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Automatic Gear Shifting Mechanism in Two Wheelers Using Electromagnetic Actuator

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Abstract - *Motorbikes are broadly used around the world mostly in countries like India, Thailand, Indonesia, etc. The gear shifting arrangement of the motorbikes is conventionally manual. The main purpose of the project is to automate the gear transmission for the standard motorcycle by using embedded system. As the increase in demand for CVT (Continuous Variable Transmission) which are gearless system but, has low fuel efficiency as compared to geared Motorcycle. This system not only increases the fuel efficiency but also eliminate the human intervention in gear system, making driving easy. The manual mechanical gear shifting will remain unchanged in this arrangement as there is an electromagnetic actuator placed with the lever which helps to shift the gear according to the speed. The system gives the option to use manual as well as automatic mode. The system also uses low cost microcontrollers which has a coding to decide the shifting of gear either up or down according to the input speed.*

Key Words: Gear shifting, Arduino, Microcontroller, Proximity sensor, DC Stepper motor, Embedded system.

1. INTRODUCTION

In every vehicle, the transmission system transmits the mechanical power from the engine to give kinetic energy to the wheels. The Gear box in the system is responsible to vary the torque according to the driving conditions by shifting the gears manually. Bad shifting is also one of the reasons for the motorcycle accidents. In case of manual gear shifting, the foot lever is used for gear shifting in motorcycle and the clutch operation makes it difficult. The Auto-clutch bikes is used in the project. So, while accelerating the bike, the clutch plates will not wear, performing the smooth operation.

Therefore, we purpose automated system which uses embedded system to shift gears. As this embedded system arrangement installed outside, there is no need for modification inside the engine of the bike.

The working of the automated system is based on the speed of the wheel. As the rpm of the wheel increases, the proximity sensor counts the rpm and sends the signal to microcontroller (MCU). The microcontroller then sends the signal to DC Stepper motor to step up. This process also follows the same with the deceleration of the wheel, as the speed decreases, the Stepper motor will step down the gear. The engine life is also increased as the engine runs smoothly without 'knocking'. This embedded system can also be used in any auto-clutch motorcycle ranging from 50cc to 200cc.

2. GENERAL COMPONENTS/TERMINOLOGIES

2.1 Sensor

A proximity sensor is a non-contact device that senses the presence of an object. According to the application, proximity sensors are classified into different types. In this project, inductive type proximity sensor is used. This sensor detects only metallic object placed next to it. This sensor works under the electrical principal of inductance, the fluctuating current indices induces the EMF (electromotive force) in a target object. The cost of this sensor is comparatively low and operating distance is less than 50mm.

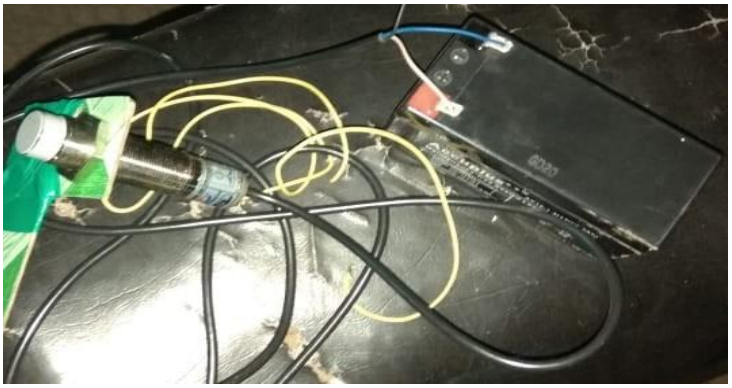

Fig -1: Proximity sensor connected with battery

2.2 Relay circuit

Relays are the switches which operates electromagnetically. It focuses on closing and opening of the circuit contacts in electronic circuit. The schematic diagram in the **figure 2** shows the components inside the relays. There are two switches of 5V and 10A are used for shifting the gears. The first relay is used to shift the gear up and second for shifting the gear down. The NPN transistor "BC547" is used to control the relays. The transistor works on logic circuit, when the input is logic "1" in the port pin it is driven into saturation (turned ON). When the input is logic "0", the relays are turned OFF.

