AUTOMATIVE TRANSMISSIONS FOR ADAPTING DIGITAL DISPLAY TECHNOLOGY

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Abstract: Digitizing the system and process to get in line with the era 4.0 has become a paramount situation demand effort in the direction. This paper focuses on digitizing the automotive transmission parameters for the comfort and safety of drivers. In this paper, the fabrication and the experimental validation of the device are explained. The approach is highly focused on increasing the accuracy of the parameters like torque, RPM by keeping the design as compact as possible.

Index Terms- Automotive transmission, digitalization, IR sensors, Load cells, Vibration Sensors, induction motor.

I. INTRODUCTION

In this era of automobile industry digitizing has become a very common phenomenon. Nowadays many automotive transmission parameters are digitized which are helpful for drivers. The common parameters which can be seen in cars nowadays are speed, R.P.M, fuel indicator, etc. But besides all that some more automotive transmission parameters can be added to the display to make driving more safe and smooth. The parameters like torque, clutch engage-disengage like automotive parameters can be added to display to make the driver and comfortable to drive smooth.
In the paper, an electronic system capable of displaying various technical parameters of an automotive transmission is designed and fabricated separately on the gearbox. This will help in viewing the live status of gear position, R.P.M, torque, etc. The setup can be used in OEMs for providing additional features in the higher segment. And also the set-up provided would be useful for performing experiments and researches related to the optimization of transmission parameters and some results of the experiment performed on the set-up are also given in the paper.

There are much progress has been made in the development of automotive transmission over the past 18 years, like as increase the no of speed, gear ratio, torque, and fuel economy and efficiency. Here 5-speed transmission is used simple refers to the gearbox. It is the arrangement of the gear which provides controlled application of the power and speed. In motor vehicles, the transmission generally is connected to the engine crankshaft, via a clutch or flywheel. In modern gearbox are used to increase torque and reducing the speed at the output shaft. It means the input shaft of the gearbox rotates faster than the output shaft of the gearbox. In the case of several gear ratios, the gearbox is used to increase the torque of the output shaft and reducing the speed of the output shaft.[1]

Internal combustion engines have been used around for about 140 years in that time, have become fully versed in all their humans. Nowadays highly accurate motor is used at a place of the combustion engine. In the electric vehicle, 3-phase, 6-pole AC internal permanent Magnet motor is used that produces around 258 HP or 192 KW and 317 IB torque. In the present time in an electric vehicle the motor speed will also be improved and range roughly.1200-1800 RPM. But researches are developing a motor that can reach around 30000RPM, with benefits of the small and lighter motor.

Here, there are different types of the automatic transmission are used in the automobile.

- Traditional automatic transmission, also torque convertor automatic.
- Automated-manual transmission
- Dual-clutch transmission
- DSG (Direct Shift Gearbox)
- Tiptronic transmission

Regarding this technology some literature are studied as given below:

1. In the study performed by K.W.E CHENG in 2016. This paper provides an overview of the recent work in modern electric vehicles and its component such as the battery, anti-lock braking (abs) skid steering, etc. in this study first discuss the energy storage.[1]

2. In the study performed by Naseer Hashem Nia Behzad Asaei in 2017. In the study there are different type of electric motor are discussed that are used for electric vehicle purpose like as, induction permanent magnet synchronous, induction motor, etc. the induction motor is the best motor for the electric vehicles application because they are robust and less coastally and also have less pollution and generate comparatively mote power. [2]

3. In the study performed by R.J Drago it all in 2009. According to this study when gearbox use in application where connection load carries high inertia the starting torque transmission by the gearbox is higher. Then the rated load of the prime mover. This paper is analysis about the issue of the start-up loading and its effects on the performance of the gearbox.[3]

4. This study is performed by Hemant Mehta in 2019. According to this study electrical vehicle are controlled by an electric motor. This study provides electric vehicles makers an extensive variety of various electric motor browse according to their necessity. In this paper the author refers to induction for a parting to the electrical vehicle because it has moiré torque, power and efficiency as compare to other motor.[4]

   The introduced work on automotive transmission is widely explained and experimental verification of that work has been done in this paper.

