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Design and Fabrication of Pedal Force Monitoring and Control In Bi-Cycle

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***Abstract**: In this system, we proposed the cycling speed is not same in linear road and ramp road. The requirement of force is higher in ramp road than the linear. In the linear road force applied in pedal and speed according to the force is measured and these values are stored in datasheet. In the ramp road the force applied in pedal is measured and speed is measured and compared with the values in measured in linear road. The difference in the speed taken as a controller input. The output of the controller is fed to the electric motor. The controller gives a signal whenever the speed is not same in the linear and ramp road. The electric motor drives the wheel to attain a speed for the same force applied as in ramp and in linear road.*
Keyword: linear and ramp, force, controller

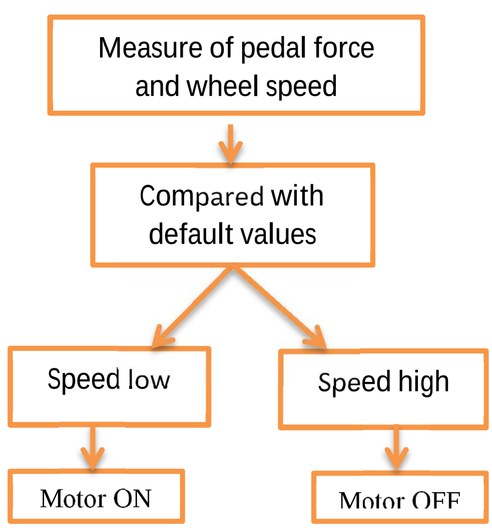
I. INTRODUCTION

The cyclist is applied the vertical force to the pedal. The force in the pedal is known as pedalling force. Pedal force is the ratio of force perpendicular to the crank and the total force applied to the pedal. Force that applied by cyclist to the pedal is to find the torque that produced in the cycle. Torque is defined as the product of the crank length and the driving force that applied by cyclist to the pedal. Most studies measuring pedal forces have been restricted to one leg but a few studies have reported two-sided unevenness in pedal forces. Pedal force effectiveness is increased at higher power output and reduced at higher pedalling strokes. Changes in load position resulted in uncertain effects in pedal force effectiveness, while lowering the upper body reduced pedal force effectiveness. Cycling experience and fatigue had unclear effects on pedal force effectiveness. There is two types of force can be formed during pedalling the cycle is Radial Force and
Tangential Force. The Total force is the sum of all the forces that act upon an object.

In this method, we used the load cell and Hall Effect sensor. The load cell is used to find the force that applied by cyclist to pedal. Hall Effect sensor is used to measure the rotation of the wheel by using the value that measured from the cycle to find the torque that generated in the cycle during in the linear and ramp road by comparing the value which are already stored in datasheet. From the
datasheet, the additional amount power is calculated that is given to the electric motor to drive the cycle in the ramp road.

II. METHODOLOGY

A. Flow Char



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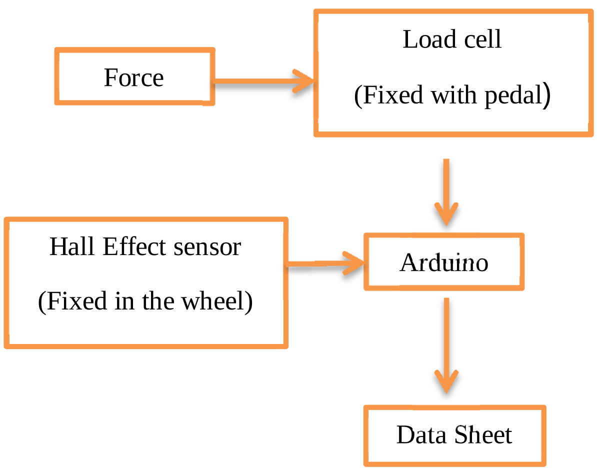
From the flow chart, we clearly explain the process that done in project. First, we want to measure the both value of pedal force and the wheel speed. Pedal force calculated from the load cell and wheel speed is calculated from the hall effect sensor. When the cyclist applied the force to pedal through the leg. The force transmitted to cause the wheel rotation. The wheel rotation value is calculated through the Hall Effect sensor. The valve acquired from the process is compared with the default values. If the speed of the wheel is high compared to the default value that need to turn off the motor. If the speed of the wheel is low compared to the default value the motor need to turn on to maintain the constant speed in cycle. The value that taken from the process is pedal force and speed of the wheel is stored in micro SD storage module. From the compared value of speed of the cycle in linear and ramp position is sent to the controller to take the necessary action to take place in which already programmed.

