional force. At that time lower amount of traction effort occurs in between the tire and road and hence high amount of skidding will occur in the motorcycles. The proposed control system design helps the rider in maintaining a secure of the motorcycle in bend. Geometry parameters such as rolling angle and steering angle of the bike are taken into consideration. The centripetal force and frictional force can be measured using the sensors by interfacing it with the Lab VIEW software. The simulation of the control system design has been carried out and the values for the skidding condition are obtained.*

Keywords*— Traction control system, frictional force, centripetal force, Rolling angle, Steering angle, Simulation.

I. INTRODUCTION

Traction control is a widely used in automotive applications in order to increase stability and safety of vehicles. Well known vehicle control systems such as Anti Slip Regulation (ASR), Electronic Stability Program (ESP) and Antilock Brake System (ABS) are used in IC engine vehicles. This type of Traction control prevents the vehicle from skidding occurrence when accelerating over a wet or loose surface, by reducing engine output, so that the vehicle can move without skidding, and produces the maximum stability while cornering especially in wet roads. Critical conditions in riding a motorcycle is the rearing up in bend. The corner skidding control system design should be measuring the centripetal force and frictional force by using the sensors. Then those values should be compared with the theoretical values. The simulation of the control system design has been carried out using Lab VIEW software and the values for the skidding condition are obtained. **FarukKececi et al (2009)**developed an adaptive vehicle skid control concept (control algorithms). Dynamic equations of an electric vehicle are formulated and the effect of the road friction coeffcient has been studied. The study has been carried out by two cases.

i) When the information of road condition is not available, the roundedness of the velocity and position error are proved.

ii) The controller performance is examined when the road condition is measured (but the friction coeffcients of road are assumed not to be known).

The simulation of adaptive vehicle skid control has been done. The Simulation results has shown the effectiveness of the controller schemes.

II. LITERATURE SURVEY

Jae - Bok Song et al (1999) studied over the improvement in acceleration performance, stability and steerability on slippery roads using slip control systems has been carried out. This paper mainly deals with the engine control algorithm via adjustment of the engine throttle angle. The vehicle tests have been carried out on low friction roads to verify the control algorithm. From the test results, it is found that the controlled vehicle has more performance in acceleration and stability than the non- controlled vehicle.

Jose Mayora et al (2009) investigated about the 'Pavement–tire friction' provides the grip which is required for maintaining vehicle control and for stopping in an emergency situations. Crash frequencies on dry and wet pavement were analysed using two methods. They are

1. Cross-sectional analysis and
2. Before–after analysis.

From the above analysis it is found that both wet- and dry-pavement crash rates present a decreasing trend as skid resistance values increase. Also the Wet-pavement crash rates were found to be significantly higher in curves than in tangents. Pavement friction improvement schemes were found to result in significant reductions in wet-pavement crash rates. This research confirmed the importance of maintaining adequate levels of pavement friction to safeguard traffic safety and thepotential of pavement friction improvement schemes to achieve significant reductions in wet-pavement crash rates .

Pascal Cardinale et al (2009) adapted a new algorithm and its hardware implementation of traction control for supermotard or motocross has been implemented. In this

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study the torque applied to the rear wheel can be controlled by reducing the gasoline injected closing through the butterfly valve or reducing the electrical current to the sparking plug. The proposed system modifies the sparking scheme inserting an switch in addition, parallel to the manual turn off switch. This switch simply bypasses to ground the electrical current flows in the sparking coil. This switch is controlled by a microcontroller on the basis of the output of some additional sensors.

Patrick Seiniger et al (2012) studied over corner braking and brake steer torque problems during real corner braking.This study describes the potential of stability control systems to help save motorcyclists lives. It summarizes safety research conducted and commissioned by the Federal Highway Research Institute (Bundesanstalt fur Strasenwesen, BASt) during the last twenty years, with particular focus on the state of the art in motorcycle control systems. In order to eliminate the problems arising from the BST effect, four different approaches are presented.

