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SWITCH OPERATED GEAR SHIFTING MECHANISM

Ram Bansal
Assistant Professor, Mechanical Engineering Department, Medi-Caps University, Indore

Idrees Rajgarhwala, Shivam Kanungo, Mufaddal Burhanpurwala, Yash Pathak
B.E. Research Scholar, Automobile Engineering, Medi-Caps University, Indore

ABSTRACT

In this project, we aim at developing easy gear shifting mechanism for transmission which will 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 is arranged with the servo motor and solenoid plunger which will help us to change the gear as per the desired torque.

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 servo motor which is controlled by the module feed in the Arduino Uno.

The upshifting and downshifting of gears is done with the help two independent switches. These two switches are connected to solenoid plungers via Arduino and mosfet. Arduino Uno is an electronic modulator board which is used to take input from switches and potentiometer and control servo motor and solenoid plungers.

Key words: Four stroke engine, gear box, Servo motor, Arduino UNO, Rotary Potentiometer, Solenoid Plunger

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1. INTRODUCTION

This project aims at developing a very easy mechanism of an electromagnetic 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. [3]

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.

Block Diagram

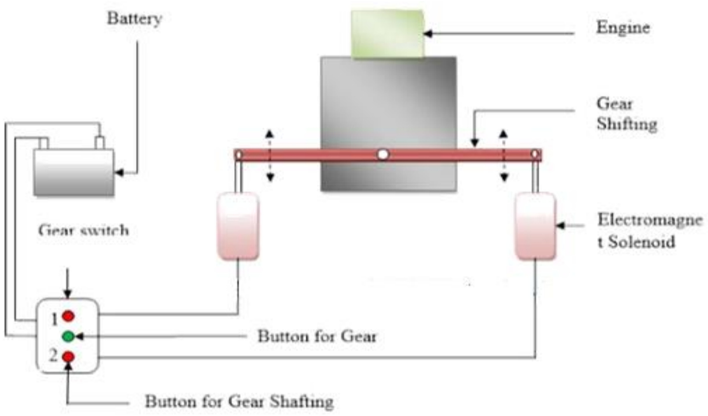

Figure 1 Model of button operated gear shifting mechanism

2. METHEDOLOGY

Button Operated Electromagnetic Gear Shifting System

When a gear shifting-up of an automatic transmission is to be effected, the load applied by the load device is increased, or the load is connected to an output rotation shaft of the engine via a selectively-connecting device, thereby reducing the rotational speed of the output rotation shaft of the engine to a required level. In this work, two electromagnetic coils are coupled to the gear rod of the two ends. The two buttons are used to activate the electro-magnetic coils so that the gear will be shifted.

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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. One of the difficulties in this situation is to choose the right reduction ratio and engaging it at the right time. [6]

Figure 2 Working model

Figure 3 Electromagnetic Coil

COMPONENTS USED

3.1. Engine & Gearbox

Table 1 Engine Specifications

Engine	Hero Honda Passion
No. of Cylinders	1
Capacity	97.2 cc
Max. Torque	8.05 N-m
Power	8.2 bhp

Table 2 Gear box Specifications

Transmission type	Manual
Gear box type	Sequential
Number of gears	4
Drive	Chain

3.2. Servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servo motors.

The motor is paired with some type of encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position.
Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

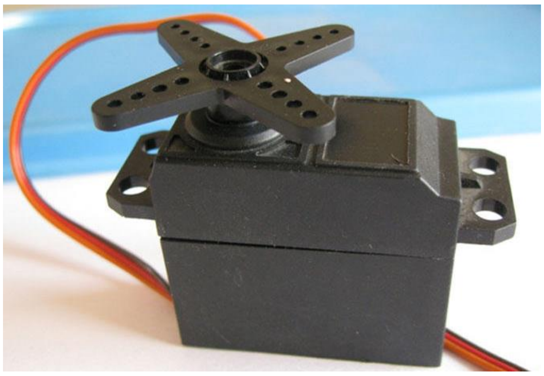

Figure 4 Servo motor

Table 3 Servo motor specifications

Operating voltage	5.0 V
Torque	1.8 N-m
Output angle	180˚
Operating speed	0.19 sec./ 60˚

3.3. 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 boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. 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 5 Arduino UNO

3.4. 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.

