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Automatic Gear Shifting

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Abstract — *Gear shifting mechanism for transmission was designed to make motor bike rider's gear shifting very easy. Everyone desires for the smooth running of the vehicle whatsoever may be the speed of pickup of the vehicle a person is operating, but one of the most important system which every engineer is concerned about in vehicle is gear shifting system for ensuring smooth and desired ride on their two wheelers. Some simple mechanism are arranged with the solenoid and electrical circuit which actuates the gear itself. In this gear shifting mechanism, gear shifting is done with the help of two solenoid plungers. During this mechanism the clutch is operated by a electromagnetic (solenoid) which is controlled by the module feed in the microprocessor (Aurdino Uno).*

Keywords- *Automation, Gear Shifting, Automobile, Microprocessor, Solenoid.*

I. INTRODUCTION

Automotive technology has been developed in many areas, like ABS system, active steering system and other safety systems, which are implemented to increase the passenger safety and comfort. The development has concluded also the gearbox, which became much smoother and produces less noise. Gear shifting mechanism must be easy to use and workable, these demands are very important especially for physically challenged and special needs people. For some drivers, the gear shifting can cause some confusing at driving specially at critical situations. A crowded road on a hill or a sudden detour makes a lot of tension on the driver. So, our project is determined to give rider a hassle free ride.

Gasoline engines develop useful torque over a limited engine-speed range. To be able to use the available torque over the range of vehicle speed, gears are needed to reduce or increase the engine speed accordingly. The conventional manual transmission uses a driver-operated clutch, typically operated by a pedal or lever.

But in case of the motorcycles and some types of racing cars, it only allows the driver to select the next-higher or next-lower gear. This type of transmission is called a sequential manual transmission. Sequential transmissions are used in auto racing for their ability to make quick shifts.

All transmission designs had one goal in common- to make shifting easier. The driver gear shifting strategy influences significantly in the vehicle dynamic behavior, performance and fuel consumption because it changes the transmission system inertia and the engine speed. This effect becomes even more pronounced in performance or competition driving. The time during which the power delivery from the engine to the wheels is interrupted due to a gear change being actuated is referred to as the "shift time". More time a vehicle loses in completing gearshifts, greater is the final lap time.

Although vehicle mass, engine performance and traction still play a major role, typical vehicle acceleration is significantly limited by the time it takes to complete a gearshift. The time taken to complete a gearshift is dependent on the following parameters:

We aim for developing a very easy mechanism of an electromagnetic (solenoid) shift arrangement for a transmission with gear wheels arranged on a gear shift rotatable about an axis, which will make the motor bike riders gear shifting very easy. Everyone is desired for the smooth running of their vehicles, what so ever may be the speed of pickup of the vehicle a person is operating, but one of the most important system which every engineer concern about in vehicles is the gear shifting system for ensuring smooth and desired ride on their two wheelers.

Some simple mechanisms will be arranged with the electromagnet and will help us to change the gear as per the desired speed.

1. Time of driver's reaction
2. Time of clutch operation
3. Time of gearshift mechanism operation
4. Time based on gear box design.

Automated mechanical gearboxes are the logical choice for improving the shift time of a fixed-ratio gearbox. Integration of the clutching and the gear-shifting mechanisms seamlessly is the major advantage of this type of gearboxes. After the actuation command by the driver, the Gear Control Unit(GCU) cuts engine power(through ignition and fuel cut), disengages the clutch, actuates the gearshift mechanism and re-engages the clutch, all in a few hundredths of a second. Also, the shift rpm can be easily controlled and the drop in the engine rpm during a gear shift can be matched with the shift time to keep the engine in the maximum torque band at all times. Furthermore, an automated manual gearbox can control the "launch RPM" and can shift automatically for drag strip or acceleration events. Thus, the engine can be kept in the power band for virtually all of the time. An Automated gear-shifting mechanism can be quicker than the manual during an autocross, since the driver no longer needs to take care of the clutch or the throttle while shifting, allowing him to tackle the track more confidently and quickly.