II. RESEARCH METHODOLOGY

1. Experimental set-up –

The experimental set-up used is a 3-phase induction motor of 45 kW. The induction motor used has a max R.P.M of 2000 and torque of 214 Nm. The operating voltage of the induction motor is 440 V. The working of the motor is quite stable and constant. This type of induction motor is generally used in electric vehicles nowadays.

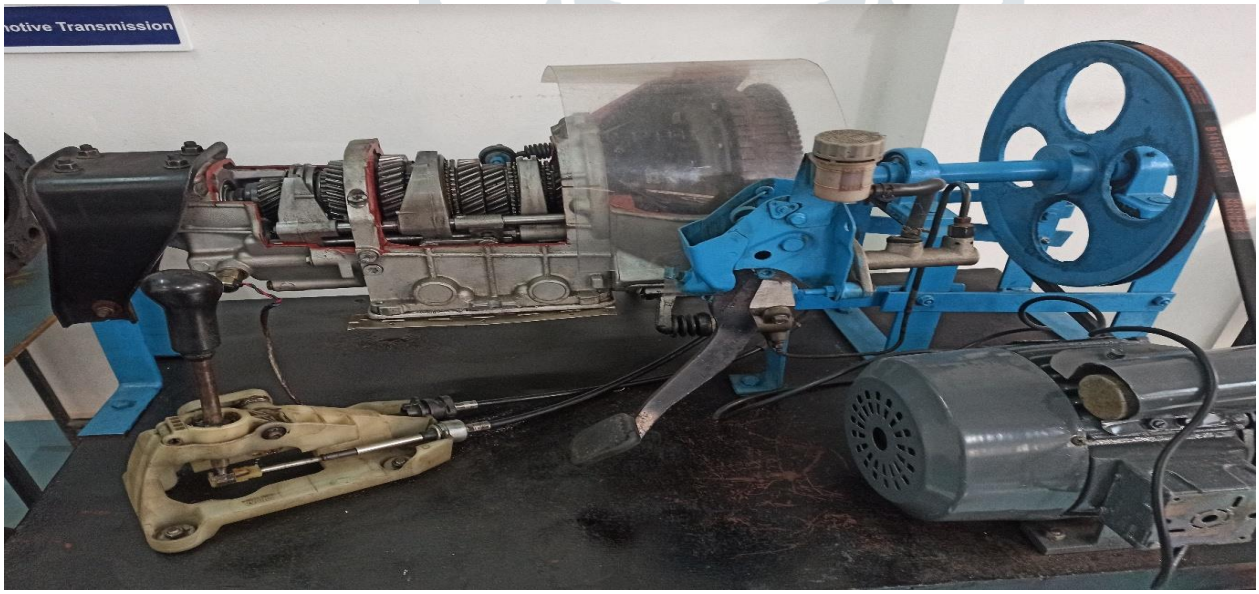

Fig-1 picture of experimental setup

In fig (1) the transmission box shown is used for the experimental validation of the device manufactured.

2. Fabrication of device –

The fabrication of digital display is a combination of many sensors and a group of sensors to get a common output. The sensors which are mainly used here are I.R proximity sensor, Load cell, and vibration sensor. The measures the parameters of gearbox like R.P.M, torque, gear position (1st, 2nd, 3rd... gear), clutch engage/disengage, and vibration of meshing gears in the gearbox.

2.1 For R.P.M Measurement

The R.P.M at the output is measured using the I.R proximity sensor. It uses the I.R waves to determine the number of rotations per minute of wheels. The flow chart for R.P.M measurement is shown in fig (2) here, the I.R waves are used to count the number of obstacles detected per minute which is the revolution per minute.