III. EXPERIMENTAL SETUP

A. Block Diagram



When the force applied to the pedal, the pedal is mounted with the load cell at both sides of the pedal which cause rotation of the wheel, the rotation value is calculated from Hall Effect sensor. Both the value is stored in Micro SD card. From the card, stored value is transferred into the datasheet.

B. Components Used

1) *Load cell:* A load cell usually consists of four strain gauges in a Wheatstone bridge configuration. The force is determined according to the resistance variation in strain gauge. The load cell is mounted on a pedal in both sides of the cycle. One end of the load cell is fixed and the other end is free. The output of the load cell is fed to the arduino after the amplification.
2) *HX711 Module:* A HX711 module is amplifier circuit it is used to receive an output signal from the load cell. Because, the output voltage of the load cell is in milli volts. For further processing in ardunio the output signal must be amplified.
3) *Effect Sensor:* Hall Effect sensor is transducer that generates the output voltage with respect to change in magnetic field. Hall Effect sensor is used to measure the linear velocity (or) speed of the cycle. The Hall Effect sensor is fixed at the front wheel of the cycle. The magnet is fixed at the spoke of the wheel. RPM is calculated by the ratio of number of counts to time taken to count. Linear velocity is calculated from the RPM.
4) *Micro SD storage module:* Micro SD storage module is the device used to store the data from the load cell and Hall Effect sensor. From the stored value, torque is calculated from the cycle.
5) *Arduino:* Arduino Uno is a microcontroller board based on the ATmega328P. It acquires data from the load cell and Hall Effect sensor for the further calculation of force, torque applied in the pedal and speed of the cycle.

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Fig 3.Experimental Setup

IV. RESULTS AND DISCUSSION

From, the Fig 3 shows the experimental setup of the process. We need to find the torque that generated in the cycle during the pedalling is the ultimate aim of the process. During the cycling we concluded that the force that applied at the both end of the pedal is not uniform there is minimum deviation of the force that applied in the pedal. We need to find the force during the cycling, but the load cell gives the value in terms of weight. so, we need to take the weight at initially after the value acquired in the data sheet the weight is convert into force. We find that the maximum weight applied to the pedal in the linear road in the one side of the pedal is w_1=15.01kg and the other side of the pedal is w_2=15.23kg and the maximum weight applied to the one end of the pedal is w_1=24.01kg and the other end of the pedal is w_2=24.13kg in the ramp road. At initially, only the maximum weight is applied to the pedal. The above reading is taken at initially. The force that applied during the cycling is low when compared to initially.so the torque that developed during the cycling is very low compared to initial. Formula that used to calculate the torque is shown below.

A. Torque = (force * linear velocity) / angular velocity (Nm)
B. Speed = linear velocity *(18/5) (Km/hrs.)
C. Force = measured from sensor on the pedal(N)
D. Linear velocity = (3.14*d*n)/60 (m/s)

Where, d = diameter of wheel (metre)
n = RPM= no. Of counts / time taken to count

From the above value, we calculated the torque that developed at the different angle of rotation of the pedal in the cycle. For linear velocity, the diameter of the wheel (d) =0.66m and the time taken to completed the one rotation of the wheel is 3s.therefore, the RPM generated in the cycle is 20.

In ramp road, the torque value is calculated the value is shown in the below table. The torque value calculated at the angle of 90 degree

SI.NO	Weight(kg)	Force(N)	Max.Torque(Nm)
1.	24.01	235.54	77.73
2.	24.13	236.72	78.12

Table 4.1 Torque calculation in ramp road

In linear road, the torque value is calculated the value is shown in the below table. The torque value calculated at the angle of 90 degree.

SI.NO	Weight(kg)	Force(N)	Max. Torque(Nm)
1.	15.01	147.25	48.59
2.	15.23	149.41	49.31

Table 4.2 Torque calculation in linear road

For the same the same weight, the torque is calculated at the different angles of the pedal in cycling for both linear and the ramp road.