A diode is connected to the relays, to avoid the damage to the transistor due to back EMF generated in the relays when transistor is OFF. The LED displays whether the relays are ON or OFF.

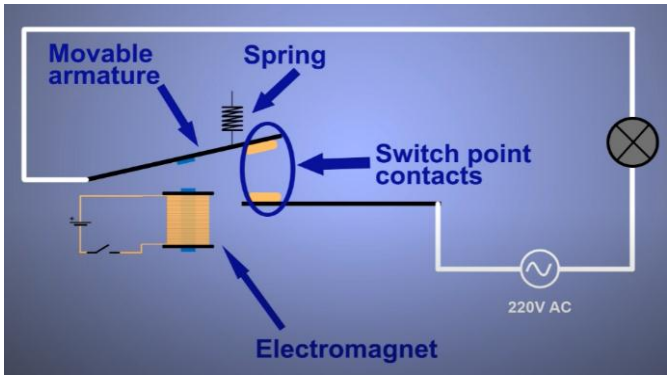

Fig -2: Relay schematic

Fig -3: Relay Circuits

2.3 DC Stepper Motor

A DC Stepper motor or stepping motor is the type of brushless DC motor which rotates in steps to complete its full rotation. The steps of the motor are controlled by microcontroller according to gear to shift. The stepper motor is connected to the gear pedal. Necessary modification is done on the gear pedal. The motor is connected to 12v power supply and runs at 500 rpm. The geared DC stepper motor of model "VJT253" is used for high torque output.

Relays are provided to control the power supply to the motor. Relay 1 is actuated to rotate the motor in clockwise direction and relay 2 for anticlockwise direction. The pitch diameter of the gear on the dc motor is 25mm meshes with the gear pedal which is fitted with spur gear of pitch diameter of 80mm. When the output shaft DC motor rotates at 45° (anticlockwise), the pedal rotates at 25° which is sufficient to shift the lever down and the gear shifts up of motorcycle. The same condition follows with gear down.

Fig -4: DC Stepper Motor

2.4 Microcontroller

A microcontroller is a device which is used as a computer in embedded system. The microcontroller includes processor, memory and input/output (I/O) peripherals. There are different types of microcontroller available based on the applications. The "ATMEGA328" microcontroller (8-bit AVR with 32kb flash program memory) with read-while-write capabilities, 1kb EEPROM, 2kb SRAM, 23 general purpose I/O, 32 general purpose working registers. The device can be operated between 1.8 – 5.5 volts. Embedded "C program is burnt into the microcontroller using "proteus software". Since it is reprogrammable, it can be burnt until a program with necessary pulses ranges is implemented to it. The **Table 1** shows the input feed in the microcontroller which shifts the gear according to the pulses.

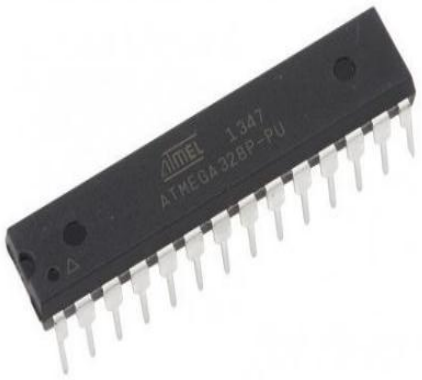

Fig -5: ATMEGA 328 AVR microcontroller

Table -1: Gear position according to the pulse

PULSE RANGE	GEAR POSITION
10	1st gear
11 - 25	2nd gear
26 - 35	3rd gear
35 &above	4th gear

2.5 LCD

An LCD (liquid crystal display) is a flat panel display as shown in **figure 6**. The LCD display used is 16 × 2 intelligent alphanumeric dot matrices. It has the capability to display 224 different characters and symbols.

