Automated Gear Shifting for Auto Clutch Bikes: A Microcontroller Approach

Vinod Kumar Verma
Assistant Professor
Department of Mechanical Engineering
Engineering College Ajmer, Rajasthan, India

Abstract: In this study, a gear shifting mechanism was designed and applied on an auto clutch featured bike to make the gear transmission process faster and less destructible for the diver using Embedded System design. The present automatic transmission is fully mechanically controlled and costs very high and it is not suitable for small displacement engines. But the gear transmission mechanism designed makes driving easier and to achieve efficient driving. This new device must be reliable, has small dimensions, economical and low maintenance cost. This research aims to improve the gear shifting process with a suitable control mechanism to implement in clutch featured bikes. According to the suggested gear shifting method, the microcontroller selects the transmission gear as per the speed of the vehicle without any human interference.

Index Terms: Gear Shifting Mechanism; Auto Clutch Bikes; Embedded System Design; Microcontroller; Automatic Transmission

I. INTRODUCTION

1.1 Overview

The topic of current interest in the area of controller development for automatic transmissions with a finite number of gearshifts which transmits the gears automatically with respect to speed. Gearshifts in automatic transmissions involve a change in the power flow path through the transmission. Advantages of these automatic transmissions include simplicity of mechanical design and savings in transmission weight and size, which are beneficial in terms of fuel economy and production costs. This enables gain in fuel economy while meeting drivability and performance goals, these savings become more significant. The designed automatic transmission is done in an auto-clutch featured bike which can be applied effectively and efficiently in a clutch featured bikes with suitable control techniques. The ultimate goal of our research is to transmit the gears without the human interference and to attain efficient, safe and easy driving in cost effective way. Microcontroller is the heart of the system which handles all the sub devices connected across it.

1.2 History

The first automatic transmission was invented in 1921 by a Canadian steam engineer, Alfred Horner Munro. Munro designed his device to use compressed air rather than hydraulic fluid so it lacked power and never became sold commercially. General Motors then developed the first automatic transmission using hydraulic fluid in the 1930's, and introduced the "Hydra-Matic" transmission in 1940. [1]

The 1948 Oldsmobile was the first model to use a true automatic transmission. The Hyrda-Matic, developed by GM engineer, Earl Thompson, was advertised as: "The greatest advance since the self-starter." The Hydra-Matic went through continual upgrading and refinements through 1955, but the basic design and theory used were consistent throughout its remarkably long-life span. General Motors replaced the Hydra-Matic in 1956 with the Jetaway. The "Jet" was not a roaring success and quickly gave way to the Turbo Hydra-Matic in 1969.

2.1 AUTOMATION

Automation is the use of control system to control a process replacing the human operators. It is a step beyond mechanization, where human operators are provided with the physical requirements of work.

Automation is now often applied primarily to reduce the human effort thereby to attain desired operation. Another major shift in automation is the increased emphasis on flexibility and convertibility in different process.

One safety issue with automation is that it is often viewed as a way to minimize human error in the system, increasing the degree and the levels of automation also increase the sequence of error that accidently created in automated systems. Different types of automation tools that exist in today's environment are Programmable logic controller, Microcontroller etc. [2]

2.2 Types of Transmission

2.2.1 Manual Transmission

A manual transmission is a type of transmission used in motor vehicle applications. It uses a driver-operated clutch engaged and disengaged by a foot pedal or hand lever, for regulating torque transfer from the engine to the transmission; and a gear selector operated by hand or by foot. Manual transmissions often feature a driver-operated clutch and a movable gear pedal. Most automobile manual transmissions allow the driver to select any forward gear ratio at any time, but some, such as those commonly mounted on motorcycles and some types of racing cars, only allow the driver to select the next-higher or next-lower gear. This type of transmission is sometimes called a sequential manual transmission. In a manual transmission, the flywheel is attached to the engine's crankshaft and spins along with it. The clutch disk is in between the pressure plate and the flywheel, and is held against the flywheel under pressure from the pressure plate. When the engine is running and the clutch is engaged, the flywheel spins the clutch plate and hence the transmission. As the clutch is depressed, the throw out bearing is activated, which causes the pressure plate to stop applying pressure to the clutch disk. This makes the clutch plate stop receiving power from the engine, so that the gear can be shifted without damaging the transmission. When the clutch pedal is released, the throw out bearing is deactivated, and the clutch disk is again held against the flywheel, allowing it to start receiving power from the engine. [3]

There are two basic types of manual transmissions. The sliding-gear type and the constant mesh design. With the basic and now obsolete sliding-gear type, nothing is turning inside the transmission case except the main drive gear and cluster gear when the transmission is in neutral. In order to mesh the gears, apply engine power to move the vehicle. One of the basic methods is shown in Figure 1: Sliding Gear Transmission.