II. CONSTRUCTION &WORKING

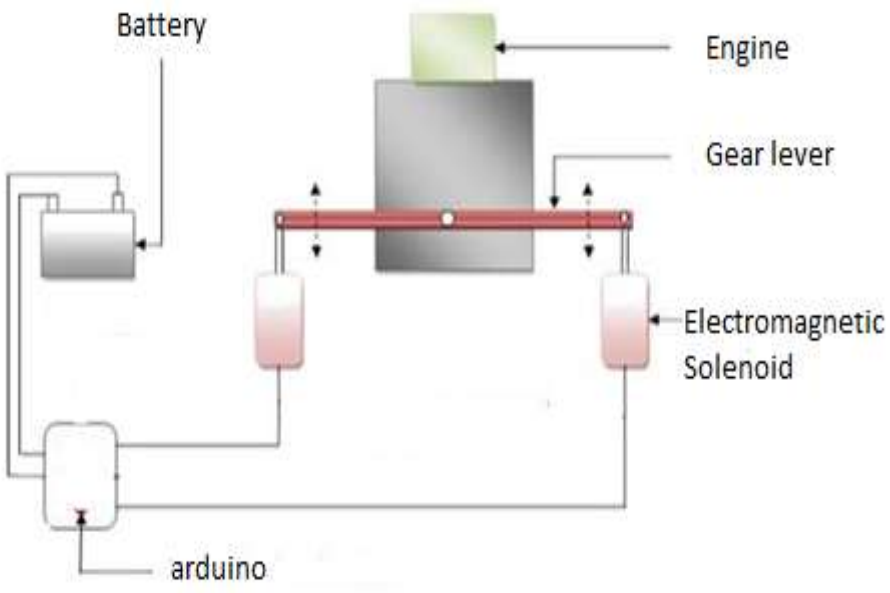


Figure 1.Construction Diagram

In this circuit, throttle is attached with the potentiometer. At starting the position of throttle is at zero and current in the potentiometer is low. As the throttle increases, current in potentiometer increase and the output of potentiometer is feed into the Arduino modulator board. It is programmed according the current of the potentiometer.

When the current increases, then Arduino board operates which in turn operates clutch lever and then clutch is engaged. This will give initial actuation for gear shifting from neutral to 1st gear.

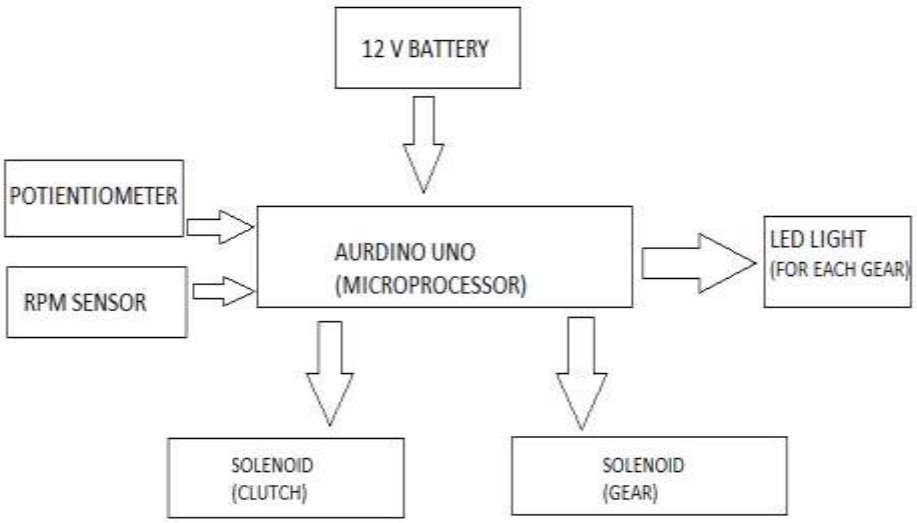


Figure 2. Working diagram

Rest of the gear is actuated automatically by sensing speed of rear wheel by RPM sensor. This rpm sensor sense then number of magnetic field and arduino will convert the rpm into speed. After achieving desired speed the arduino board will actuate the clutch and engages the solenoid for shifting gears. Same thing happens for down shifting. If aurdino sense the decrement in speed the arduino will actuates the solenoid for downshifting gear.