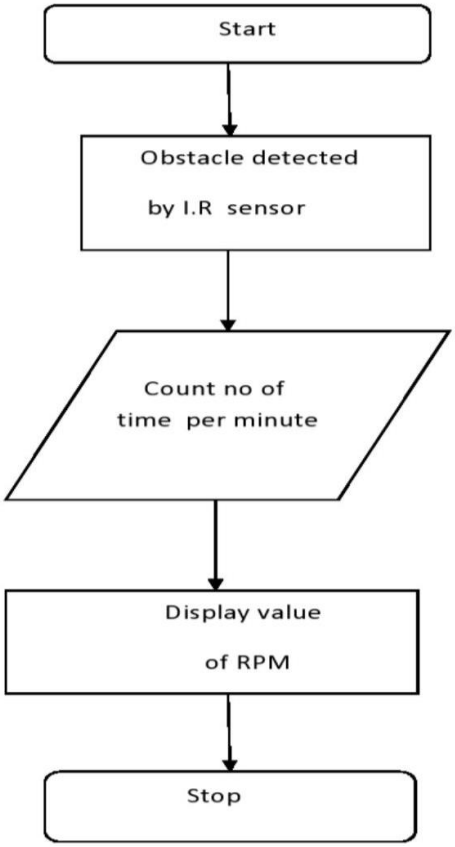

Fig-2-working of RPM measurement

The circuit diagram for the connections of the I.R sensor with the circuit board at the input and output shaft of the gearbox is presented in the diagram shown in fig. (3).

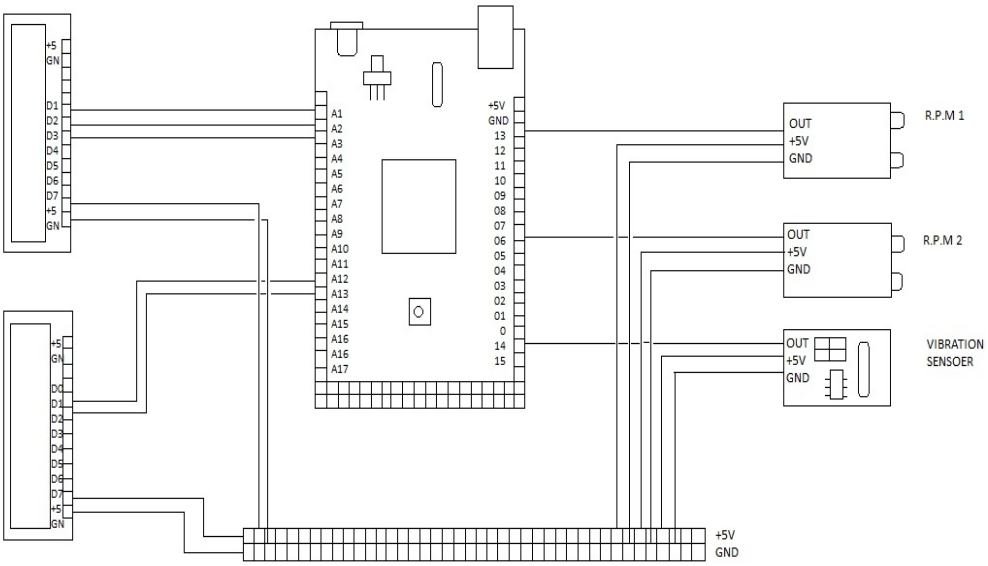

Fig-3 circuit diagram for RPM and vibration measurement

2.2 Vibration measurement

The meshing of gear produces noise and vibration and vibration during gear transmission. These vibrations can damage the gears in the long run. So, proper measuring and servicing of that can save the gears from being distorted.
For vibration measurement, the Vibration sensor is used and mounted on the gearbox. The flow chart for the working of the vibration sensor is shown in fig. (4).

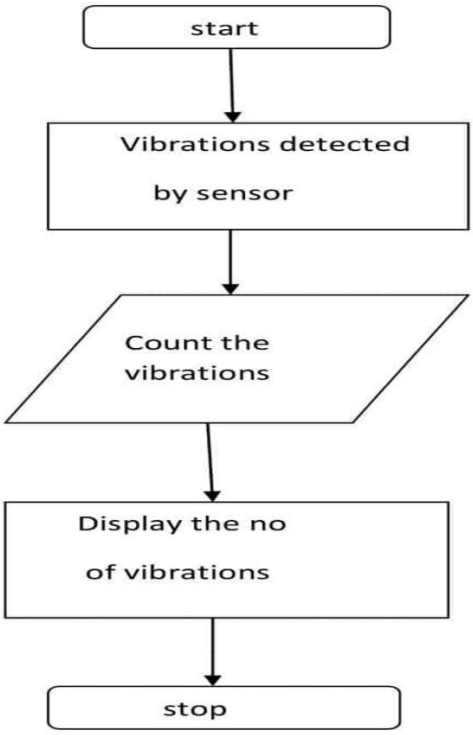

Fig-4 working of vibration sensor

In this way, the vibration of meshing gears is counted and the circuit design of the sensor is shown in fig. (3).