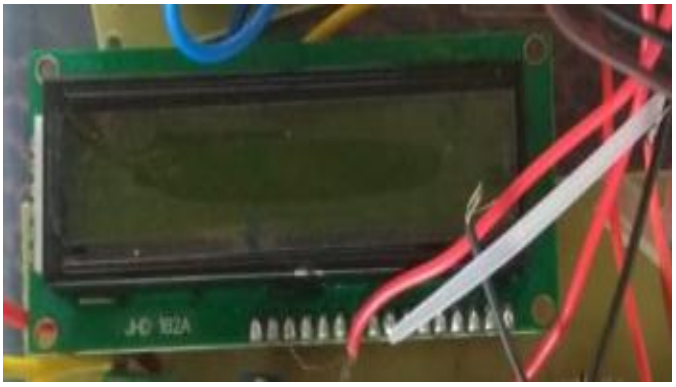

Fig -6: LCD Display

3. CODING

3.1 Software and Flowchart

Coding for the operation of the DC stepper motor is done by using software called "Arduino IDE". Arduino IDE is used to write and upload programs written in C and C++ language on the Arduino board. "If else" statements are used for shifting of gears. The delay time of "8 seconds" with respect to the cycle is feed. This programming is complicated in understanding at a first glance. The flow chart at **Fig -7** show the representation to the basic programming. For example, if the pulse is 15 per 8 sec then second "IF" condition is satisfied, actuating the 2nd gear (YES). The input is counted for every 8 sec which makes the close loop. If the condition is not satisfied, then (NO) and it compares with the next "IF" condition.