Total 8 Speed values has been feeded to the arduino. 4- for up shifting gear and 4- for downshifting gear. when the speed exceed to the value by 1 unit it will actuate the gear for proper riding.

III. COMPONENT DETAILS

3.1 Arduino

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (*shields*) and other circuits. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

Figure 3. Arduino UNO

3.2 Potentiometer

A Potentiometer is a three- terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor.

Figure 4. Potentiometer

3.3 Solenoid Plunger

Electromechanical solenoids consist of an electromagnetically inductive coil wound around a movable steel or iron slug called the armature, or plunger. Solenoid coils need more current only during actuation, called the pull in current, to pull the plunger into the solenoid. Solenoid coils operating with nominal current consistently raise the temperature in the coil due to higher power dissipation. Once the plunger movement is detected, the steady state current can be reduced to the hold current value to minimize the power dissipation in the solenoid. The detection of the plunger movement is required to ensure the proper operation of the valve, relays or contactors.

Figure 5. Solenoid Plunger

3.4 Hall Effect Sensor

The hall sensor measures the hall effect, which is a production of a voltage difference across an electrical conductor, transverse to an electric current in the conductor as well as a magnetic field perpendicular to the current. The output of the hall sensor switches low and turns on when a magnetic field perpendicular to the hall sensor exceeds the bop threshold and it switches high and turn on when the magnetic field disappears. And the comparator circuit that make the output signal more reliability

Figure 6. Hall Sensor

IV. CALCULATIONS

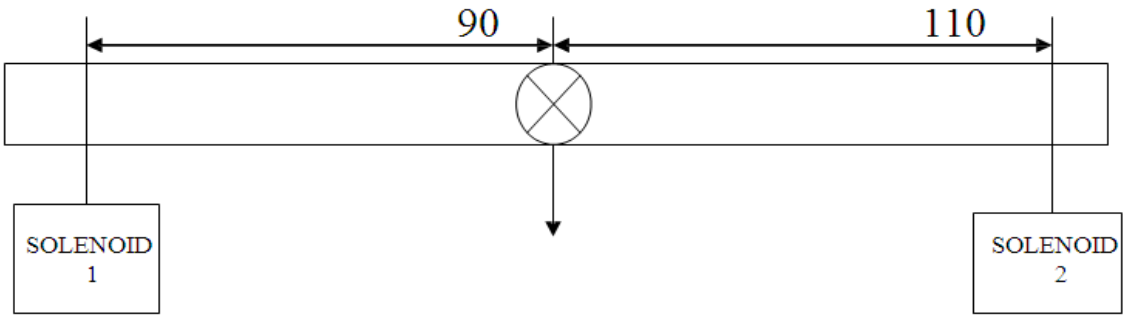


Figure 7. Gear Lever

FORCE REQUIRED FOR SHIFTING GEAR:-

Weight for upshift:- 0.9 Kg
Weight for downshift:- 0.92 Kg

FORCE FOR SHIFTING GEAR (UP):- .9* 9.81 = 8.82 N
FORCE FOR SHIFTING GEAR (DOWN) :- .92 * 9.81 = 9.02N

FORCE EXERTED BY SOLENOID = 11N

Therefore force required for shifting gear will be done by solenoid.

