Clutch Operated Semi-Automatic Transmission in Motorcycles

Prashant L. Agrawal[1], Hardik M. Joshi[2], Aman N. Patel[3], Meet Suthar[4]
[1, 2, 3, 4]Department of Automobile Engineering
[1, 2, 3, 4] L.J.I.E.T

Abstract-*There are advantages and disadvantages of using either manual or automatic transmission in two wheelers. This paper is about how a semi-automatic transmission can eradicate the problems like fuel efficiency in automatic transmission and chaotic gear shifting in manual transmission. The semi-automatic transmission is controlled by using clutch so when the clutch is dis-engaged by the user the gear will be shifted to its best suitable position using micro controller, sensors and actuator. This mechanism can be installed to any motorcycle having a manual transmission with a shifting lever. This is a cheaper option to convert the manual transmission motorcycle to semi-automatic transmission and it can be also used by physically handicapped users.*

I. INTRODUCTION

The numbers of two-wheeler vehicles are increasing day by day due to their merits. Two-wheeler vehicles have many advantages like good fuel efficiency, transmission options, compactness and many more.

The two vital components of these vehicles are engine and transmission. But the fact is that people have to sacrifice the fuel efficiency because of the types of transmission they have to use. For example, any motorcycle with manual transmission system has a better fuel efficiency then a moped of same configuration that is equipped with an automatic transmission, So, this paper is about developing a mechanism with the help of which the users don't have to sacrifice the fuel efficiency of the vehicle due to automation. This mechanism can be added to a motorcycle with manual transmission. It will shift the gears with the help of sensors and actuators by the action of dis-engaging the clutch. So as the clutch is dis-engaged the actuator will shift the gears with the help of sensors and the microcontroller.

Manual transmission can be tiresome for commuters & difficult to get used to for learners. The problem with automatic transmission is that it decreases fuel efficiency. Hence we need a system that satisfies pros & eliminate cons of both these types of system.

Megacities suffer from huge traffic problems and users have to change the gear frequently during traffic. So, it is very chaotic situation which leads to be confusing and time consuming. So this mechanism eradicates the chaos during traffic and helps the user to change the gears automatically during traffic.

As the manual transmissions requires both the human hands and legs to be engaged during riding. The handicapped users have only one option left which is automatic transmission. As this mechanism, can be added to any conventional two-wheeler with manual transmission, this mechanism can be used by handicapped user and the can ride motorcycle too.

Automatic transmission occupies much space due to its components like centrifugal clutch and gear box. They are very heavy which increases the overall weight and cost of the vehicle. The overall efficiency of the CVT (continuous variable transmission) also changes with time because of slipping of the belt.

II. METHODOLOGY

This system is mainly dependent on sensors, microcontroller and actuator. But all the components which are necessary to provide semi-automation are listed below.

- Clutch position sensor
- Speed sensor
- Gear position sensor
- Microcontroller
- Relay
- Solenoid actuator
- Voltage Regulator

Clutch position sensor

The clutch position sensor is basically a type of switch. The clutch switch used in motorbikes is of the basic contact type connection circuit which works on 12V battery. The circuit is initially open, and whenever the clutch is pressed, the circuit gets completed. The clutch position sensor is shown below in figure 1.

Figure 1. Clutch position sensor

Speed sensor

This sensor is used to detect the instantaneous speed of the vehicle. The speed sensor detects the speed by converting the mechanical motion of the vehicle into electrical energy. This is done without direct contact when placed near a gear or shaft or other regular moving device. As the ferromagnetic material, i.e., gear teeth or flywheel or other target features pass by the tip of the sensor, the magnetic field gets disrupted. The amount of magnetic flux passing through the magnet, and henceforth the coil, varies too. Due to the flux varying with time, a voltage is induced in the coil. The output signal can be fed electronic circuit. The sensor provides an uncomplicated, accurate, reliable, inexpensive transducer for highly sophisticated control systems. There are different types of speed sensors used in different motorcycles but our aim is to get the instantaneous speed of the vehicle in digital form regardless of the type of sensor used. The speed sensor is mounted on the hub of the vehicle. Figure 2 shows the speed sensor:

Figure 2. Speed sensor

Gear position sensor

Gear sensor is similar in construction and working to the clutch switch it just differs at one place it has more than two contacts. It has total number of six contacts for six different gears from neutral to fifth respectively. So if third pin is in contact, then it is said to be in second gear.