There are a number of terms in the electronics industry used to describe certain types of potentiometers:

- slide pot or slider pot: a potentiometer that is adjusted by sliding the wiper left or right (or up and down, depending on the installation), usually with a finger or thumb
- thumb pot or thumbwheel pot: a small rotating potentiometer meant to be adjusted infrequently by means of a small thumbwheel
- trimmer pot: a trimmer potentiometer typically meant to be adjusted once or infrequently for "fine-tuning" an electrical signal

Table 4 Potentiometer Specification

Type	Rotary
Electrical angle	170˚
Resistance	5kΩ
Applied voltage	<12V
Operating temperature	-55˚C to +125˚C
Shaft starting torque	60 gm-cm
Weight	38gm

Figure 6 Rotary Potentiometer

3.5. 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.

However once the solenoid is actuated, the solenoid coil needs approximately 30% of its nominal current, called the hold current, to keep the plunger in the same position. 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 7 Solenoid Plunger

WORKING

4.1. Working Circuit

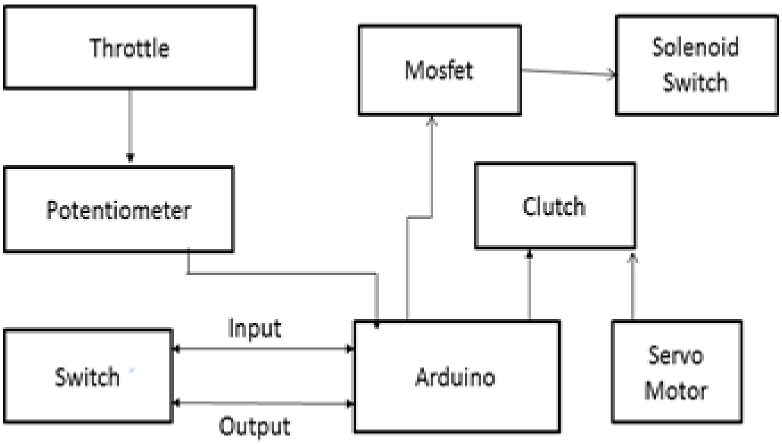

Figure 8 Working circuit

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 decreases, then Arduino board operates servo motor which in turn operates clutch lever and then clutch is disengaged. When the current increases, then Arduino board operates servo motor in reverse direction and then the clutch is engaged again.

Two switches for upward and downward shifting are also connected with Arduino modulator board. When the switch for upward gear is pressed then the Arduino passes the command to servo motor by which servo motor will rotate in forward direction and clutch disengages and when clutch got fully disengaged Arduino board will pass the command to mosfet through which solenoid actuates and gear will be shifted in forward direction. After the solenoid have actuated, Arduino board will again pass the command to servo motor to rotate in reverse direction so that clutch will get engaged again.

When the switch for downward gear is pressed, Arduino again passes the command to servo motor by which servo motor will rotate in forward direction and clutch disengages and when clutch got fully disengaged Arduino will pass the command to mosfet through which solenoid actuates and gear will be shifted in forward direction. After the solenoid have actuated, Arduino board will again pass the command to servo motor to rotate in reverse direction so that clutch will get engaged again.