1. Reducing the brake force
2. Reducing the offset between steering axis and tire contact patch
3. Adapting the steering damper characteristics
4. Providing an active counter steer torque.

III. METHODOLOGY

The control system architecture has been designed based on the various results obtained through the theories related for skidding condition. The Conditions for Skidding are derived as follows

Frictional force = μ (mg)

For skidding,

Centripetal force > frictional force

$(mv^2/r)>\mu$

$[\mu=mg]$

$(v^2/ rg) > \mu$

But $(v^2/ rg) = \tan\theta$

$\tan\theta > \mu$

When the tangent of the angle of banking is greater than co-efficient of friction, skidding occurs.

Overall condition for skidding,

$(v^2/ rg) > \tan\theta$

Where,

V - velocity of vehicle in m/s

r - radius of the track in m

θ -angle of inclination of vehicle with reference from vertical

Based on the above conditions, the design has been made using various sensors and microcontrollers. If the skidding condition occurs, then the fuel flow rate will reduced so that the torque can be reduced to avoid skidding. The working procedure of the proposed model and the overall design of the system is shown in “Fig. 1”. The microcontroller is interfaced with various sensors and it is programmed based on skidding conditions. The various valves to control the fuel flow rate are interface with microcontroller. The controller architecture of the proposed system is shown in “Fig. 2”.

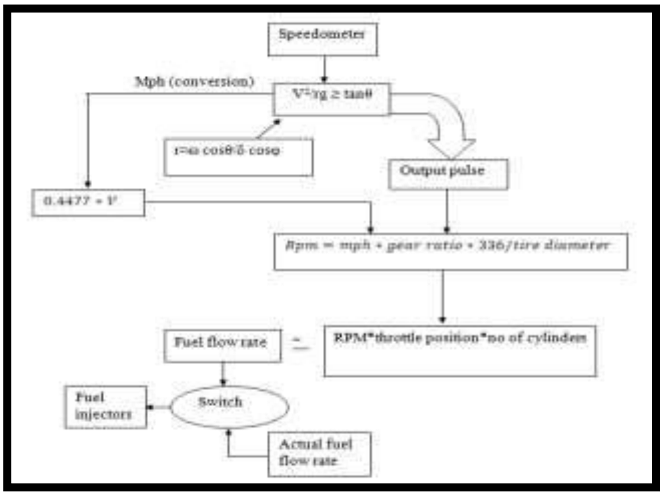

Fig. 1: Working procedure of the proposed model

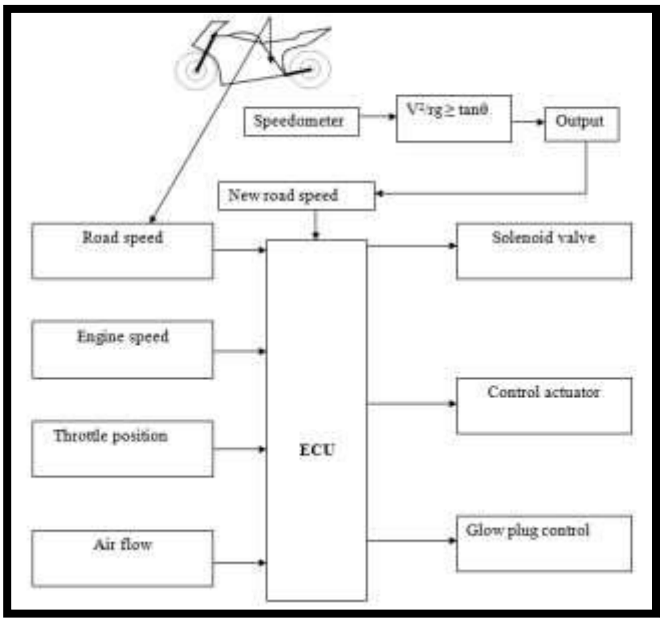

Fig. 2: Controller Architecture

The various sensors to measure speed, steering angle and bend angle are interfaced with microcontroller to get input values. The microcontroller will be programmed based on skidding conditions. The architecture of the sensor-microcontroller interfacing is shown in “Fig.3”.