2.3 Gear position indicator

The gear position indicator is a mechanism or a combination of four I.R sensors used to determine in which gear the automobile moving. For measuring that all four I.R sensors are placed in front of gear selectors of the gearbox. There are two gear selectors and the four I.R sensors are placed two in front of each. The working procedure and matrix of the mechanism are shown in the flow chart in fig. (5).

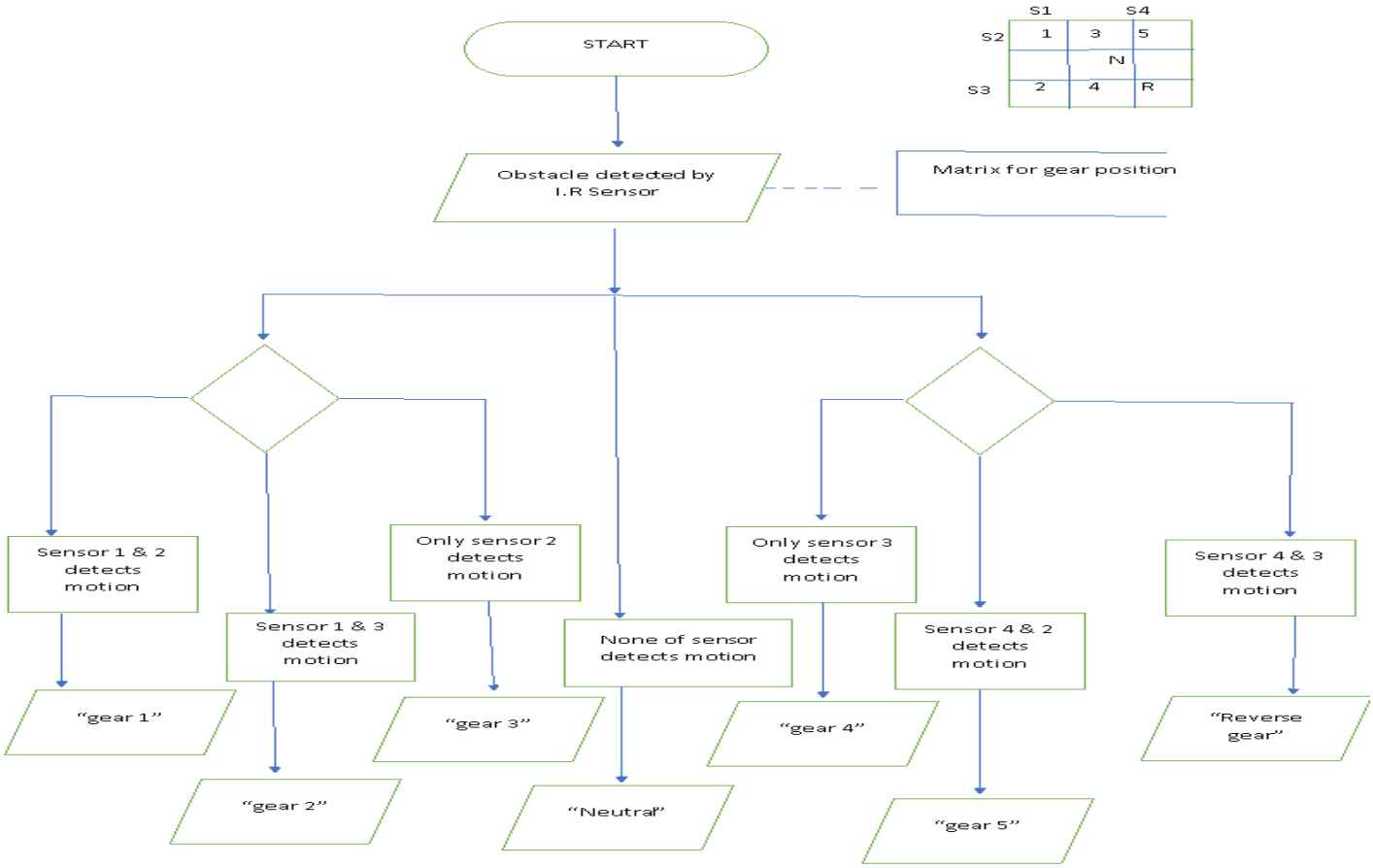

Fig-5 working of gear position mechanism

This matrix used in the determination of present gear of automobiles with the help of the I.R sensor. In which two I.R sensors are placed on the first selector and two on the second one. So, the given combination of sensors works as when sensor 1 and 2 detects the motion of gear selectors it