Gear Ratio Calculation:-

TABLE 1

[1] GEAR ENGAGEMENT	[2] INPUT GEAR [3] TEETH	[4] OUTPUT GEAR TEETH	[5] GEAR RATIO
[6] 1	[7] T_1= 11	[8] T_8= 34	[9] 3.09
[10] 2	[11] T_2= 17	[12] T_7= 29	[13] 1.70
[14] 3	[15] T_3=22	[16] T_6= 26	[17] 1.56
[18] 4	[19] T_4= 22	[20] T_5= 24	[21] 1.09

Now final drive ratio calculation
Number of teeth in GEARBOX output shaft sprocket =14
Number of teeth in wheel's sprocket = 44
Therefore final drive ratio= 3.14

So, final drive ratio for each gear is shown bellow :-

TABLE 2

GEAR ENGAGEMENT NUMBER	FINAL DRIVE RATIO
1	9.70
2	5.389
3	4.89
4	3.42

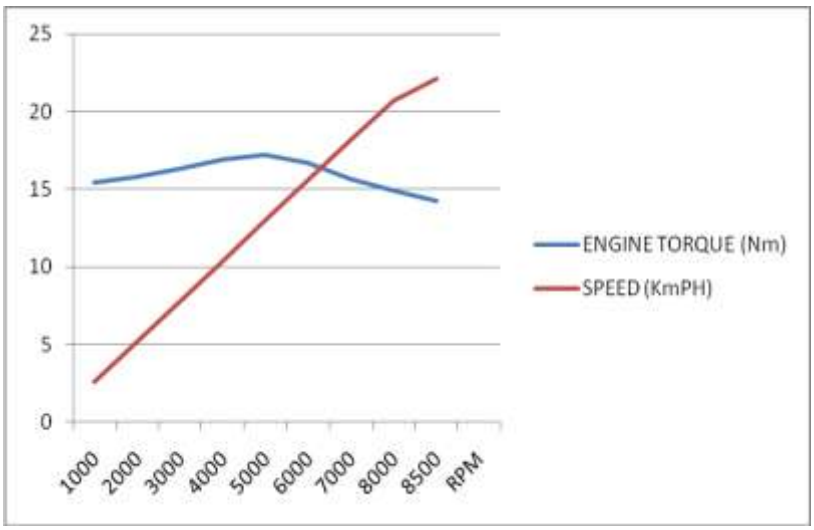
Torque Calculation:-
maximum engine torque = 7.2 Nm
Torque on wheel in each gear:-
(T_W= ENGINE TORQUE * FINAL DRIVE RATIO)

TABLE 3

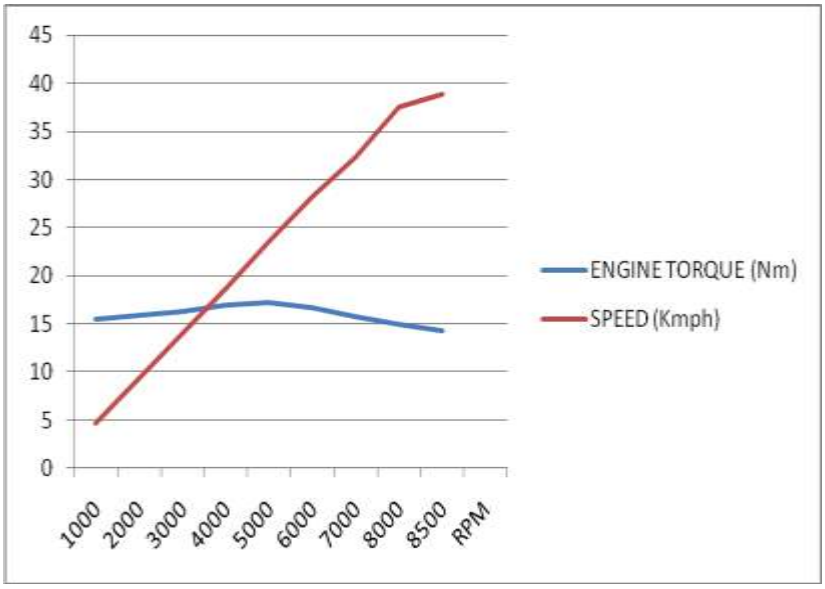
GEAR ENGAGEMENT NUMBER	TORQUE ON WHEEL (Nm)
1	69.06
2	38.36
3	34.81
4	24.35

Here we clearly see the maximum torque is required to drive the vehicle is 69.06 Nm and minimum torque is 24.35 Nm. Below graph represents Engine torque and Speed according to Rpm