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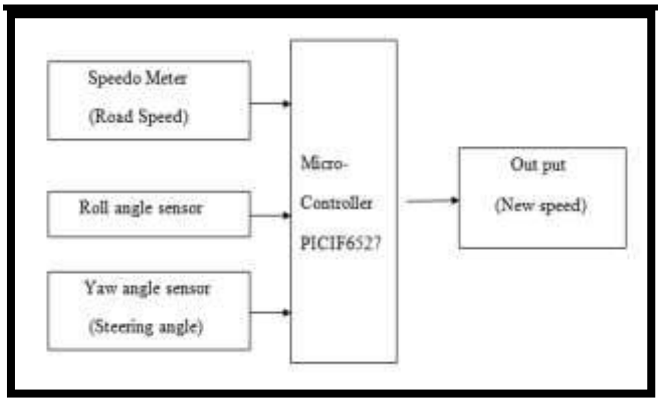

Fig. 3: Architecture of the sensor- microcontroller interfacing

IV. SELECTION OF SENSORS

The sensors are used for measuring the various input values. The roll angle sensors are used for measuring the rolling angle of the two wheeler, the rotary potentiometer is used for measuring the steering angle of the two wheeler and reflective infrared sensor (RPM sensor) are used for measuring the speed of the rollers. These sensors will give the input voltages to the microcontroller.

4.1. Roll Angle Sensor

This sensor is used for measuring the inclination angle of the bike. When the bike is inclined or bends, this sensor should be generating the voltages for the corresponding angles of bend. The Roll angle sensor is shown in "Fig 4".

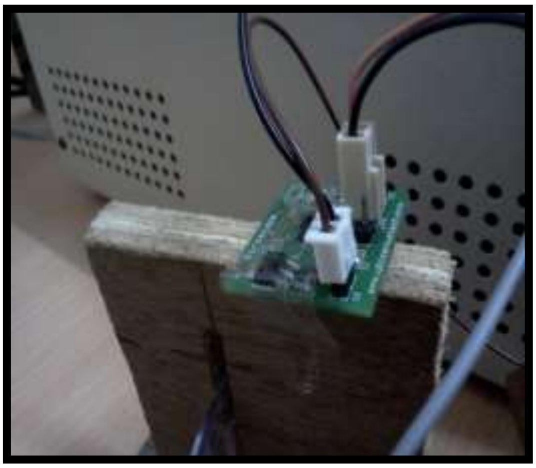

Fig.4: Roll Angle Sensor

4.2. Rotary Potentiometer

A Potentiometer is a device that can be used to convert a linear or angular displacement into a voltage. The potentiometer has an input shaft to which a wiper is attached. It is shown in "Fig 5". The displacement is applied to the input shaft when the shaft moves, the wiper contact slides over the resistance material. Hence the voltage is generated.

Fig.5: Rotary Potentiometer

4.3. Reflective Infrared Sensor (Rpm Sensor)

The behaviour of sensor shown in Fig. can be used to generate a pulse train that can then be converted into a measurement of RPM by counting the number of pulses that occur during a known time interval.

Fig.6: Reflective Infrared Sensors

V. SENSORS ANALYSIS

Laboratory Virtual Instrumentation Engineering Workbench (Lab VIEW) is a platform from National Instruments. It contains comprehensive set of tools for acquiring, displaying, analyzing and storing data.

5.1. Lab VIEW - Sensor Interfacing

Here the sensors are interfaced with Lab VIEW as shown in "Fig 7" to find the response of the roll angle sensor.