Figure 3. Gear position sensor

Microcontroller

Arduino-Uno is an Open Source Hardware based on microcontroller dependent upon program which is written as per logics gates to execute different tasks under different conditions (inputs). Arduino works on two types of signals which are analog and digital. For some strictly 0 and 1 condition analog is used and for various number of inputs like from 0 to 120 digitals isused. Arduino works on microcontroller ATmega328p which has flash memory 8-bit, required and maximum working voltage is 5 V, a 16 MHz quartz crystal, 14 digital input/output pins from which 6 can be used as PWM pins, 6 analog pins along with a USB connection, a power jack and a reset button.

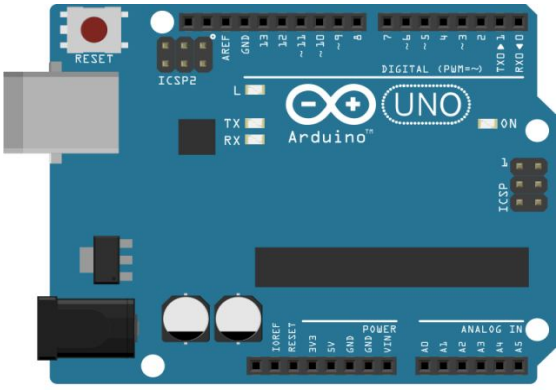

Figure 4. Arduino

Relay

Relay is an electromagnetic component which is used to control a circuit by low amount of power signal. Figure 4.1 shows relay.

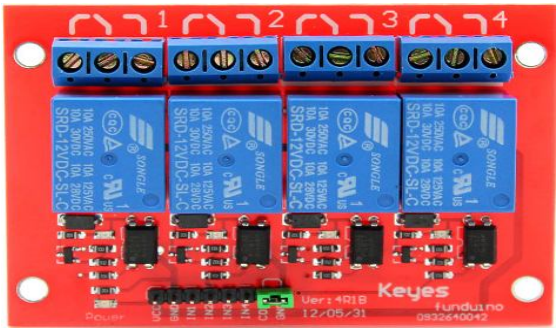

Figure 4.1. Relay

To actuate 12 V solenoid actuator by mean of 5 V Arduino output the required circuit is as shown in figure which contains module of four relay connected with actuator as shown in figure 4.2.

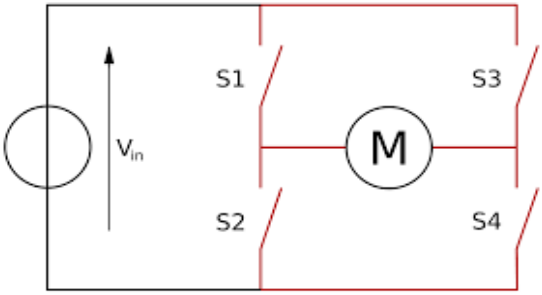

Figure 4.2

To actuate the actuator in various direction required circuit are as shown in figure 4.3. Initially relays are in open condition by controlling various relays we can move actuator in different direction like forward, reverse and we can also apply brake wherever we want by mean of controlling relay module.

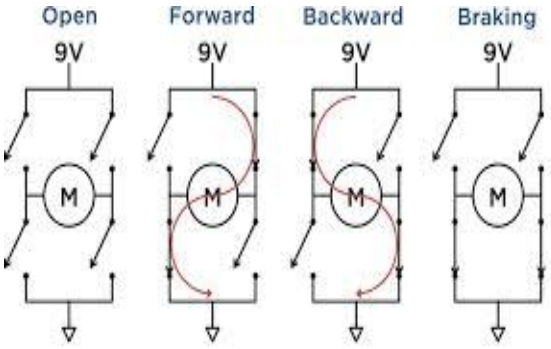

Figure 4.3

Voltage Regulator

All the components of bike works on 12V but Arduino works on 3.3 to 5V. So, to use various bike components and get sufficient input, it is necessary to make it useable for Arduino, voltage regulator is used.

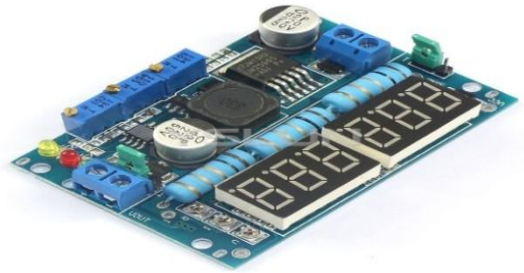

Figure 5. Voltage regulator

Solenoid actuator

It is pull push type actuator which works on the principle of electromagnetics, working voltage is 12V, one magnetise plunger is covered with the coil winding all over it. Now as shown in third figure, whenever the current is passed through the coil, it pushes the plunger outside, and if current is passed in opposite direction, it pulls the plunger inside. The construction is as per shown in figure 6.2, and the working is as per figure 6.3. The shifting force required is different for each and every motorcycle. We have used a 35pound-force actuator which is sufficient force to shift the gears of most of the motorcycles.