All modern transmissions are of the constant-mesh type, which still uses a similar gear arrangement as the sliding-gear type. However, all the main shaft gears are in constant mesh with the cluster gears as shown in Figure 2: Constant Mesh Transmission. This is possible because the gears on the main shaft are not splinted to the shaft, but are free to rotate on it. With a constant-mesh gearbox, the main drive gear, cluster gear and all the main shaft gears are always turning, even when the transmission is in neutral.

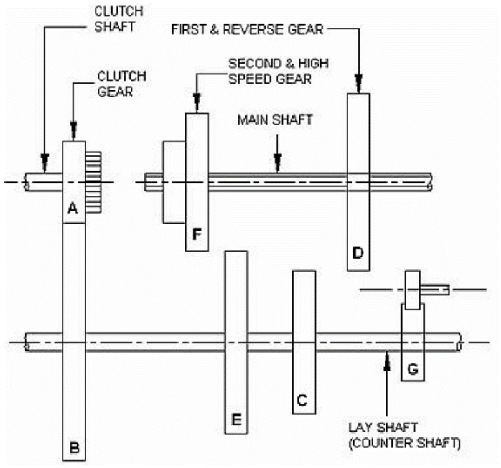


Figure No. 1: Sliding Gear Transmission [16]

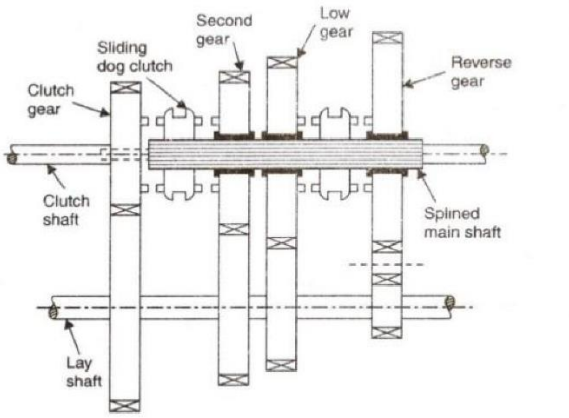


Figure No. 2: Constant Mesh Transmission [16]

2.2.2 Automatic Transmission

An automatic transmission, also called as self-shifting transmission, is a type of motor vehicle transmission that can automatically change gear ratios as the vehicle moves, freeing the driver from having to shift gears manually. Like other transmission systems on vehicles, it allows an internal combustion engine, best suited to run at a relatively high rotational speed, to provide a range of speed and torque outputs necessary for vehicular travel.

The most popular type found in automobiles is hydraulic automatic transmission. Similar but larger devices are also used for heavy-duty commercial and industrial vehicles and equipment. This system uses a fluid coupling in place of a friction clutch, and accomplishes gear changes by hydraulically locking and unlocking a system of planetary gears. These systems have a defined set of gear ranges, often with a parking pawl that locks the output shaft of the transmission to keep the vehicle from rolling either forward or backward. Some machines with limited speed ranges or fixed engine speeds, such as some forklifts and lawn mowers, only use a torque converter to provide a variable gearing of the engine to the wheels.

Besides the traditional hydraulic automatic transmissions, there are also other types of automated transmissions, such as Constant Variable Transmission Low and High Gear Ratio transmission system. That free from the driver from having to shift gears manually, by using the transmission's computer to change gear, if for example the driver were redlining the engine. Despite superficial similarity to other transmissions, traditional automatic transmissions differ significantly in internal operation and driver's feel from semiautomatics and CVT's. In contrast to conventional automatic transmissions, a CVT uses a belt or other torque transmission scheme to allow an "infinite" number of gear ratios instead of a fixed number of gear ratios. A semi-automatic retains a clutch like a manual transmission, but controls the clutch through electro hydraulic. The ability to shift gears manually, often via paddle shifters, can also be found on certain automated transmissions semi-automatics and CVT's.

Comparison between manual and automatic transmission

Manual transmission

It is easier to build a strong manual transmission than an automatic one. This is because a manual system has one clutch to operate, whereas an automatic system has a number of clutch packs that function in harmony with each other.

Manual transmissions normally do not require active cooling, because not much power is dissipated as heat through the transmission.

Manual gearshifts are more fuel efficient as compared to their automatic counterpart. Torque convertor used to engage and disengage automatic gears may lose power and reduce acceleration as well as fuel economy.