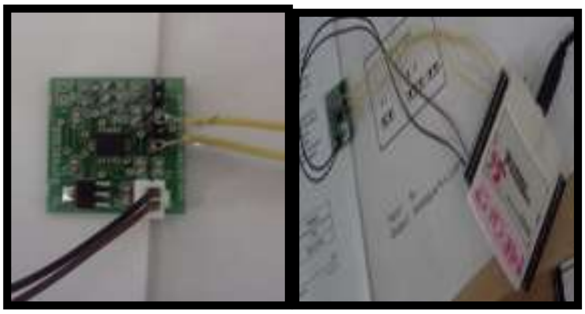

Fig.7: Sensors Interfacing with the DAQ Card

5.2. Procedure of Lab VIEW Program

1. Open Lab VIEW.
2. The 'Front Panel' and 'Block Diagram Panel' appear.
3. Create DAQ assistant from the function palette.
4. Configure DAQ. Select input > DAQ assistant.
5. Select the appropriate channel through which you have connected the wires (ai0, ai1) and click 'Next'.
6. In the next dialog box, select voltage range as 0 – 5 V, Terminal configurations > RSE and acquisition mode > N samples.
7. Create the program starting from DAQ assistant and create while loop.
8. Select the graph indicators and chart from the control palette.
9. Create another chart in a similar fashion to display the displacement waveform. Name one chart in a similar fashion to display the displacement waveform.
10. Also Click control palette > Numerical indicators > numerical indicator to display voltage or displacement as digital indicator.

Execute the program by clicking run button and get the output. The developed program and the results obtained in the display are shown in "Fig. 8"

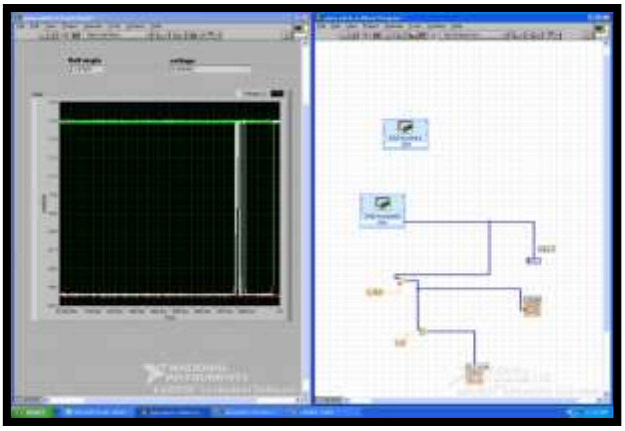

Fig. 8: Lab VIEW Diagram

5.3. Angle Calibration of Rotary Potentiometer

On interfacing with Lab VIEW, the result of Rotary Potentiometer can be obtained as
Turning of 1 degree = output voltage is 0.67 mV/sec

Fig. 9: Rotary Potentiometer

Fig. 9.1: Rotary Potentiometer connected with multimeter

Rotary potentiometer shown in "Fig .9.1" gives the following voltages for the particular angles. We have taken those values by using the multimeter. The Potentiometer calibration has been shown in Table.1

Table.1: Potentiometer Angle Calibration

S. No	Angle (degree)	Voltage (volts)
1	1	0.018
2	10	0.18
3	45	0.81
4	60	1.08
5	90	1.66
S. No	**Angle (degree)**	**Voltage (volts)**
6	135	2.43
7	180	3.33
8	225	4.16
9	270	5

VI. MODEL INTERFACING WITH Lab VIEW

6.1. Basic Idea of Model Interfacing With Lab VIEW

The model with three input values is interfaced and the condition for skidding has been manipulated. The block diagram for the Lab VIEW simulation is shown in "Fig. 10".

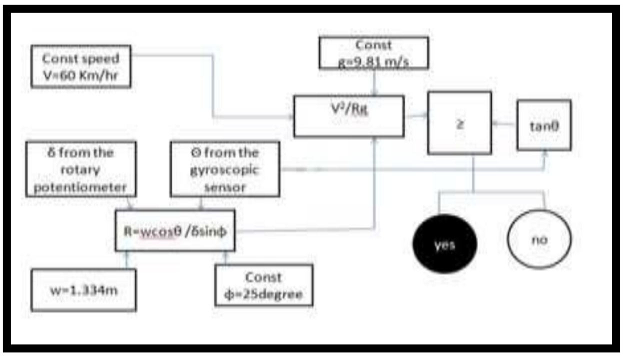

Fig. 10: Block diagram of Model Simulation

6.2. Lab VIEW - Model Interfacing

The model is interfaced with Lab VIEW to achieve the skidding condition of the model. The experimental setup for the Simulation is shown in "Fig. 11".