Figure 6.1. Solenoid actuator

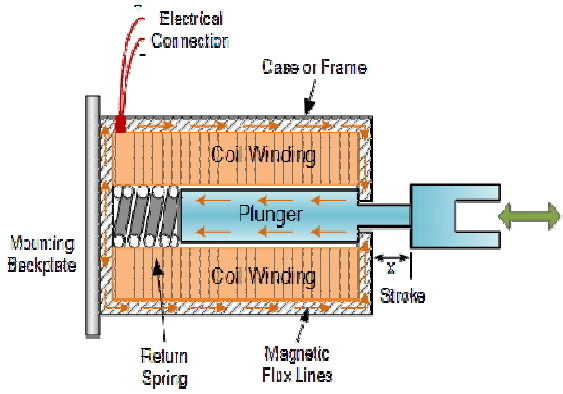

Figure 6.2. Construction of solenoid actuator

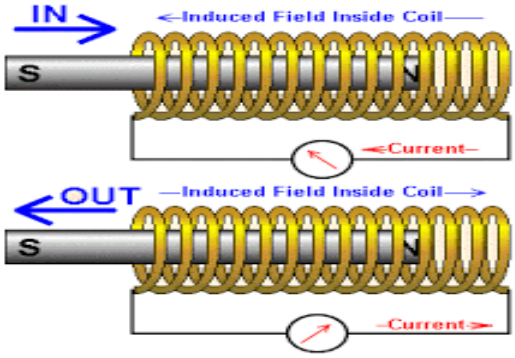

Figure 6.3. Working of solenoid actuator

III. WORKING

The working starts with the action of clutch dis-engagement. As soon as the clutch is disengaged the speed sensor and the gear position sensor activates. They send the instantaneous speed and the current gear position of the vehicle to the microcontroller. The microcontroller takes the input and analyses the data given by the sensors. After analysing the data from the sensors, it sends signals to actuate the solenoid actuator to its best suitable position. And by the action of actuator the gear shifts to its best position.

So the only thing user has to do is dis-engage the clutch and the gear will be shifted automatically according to the speed of the vehicle. The main advantage of this mechanism is that the users don't have to dis-engage the clutch multiple time to shift more than one gear at a time. For example if the vehicle is in 5th gear and the user apply the brakes and the vehicle should be in second gear, so the mechanism will shift the actuator three times just by disengaging the clutch single time. This will not only save the time of the user but it will also help the vehicle to accelerate the vehicle quicker. This mechanism can be switched off with a switch provided near the speedometer of the bike, so if the user wishes to operate the transmission manually he can just switch off the switch at the speedometer. So, this is a versatile mechanism which can stand in any condition like traffic, curvy roads, off road, cruising, etc.

In this automation system, there total three type of components 1st to gives inputs, 2nd to makes processes on the signals as per program and 3rd to works on output signals provided by processor. Here clutch switch, speed sensor and gear position sensor, these three components are input providers. Arduino is processor which contains flash memory and clock, and solenoid Actuator works on output signals.

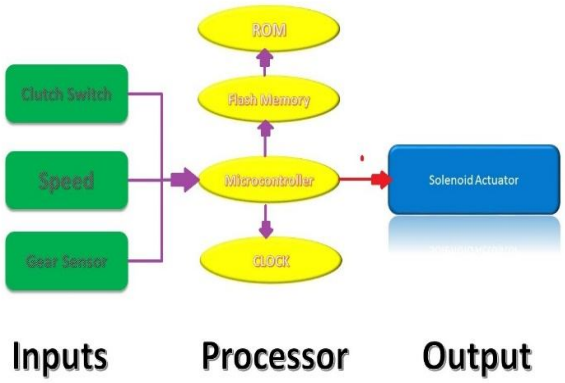

Figure 7. Working flowchart

Circuit diagram

In the image below it is shown that how the components have been connected to the Arduino and Battery. The circuit is developed using the information of component and allotted Arduino pin respectively.