Manual transmissions generally require less maintenance than automatic transmissions. An automatic transmission is made up of several components and a breakdown of even a single component can stall the car completely.

Automatic transmission

The manual transmission locks and unlocks different sets of gears to the output shaft to achieve the various gear ratios, while in an automatic transmission; the same set of gears produces all of the different gear ratios.

Automatic vehicles are easier to use, especially for the inexperienced driver. Manual system requires better driving skills, whereas with an automatic, the clever system does it all on its own. This holds a greater advantage for new and inexperienced drivers and also helps during congested traffic situations where it becomes difficult to change gears every second.

Automatic transmission requires less attention and concentration from the driver because the automatic gears start functioning as soon as the system feels the need of a gear change. For vehicles with manual gear shifts, the driver has to be more alert while driving and better coordinated.

There is no clutch pedal and gear shift in an automatic transmission car. Once you put the transmission into drive, everything else is automatic.

Automatic vehicles have better ability to control traction when approaching steep hills or engine braking during descents. Manual gears are difficult to operate on steep climbs.

2.4 Advantages of Automatic Transmission

Easier to drive in stop-and-go traffic and available in most cars, an automatic transmission has definite benefits

The main benefit of automatic transmissions is that they are simply easier to use.

Fuel efficient.

2.5 Embedded System

All embedded system uses either a microprocessor (or) microcontroller. The software for the embedded system is called firmware. The firmware will be written in assembly language (or) using higher level languages life 'C' (or) 'Embedded C'. The software will be simulated using micro code simulation for the target processor. Since they are supposed to perform only specific tasks, the programs are stored in ROM.

An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular function. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines and toys are among the myriad possible hosts of an embedded system. Embedded systems that are programmable are provided with programming interfaces, and embedded system programming is a specialized occupation.

An Embedded system is a special-purpose computer system, which is completely encapsulated by the device controls. It has specific requirements and performs pre-defined tasks, unlike a general-purpose personal computer.

Avoids lot of electronic components.

Build in with rich features.

Probability of failure is reduced.

Easy interface.

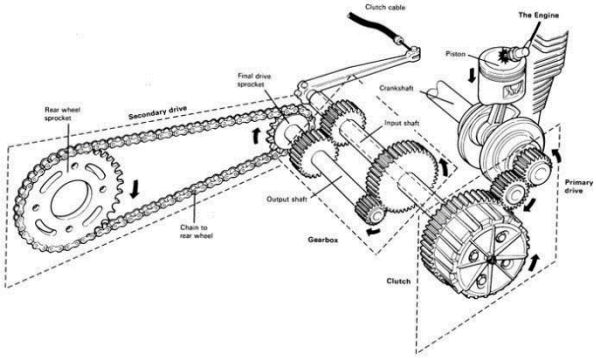


Figure No. 3: Manual transmission in two-wheeler [16]

3.1 LITERATURE SURVEY

3.1.1 Introduction

It is very important to realize automatic shift for engineering vehicles, because its poor working conditions and complicated operation condition. Realizing automatic shift can improve the performance and fuel economy of vehicles, it can also improve efficiency and quality of gear shift, lighten the working strength of drivers, etc. At present, there is not a perfect automatic shift technology for vehicles, they can only use the automatic shift technology of ordinary vehicle. Engineering vehicles mainly work on engineering work, so they will consume lots of power of the engine, and the change range is very large. This is very different from the vehicles used for driving. We cannot greatly improve the vehicle 's performance and fuel economy if we implement the existing gear shift technology. Therefore, studying automatic shift technology of the engineering vehicle has important theoretical and practical significance.