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Degree	0	30	45	60	90
Torque	0	38.86	54.97	67.31	77.73

Table 4.3 Torque calculation at weight of 24.01kg

Degree	0	30	45	60	90
Torque	0	39.06	55.24	67.65	78.12

Table 4.4 Torque calculation at weight of 24.13kg

Degree	0	30	45	60	90
Torque	0	24.29	34.5	42.08	48.59

Table 4.5 Torque calculation at weight of 15.01kg

Degree	0	30	45	60	90
Torque	0	24.65	34.86	42.7	49.31

Table 4.6 Torque calculation at weight of 15.23kg

V. CONCLUSION

From the calculation, that we concluded the torque generated in the linear road is low when compared to the torque that generated in the ramp road. Therefore, more amount of force is required to pedal the cycle in the ramp road compared to linear road.by comparing the torque that generated the difference is given to the controller and the controller take the necessary action to drive the electric motor to give additional amount of energy for drive the cycle in ramp road.

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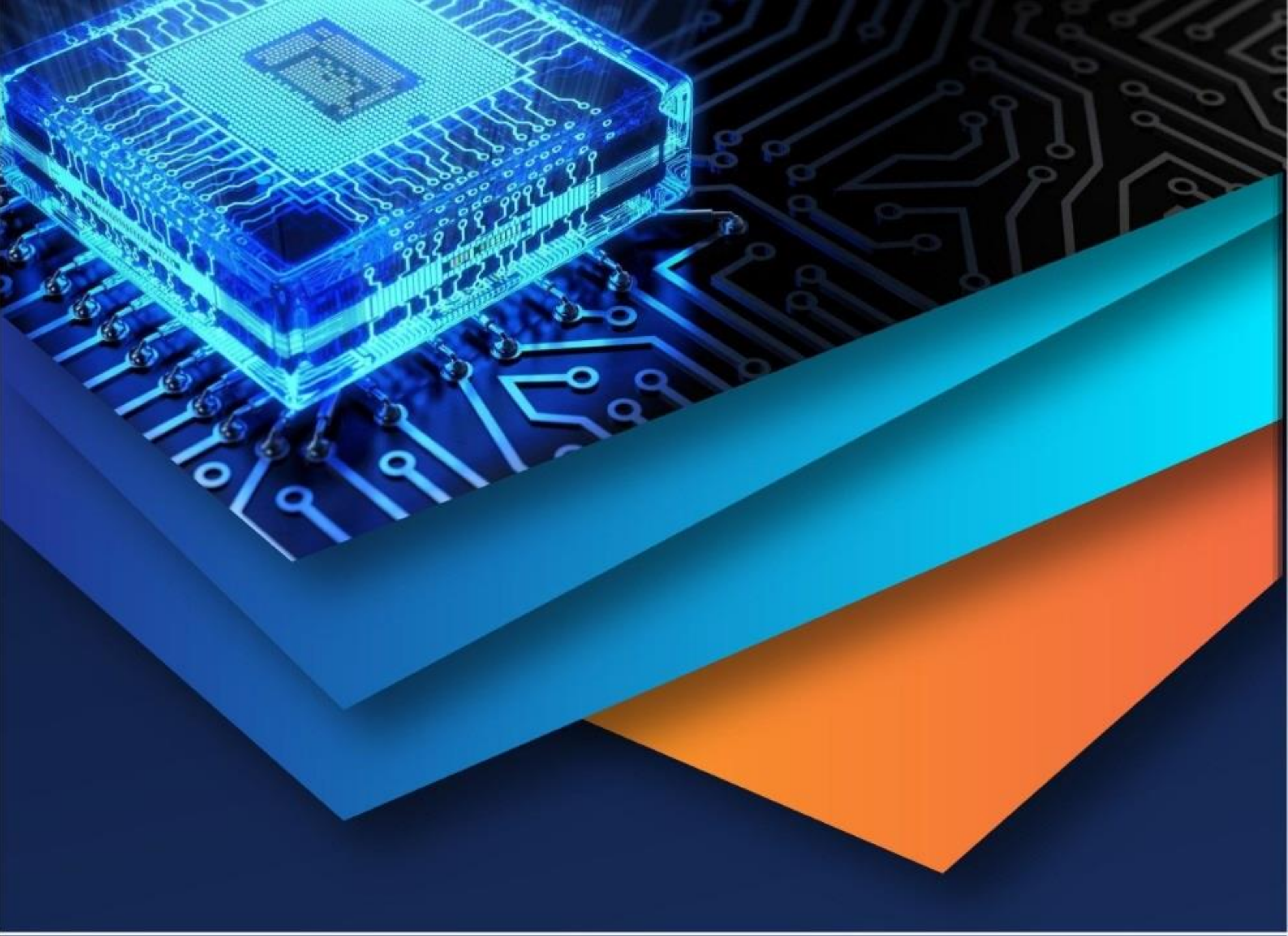

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