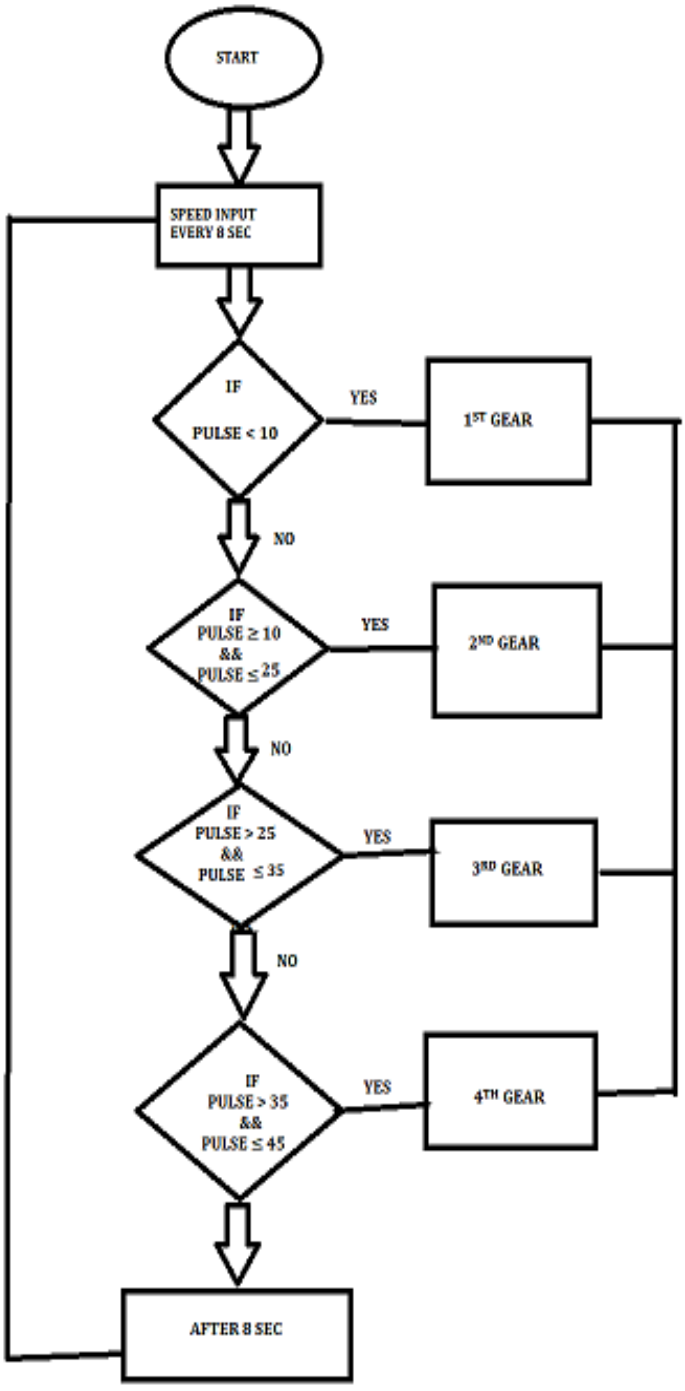

Fig -7: Flowchart of coding

The simulation in microcontroller and the circuit design is done in "proteus" software. Proteus design suite is basically a simulation software for various design with microcontrollers. Main purpose choosing proteus software is because of its availability of almost all microcontrollers in it. In the **Fig -8** shows the power regulating circuit in proteus interface.

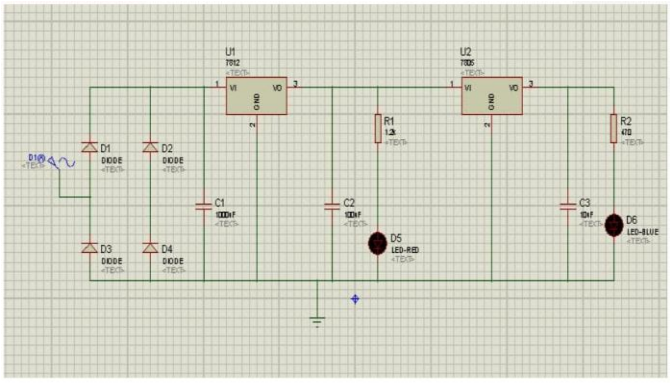

Fig -8: Power regulating circuit in proteus

4. AIM AND OBJECTIVES

- To design embedded system for automated manual gear transmission.
- To code the required program for Arduino board in order to actuate DC stepper motor.
- To fabricate and design the gear shifting and modify the vehicle accordingly.
- To analyse the designed mechanism and check for fuel efficiency if any.

5. METHODOLOGY

- Selection of suitable Auto-clutch bikes
- Selection of DC stepper motor and placing it with the Gear pedal with the help of coupler with calculated offset
- Calibration of the gear shifting mechanism with respect to the input speed by trial and error method and electronic circuit design
- The efficiency of gear vehicle is tested and compared with CVT vehicle

5. 1 LITERATURE REVIEW

The study of following research paper is done.

- Modelling of an automated manual transmission system.
- Automated gear transmission in two wheelers.
- Development of a New Automatic Gear Selecting Machine for Automobile.
- Gear positioning with respect to rear wheel speed.
- Electronic Automatic Gear Shifting System for a Motor Cycle.

6. DESIGN AND MANUFACTURING

6.1 DC Stepper Motor and Gear pedal

DC stepper motor is installed with gear pedal or lever with the help of coupler and it is used to forward or backward of the gear pedal.

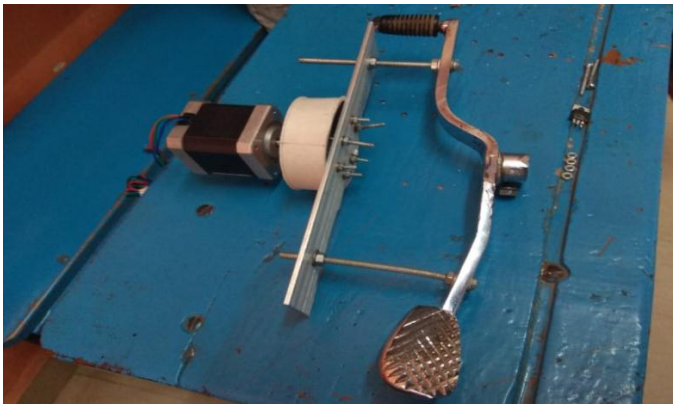

Fig -9: Motor and lever coupled

6.2 Electronic Circuit and Arduino

Soldering of electronic component according to the requirement is done on board. The power supply for the circuit is supplied from the vehicle battery hence, no external power supply need. The electronic circuit is shown in **Fig -10**.