CALCULATIONS

5.1. Force Exerted by Plunger

Relative permeability of air and coil: - 1

Current density in coil: - $1*10^6$ Amp. / m^2

Cross-sectional area of coil = Height * Width

$$= 0.04*0.011$$

$$= 4.4*10^{-4}\ m^2$$

Let,

Ampere turn density (ATD) = Current density (I)

Current density = $1*10^6$ A/m^2

Ampere turn (AT) = Ampere turn density*Area of coil = $1*10^6 * 4.4*10^{-4}$

$$=440$$

$$H_g = AT/g = 440/0.002$$

$$=2{,}20{,}000 \text{ Amp./Meter}$$

Where, g is air gap distance

$B_g = \mu_o * H_g = 4\pi * 10^{-7} * 220{,}000$

=0.276 Tesla

Force exerted on plunger

$$f_e = 0.5*(B_g/\mu_{o)*}A$$

Where, A is plunger cross sectional area

$$= \pi / 4 * d^2 = \pi / 4 * (0.025)^2$$

$$=4.9 * 10^{-4}\ m^2$$

$$f_e = 0.5 * (0.276 / 4\pi * 10^{-7}) * 4.9 * 10^{-4}$$

$$f_e = 54\ N$$

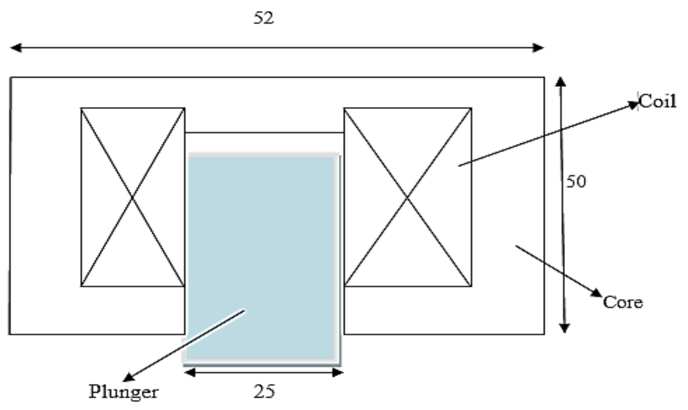

Figure 9 Solenoid Plunger

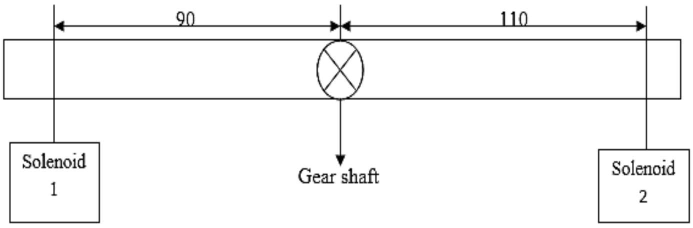

Figure 10 Solenoid Gear Shifting Mechanism

*All dimensions in mm
Torque on gear shaft
From front

= 54 * 0.09

= 4.86 Nm

From rear lever

=54 * 1.10

=5.94 Nm

5.2. Minimum Force on Selector Shaft

Minimum torque on gear shaft = 4.86 Nm
Length of lever attached to the other end of gear shaft = 45mm = 0.045 m
Lever of gear shaft applies force on selector shaft
Force at the end of lever = F_{lever} = Torque on gear shaft / Length of lever

$$F_{lever} = 4.86 / 0.045 = 108 \text{ N}$$

Thus, min. Force on selector shaft is 108N.

5.3. Torque Applied on Clutch Disengaging Shaft

Torque of motor = 1.5 Nm
Length of lever = 0.035 mm
Force on lever attached to motor =1.5/0.035 = 42.65 N
Length of lever attached to disengaging shaft = 40 mm = 0.04 m
Force on lever = 42.65 N
Torque on Shaft = 42.85 * 0.04 = 1.71 Nm

6. RESULTS

Table 5 Results

S. No.	Part Name	Size
1	Ampere turn	440
2	Force exerted on plunger	54 N
3	Torque on front end	4.86 Nm
4	Torque on rear end	5.94 Nm
5	Force at the end of lever	108 N
6	Force on lever attached to motor	42.65 N
7	Torque on shaft	1.71 Nm

ADVANTAGES

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

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