Fig.11: Lab VIEW - Model Interfacing

6.3. Lab VIEW Program

The Program has been developed in the Lab VIEW software to find out the skidding condition. The developed program with sensors interfacing is shown in "Fig 12".

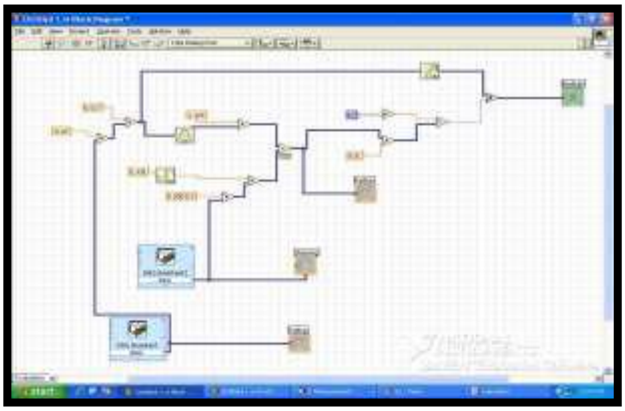

Fig.12: Lab VIEW Program

VII. RESULTS & DISCUSSIONS

7.1. THEORETICAL SKIDDING CONDITION VALUES

The theoretical values are compared with the simulation results. Three parameters such as velocity, radius and inclination angle are independent to each other. The theoretical condition for simulation model is taken as follows.

$V = 60$ km/hr

$R = 50$ m

Condition $V^2/Rg \geq \tan\theta$

So, θ=30.4 degree

The skidding condition values of the two wheelers for corresponding angles and velocity are tabulated.

Table.2: Skidding Condition Parameter Values (Theoretical)

S. No	Velocity (km/hr)	Radius (m)	Angle (degree)
1	54	35	33.22
2	80	50	45.18
3	85	60	43.07
4	90	50	51.87
5	60	50	30.04
6	36	10	45.54
7	45	30	29.96

In this simulation model the speed of the vehicle should be constant. The radius of the curvature has been attained by four parameters. Those parameters are Wheel base, caster angle, steering angle, inclination angle. The skidding condition has been attained at the following values.

Speed (V) = 60 km/hr
Caster angle (φ) = 25 degree
Wheel base (w) = 1.334m
Inclination angle (θ) = 29.92 degree
Steering angle (δ) = 97.4 degree

VIII. CONCLUSION

The control system architecture has been developed with sensors of low cost and the Lab VIEW simulation has been carried on the model. The values for the skidding condition are obtained. Results were compared with the theoretical values and it is found that the simulation results coexist with the theoretical results. This work can be further developed by conducting an experiment using proposed model in a two wheeler.

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REFERENCES

[1] Farukkececi, Gang Tao (2006) "*Adaptive Vehicle Skid Control*" Mechatronics, Vol. 16, pp. 291–301.
[2] Jae-Bok Song, Byong- Cheolkim, Dong- Chul Shin (1999) "*Development of traction control system slip control logic based on engine throttle control*" KSME International Journal, Vol. 13, pp.74-81.
[3] Jose M.PardilloMayora, Rafael Jurado Pi (2009)'Na "*An assessment of the skid resistance effect on traffic safety under wet pavement conditions*" Accident Analysis and Prevention, Vol. 41, pp. 881–886.
[4] Pascal Carotinale, CamilloD'Angello and Massimoconti (2009) "*The traction control system for motor cycles"* EURASIP Journal on Embedded Systems, Article ID 161373.
[5] Patrick Seiniger, A.KaiSchroter (2012) "*Perspectives for motor cycle stability control systems*" Accident Analysis and Prevention, Vol. 44, pp. 74– 81.
[6] S S Rattan (2005), "Theory of Machines" The McGraw Hill Corporation, second edition, pp. 699-710.