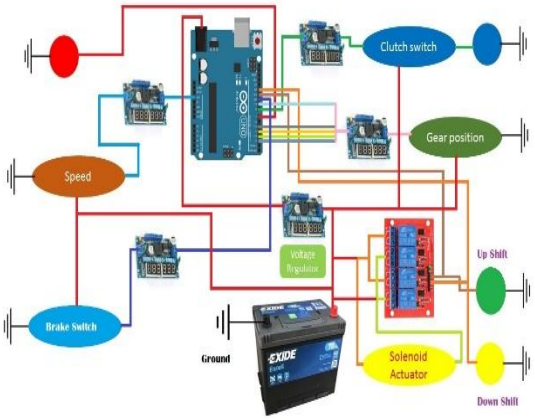

Figure 8. Circuit diagram

IV. PROGRAM

Program of this system is divided into two parts one is FUNCTIONS and other is MAIN. Functions contains various functions like gear check, speed check clutch switch check, etc. and Main contains uses of this functions which further uses to make decisions depending upon different logics and conditions.

Function Program

```
int clutchCheck(int x)
    {
    int result = digitalRead(x);
    return result;
    }
int speedCheck(int x)
```

```
        {
        int result = analogRead(x);
        int res = map(result, 0, 1023, 0, 120);
        return res;
        }
    int gearCheck(int g1, int g2, int g3, int g4, int g5)
        {
        int res;
        int c1 = digitalRead(g1);
        int c2 = digitalRead(g2);
        int c3 = digitalRead(g3);
        int c4 = digitalRead(g4);
        int c5 = digitalRead(g5);
        if (c1 == 1)
                    {
                    res = 1;
                    }
        else  if (c2 == 1)
                    {
                    res = 2;
                    }
        else  if (c3 == 1)
                    {
                    res = 3;
                    }
        else  if (c4 == 1)
                    {
                    res = 4;
                    }
        else  if (c5 == 1)
                    {
                    res = 5;
                    }
        else
                    {
                    res = 0;
                    }
        return res;
        }
    int spd_ger(int x)
        {
        int res = x ;
        if (res  > 44)
                    {
                    return 5;
                    }
        else if (res <= 44 && res > 33)
                    {
                    return 4;
                    }
        else if (res <= 33 && res > 22)
                    {
                    return 3;
                    }
        else if (res <= 22 && res > 11)
                    {
                    return 2;
                    }
         else if (res <= 11 && res > 0)
                    {
                    return 1;
                    }
         else
                    {
                    return 0;
                    }
        }
    int actu(int x)
        {
        return 0;
        }
```

Main Program

```
void setup()
        {
        pinMode(2, INPUT);//gear
        pinMode(3, INPUT);//gear
        pinMode(4, INPUT);//gear
        pinMode(5, INPUT);//gear
        pinMode(9, INPUT);//gear
        pinMode(10, INPUT);//break
        pinMode(7, OUTPUT);//ignition
        pinMode(12, OUTPUT);//shift
        pinMode(11, OUTPUT);//shift
        pinMode(8, INPUT);//clutch
        digitalWrite(7, 1);
        Serial.begin(9600);
        }
void loop()
        {
        int res;
        int y = clutchCheck(8);    //to check      the clutch is
pressed or not;
        int z = breakCheck(10);
        if (z == 0 || y == 0)
                {
                int spd = speedCheck(0); //to check speed
                int gear = gearCheck(9, 5, 4, 3, 2);        //to check
the gear posetion
                int gearact = spd_ger(spd);
        //to detirmine actual gear                    posetion acc to
speed
                int diff = gearact - gear;
                int act = actu(diff);
                if (y == 1)
                {
                for (int i = diff; i <= diff && i > 0; i--)
                        {
                        diff = diff - 1;
                        digitalWrite(12, 1);
                        delay(1000);
                        digitalWrite(12, 0);
                        delay(1000);
                        Serial.print(diff);
                        }
                        for (int i = diff; i <= diff && i < 0; i++)
                        {
                        diff = diff + 1;
                        digitalWrite(11, 1);
                        delay(1000);
                        digitalWrite(11, 0);
                        delay(1000);
                        Serial.print(diff);
                        }
                }
                Serial.print("clutch:");
        Serial.print(y);
        Serial.print("     break:");
        Serial.print(z);
        Serial.print("     speed:");
        Serial.print(spd);
```

```
            Serial.print("      gear:");
            Serial.print(gear);
            Serial.print("      gear_idal:");
            Serial.print(gearact);
            Serial.print("      shift:");
            Serial.print(diff);
            Serial.println("");
}
else if (z == 1 && y == 1)
            {
            //Make it Neutral
            }
}
```

V. FLOW OF THE SYSTEM

As shown below flowchart of the working algorithms. Firstly, it gathers data about Arduino pins then produces followings steps:

1st step:

fetching of data like speed of vehicle, gear position, actual required gear.