shows gear 1 on display when sensor 1 and 3 detects motion it shows gear 2 when only sensor 2 detects motion it shows gear 3 when only sensor 3 detects motion it shows gear 4 when sensors 4 and 2 detects motion it shows gear 5, when sensor 4 and 3 detects motion it shows Reverse gear and when none of the sensors detects the motion of gear selectors it shows Neutral. This is how the combination of four I.R sensors is used to determine the present gear of the vehicle. The circuit design for four I.R sensors is shown in fig. (6).

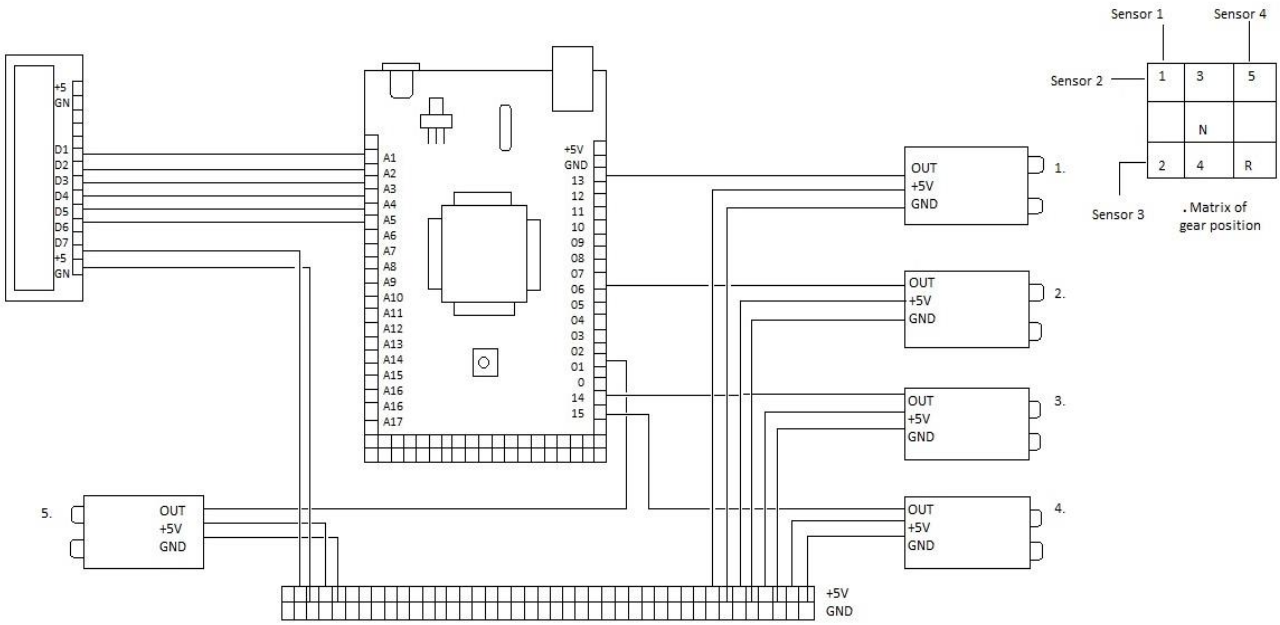

Fig-6 circuit diagram for gear position and clutch engage/disengage mechanism

- 1,2,3,4 – I.R sensors to be placed in front of gear selectors for gear position.
- 5 – I.R sensor for determination of engagement and disengagement of clutch.