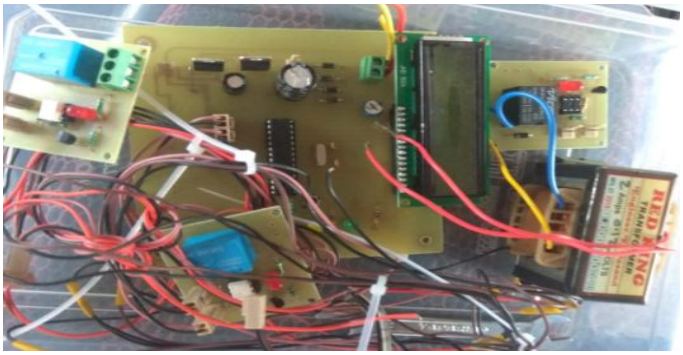

Fig -10: Electronic circuit with all components

Arduino is an open source electronic platform which is easy to use hardware as well as software. Arduino boards are able to read the inputs like light on a sensor, finger on button and turn it out on the outputs like activating motor, turning on "LED". Arduino microcontrollers are preprogrammed with a boot loader which simplifies uploading of programs to the on-chip flash memory. Boards are loaded with program code via a serial connection to a computer. Arduino UNO with the specific part are shown in the **Fig -11**.

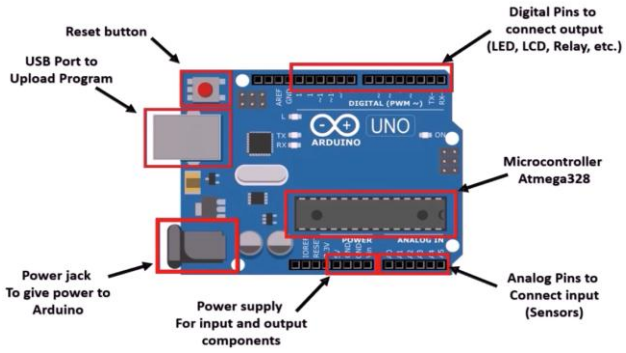

Fig -11: Arduino UNO

7. RESULTS AND CONCLUSION

7. 1 SHIFTING GEARS

Readings given in the tables are tentative and can be changed according to the speed by optimizing the program.

Table -2: Up shifting results

Sr No.	Speed of vehicle in km/ hr	Pulse	Gear Shifting	
			FROM	TO
1.	14	10	FIRST	SECOND
2.	24	26	SECOND	THIRD
3.	38	36	THIRD	FOURTH
4.	45	43	NO SHIFT	

Table -3: Down shifting results

Sr No.	Speed of vehicle in km/ hr	Pulse	Gear Shifting	
			FROM	TO
1.	37	34	FOURTH	THIRD
2.	23	25	THIRD	SECOND
3.	13	10	SECOND	FIRST
4.	1	4	NO SHIFT	

7. 2 CONCLUSIONS

After developing this project, we conclude following points.

- Improvement in fuel efficiency by 2 to 4km
- The system is cheap and can be implemented in any auto-clutch bikes available in market
- Smooth rides in all city conditions
- No need for internal modification in bikes
- Less human intervention in riding bike
- Gear limits can be changed by optimizing the program in microcontroller
- The vehicle can be switched to automated as well as manual by easy switch
- Due to its low cost and easy manufacturing, companies can implement this system and increase their sales

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