2nd step:

Checking of clutch switch position and front brakes switch position.

3rd step:

Required gear to actual gear difference calculation.

4th step:

Analysing of required shifting, whether it is upshift or downshift.

5th step:

Shifting of gears.

Meanwhile this process repeats itself again and again.

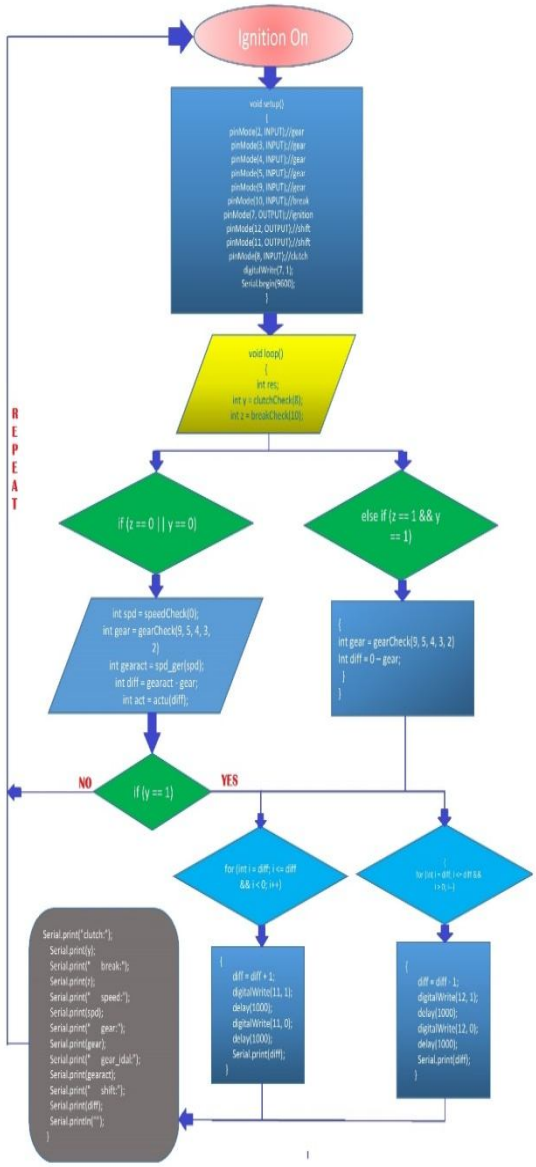

Figure 9. Algorithm flowchart

Various Working Conditions

1st Initial starting of vehicle:

When vehicle is in stop condition and clutch is pressed it puts the vehicle in first gear.

2nd Upshifts and Downshift:

When vehicle is in running condition there is two sub conditions,

1st vehicle speed is greater than gear position so whenever rider presses the clutch it up shifts the gears.

2nd gear position is higher than speed means vehicle speed is reducing while the clutch pressed condition it down shifts.

3rd neutral:

Whenever rider presses clutch and front brake together it makes the vehicle in natural position.

VI. CONCLUSION

This system is beneficial for handicapped drivers, learners, commuters because of semi-automation. Unlike other automatic transmission systems, this mechanism retains the fuel efficiency of vehicle with semi-automation. This system is cheap because most of the parts used here are pre-installed in most of the vehicles. All the devices/parts in this mechanism are interdependent on each other. Malfunctioning of any of these parts would compromise the working of the whole system. This system is flexible enough that one can modify the programme and adjust timing of actuator accordingly to the requirements. The source of energy for this mechanism is the vehicle's battery. Hence, complete drainage of the battery will result in system failure.

REFERENCES

[1] M. S. Kumbhar, Proffessor Dr. D. R Panchagade, "A Literature Review on Automated Manual Transmission (AMT)," (IJSRD, 2014), ISSN (online): 2321-0613.

[2] Makarand S Kumbhar, Dhananjay R. Panchagade, and Kapil Baidya, "Development of Actuator Control Strategy for DC Motor Controlled Automated Manual Transmission (AMT)," (IJRTE, 2014), ISSN: 2277-3878.