2.4 Determination of engagement and disengagement of clutch

The mechanism consists of the I.R sensor for the determination of either the clutch is engaged or disengages in gear transmission. As it is known if the gear is changed without the disengagement of clutch then it can damage the clutch plates. So, to avoid that it is necessary to change gear only when the clutch is disengaged with transmission and by displaying it on screen the driver gets proper information when to shift gears. The flow chart for the working of the I.R sensor is shown in fig. (7).

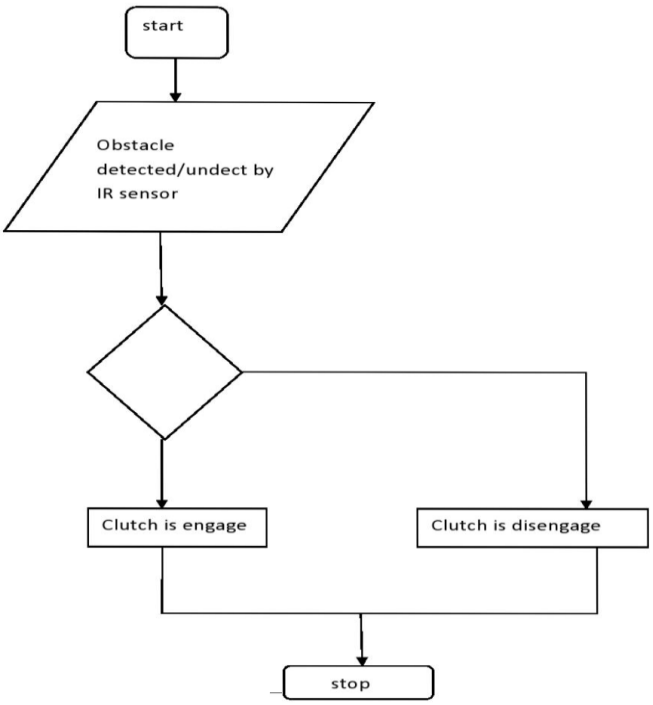

Fig-7 Working of clutch engage/disengage mechanism

The I.R sensor is mounted below the lever that connects the clutch paddle with the transmission. When the clutch is pressed the I.R sensor detects motion in the lever and displays clutch is disengaged and when its paddle is released it does not detect motion and displays clutch is engaged. The circuit diagram for the fabrication of the device is shown in fig. (6).

2.5 Torque measurement

Torque is an important parameter in automobiles especially during the starting of the vehicle or when the vehicle is at elevation. So, determining the torque and displaying it will help the driver in a safe and comfortable drive. The value of torque is obtained using the load cell with a mechanism of the rod which is connected to the output shaft of the gearbox. So, when the shaft starts rotating it impacts a force on the load cell which is determined by the load cell and the microcontroller displays that value by multiplying with the perpendicular distance of the rod which touches the load cell and the value of torque is displayed on the screen. The flow chart for the working mechanism is shown in fig. (8).