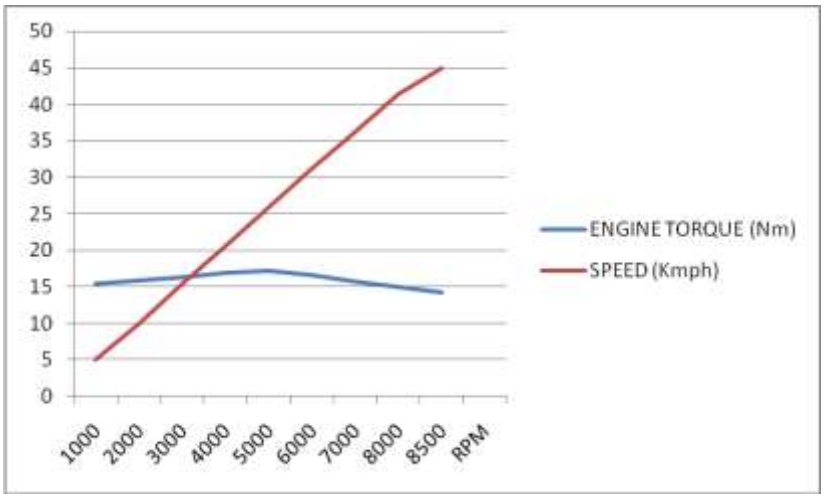
The below graph helps us to find the value of speed at which the microprocessor (Aurdino) needs to change the gear. The microprocessor is programmed by us in such a way that it will change the gear by a specific of speed . The value of speed is obtained by this graph so that the desired torque and speed can be achieved.



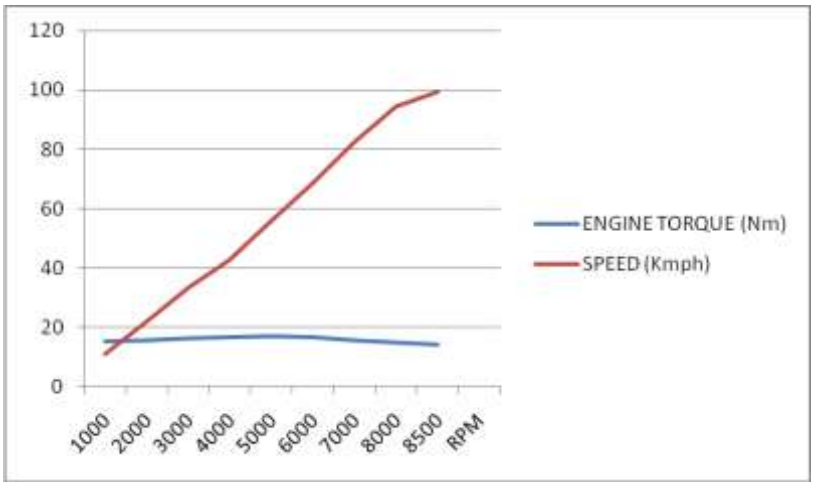
Graph 1- Engine torque vs vehicle speed graph for gear 1



Graph 2- Engine torque vs vehicle speed graph for gear 2



Graph 3 - Engine torque vs vehicle speed graph for gear 3



Graph 4 Engine torque vs vehicle speed graph for gear 4

Now Maximum speed of bike in each gear for shifting gear are shown below:-

TABLE 4

GEAR NUMBER	SPEED (KMPH)
1	15
2	28
3	36
4	45

The value of speed is obtained by above graphs. And this values are given to the microprocessor for seamless gear shifting so that no jerk and vibration are obtained during gear shifting.

V. ADVANTAGES

1. Seamless shift gearboxes.
2. The driver is not required to manually operate the clutch.
3. The driver is not required to lift off the accelerator when changing up through the gears.
4. The driver suffers from no loss of drive.
5. Fuel efficient.
6. Simple driving control.
7. Less fatigue to driver.
8. Noiseless gear shifting.
9. No shocks or jerky during driving.

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