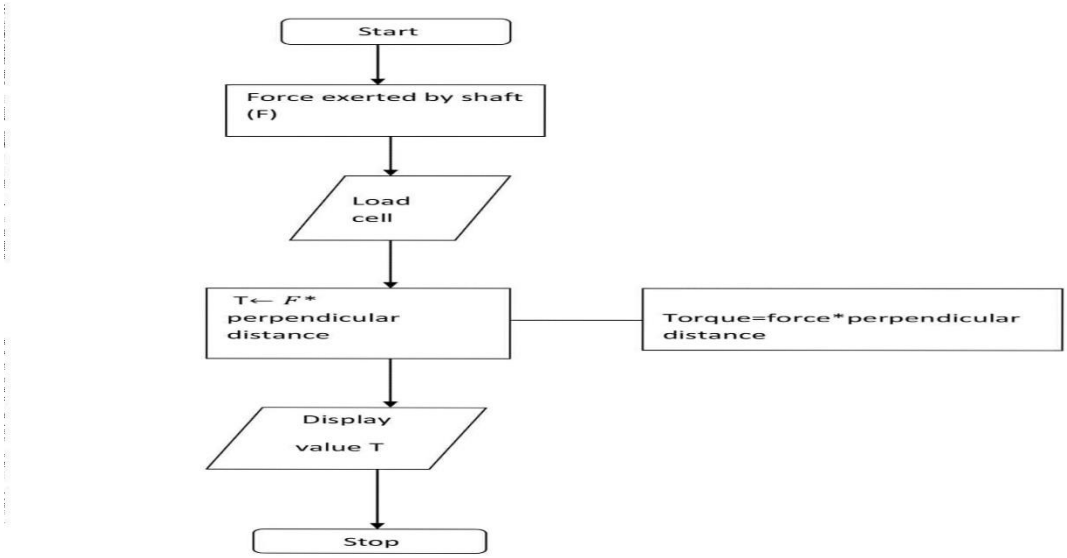

Fig-8 working of torque measurement

That's how the whole mechanism works. The connections of the load cell with the circuit are shown in the circuit diagram in fig. (9).

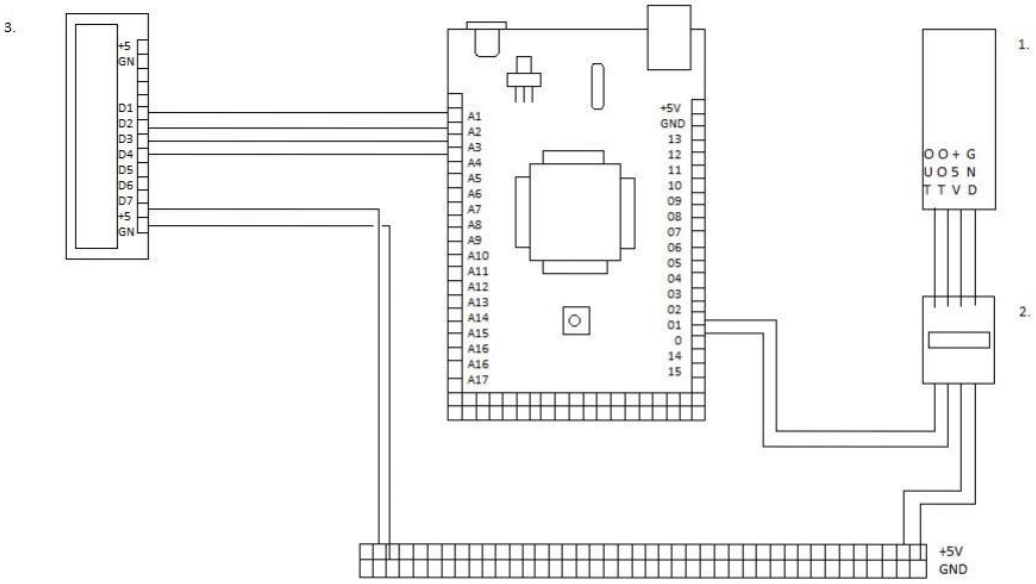

Fig-9 circuit diagram for torque measurement

- 1- Load cell sensor
- 2- Amplifier
- 3- Display

3. Experimental procedure

For experimental validation of the device manufactured firstly the data of R.P.M and torque is measured using the device and to verify that the R.P.M is measured using a tachometer in the laboratory. The data of both Devices and tachometer are identical at the same time. Similarly, the torque of the output shaft is measured using the device first and then the data is now verified by prony brake physically and data of both the device and prony brake at identical at particular R.PM. This shows the device gives the accurate value of R.P.M and torque.

The value of torque and R.P.M is measured for gear 1,2,3,4 and 5 at different R.P.M and the value of torque recorded for that particular R.P.M. The data obtained by the device are given below.

1. For 1st gear

Torque	210	260	380	275	200
R.P.M	900	1054	1140	1280	1310

Table-1

2. For 2nd gear

Torque	172	210	276	196	127
R.P.M	1080	1100	1224	1400	1459

Table-2

3. For 3rd gear

Torque	110	192	212	142	112
R.P.M	1148	1300	1372	1550	1592

Table-3

4. For 4th gear

Torque	68	126	156	136	82
R.P.M	1274	1400	1542	1640	1734

Table-4

5. For 5th gear

Torque	50	68	96	84	56
R.P.M	1367	1500	1669	1782	1900

Table-5

As from the above table 1, 2,3,4,5 the values of the torque recorded five times for every gear and the graph is plotted for obtained data.

III. RESULTS

Based on data taken from device as shown in table (1, 2, 3, 4, and 5) the graph is plotted as shown in (fig-10)

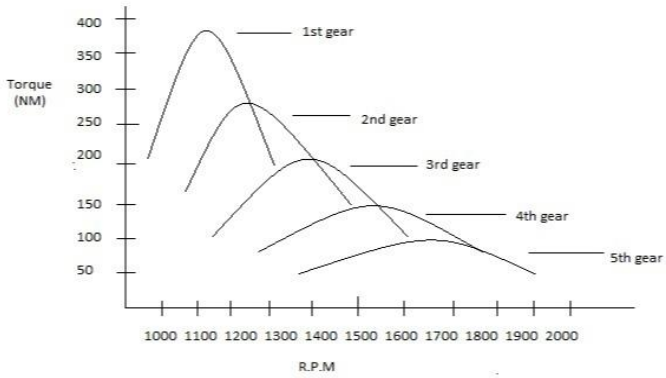

Fig-10 graph plotted on the basis of data of obtained from device

The graph plotted based on data from table (1, 2, 3, 4, 5,) is identical to the graph plotted by Roungui Zhang in 2016 [5] shown in fig (11) for motor of same configuration

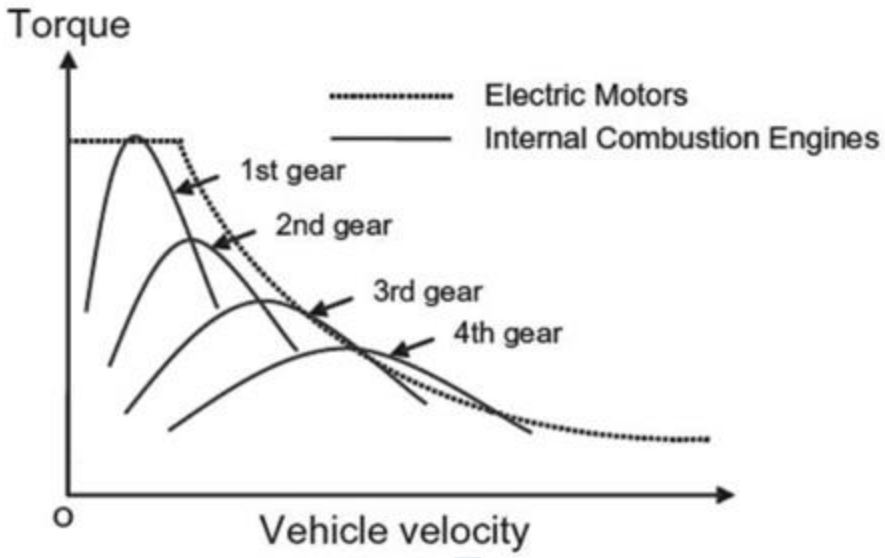

Fig-11 graph plotted by Ronghui Zhang in his study[5]

By comparing both of graphs it is obtained that the accuracy of value gained by the device is 98-99%
It shows the manufactured device gives 6 parameters of automotive transmission with accuracy in compact design.

IV. CONCLUSION

This device can be used in electrical vehicles for enhancing the accuracy of parameters necessary for driving. The device is compact so it can be easily installed on the type of automobile and the sensor used is also reliable which can work for some years without any defect. By using this type of device in the vehicle the safety and comfort of the driver and passengers also be increased. By providing this type of device in the automobiles the approach to words digitizing different automobile parameters will also be enhanced.

V. ACKNOWLEDGMENT

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