3.1.2 Present work on automatic gear shifting-

A patent [4] on semi-automatic gear shifting apparatus for use in shifting gears in gearboxes of motorcycles and the like gearboxes wherein gears are shifted by rotating spindles which are connected to the ratchet type gear shifting means. Here the shifting apparatus consists of a lever arm, one end of which is connected to the spindle and the other end is connected to the toe pedal. Also, an actuating rod is connected to the toe pedal, the rod is reciprocated to move the lever and in turn the spindle. This spindle is actuated by a pair of push button switches mounted on the handle bar. A patent [5]an actuator with a tachometer for the forecast movement of the gears is used. The gear shifting mechanism also includes a solenoid and pivotal mounting to provide movement of the actuator assembly in second direction. In this patent the invention of automated driver system for a manual transmission vehicle includes a gear shifting mechanism under control of a microprocessor. The gear shifting mechanism includes a gear shift actuator, D C Motor, Tachometer with a lead screw assembly and also a Linear displacement transducer is used. Patent [6] has said that a solenoid actuated transmission shifting apparatus is provided for temporary and permanent installation is automobiles with convention motor cycle transmission. The shifting apparatus allows for up shifting and downshifting through the transmission gears by pressing pushbuttons mounted on the handle bar. It is an object of this invention to provide a pushbutton solenoid shifter that incorporates the use of electronic solenoids to actuate the shifting of gears in manual transmission of motorcycle. [7] Patent has mentioned that the transmission gears and clutch shifting apparatus for automatic operation of manual shift mechanism in a automotive vehicle include gear and clutch actuation mechanisms mounted on bar of vehicle and coupled by the cables to the control actuation mechanisms mounted off the vehicle board. The on-board gear shift actuator includes two intersecting movable slots for causing movement of the shift lever. In this invention electrical control and actuation mechanism are mounted outside the vehicle. A relatively small gear and clutches is mounted on the vehicle, cables are used to connect these actuators with each other. The patent [8] has explained that a multi speed automatic transmission for automobiles having parallel input and output shafts includes two parallel gear sets and constant meshing gear wheels, which provide two fixed speed ratios. The first power path uses the first speed ratio which includes a first control clutch and a second control clutch. The second power path uses the second speed ratio which is higher than the first speed ratio, which include a third control clutch. This also has a double planetary gear set, a first and second control brake. Alternatively, either the input or output shafts are in alignment and one the two speed ratios are used. This transmission features six forward speeds, a braked neutral and a reverse drive.

The journal [9] gives us a brief introduction to shift schedule of gears to save energy and improve fuel economy. Since there is no perfect automatic shift technology for engineering vehicles, this theory is implemented to improve the ordinary vehicle transmission. The author predicts that automatic gear transmission vehicle chooses the best shift rule based upon driver's information of manipulation. the author also claims that the rule of shift decision changes the traditional shift mechanism to intelligent shift decision. Journal [10] has specified that automatic transmission is a key technology to improve the performance of vehicles. With the synthesized application of mechatronics technology, computer technology, auto control technology on vehicles, development of modern vehicles is leading to an intelligent gear shifting mechanism. Gear shifting strategy as explained in the journal is the core of intelligent control system of automatic

transmission that improves vehicle's performance and fuel efficiency. The gear shift strategy is the rule of changing the time of automatic shifting between gears with respect to rear wheel revolution. A journal [11][8] has provided the solution for power loss in manual gear transmission system. The main objective is to create a mechanism to reduce inconvenience caused in manual gear vehicles. The shifting of gears is done automatically as well as manually. In automatic gear shifting mechanism the gears are shifted in accordance with the speed of the vehicle. The wheel revolutions are sensed and the signal is transferred to the microcontroller which shifts the gear with respect to the implemented C program. The journal [12] has shared an information, that the production of manual transmission is reduced by fifty percent and automated manual transmission (AMT) production is increased. The AMTs are used in racing cars and in modern hybrid electric vehicles.

3.2 Aim of the research

The aim of research is to modify the motorcycle engine by replacing the manual gear transmission with the automatic one. For this purpose, friction clutch is replaced with the magnetic clutch and gear is shifted with high torque DC motor. This modification made ride easy and comfortable.

3.3 Purpose of the research

For improve efficiency

Present time in automobile motorcycle that general in running use by people almost use the manual gear shifting mechanism and in that mechanism some time at low speed high gear running for example suddenly from the high speed to brakes and vehicle come low speed and try to run at low speed and not shift the gear lower that time more power consumes for the rotating the high gear ratio and chance for brake gears and decrees the engine efficiency for that problem solve we are trying to automatic gearing by which at low speed gear shift automatically and save the power which consumes by engine and increase the efficiency.

For improve average

According to previous problem the power saving mode come in engine and at small amount of input fuel increase the output in term of long way travelling.

Reduce the driver effort

In manual gear shifting arrangement every time for shifting the gear required human effort and we also try to reduce it .so there is no clutch lever in the driver's hand so he is free from the operating the clutch lever.

Automatic clutch operation for driver conformability

For the gear change of shift from lower to higher or higher to lower must in gear box disengage require d and for that engage and disengagement clutch is work but we are using the magnetic clutch by which that clutch is also work automatically according to speed and give batter conformability to driver from the clutch arrangement.

4.1 Components used in automated manual transmission

1. Lead acid battery
2. Microcontroller board

i. Resistor
ii. Capacitor
iii. LCD display
iv. Transistor
v. Microcontroller
vi. Relay
vii. Crystal oscillator
viii. PCB
ix. 7805 IC(voltage regulator)

3. Gear box of bike
4. DC motor
5. High Torque motor

4.2 Description of Equipments

4.2.1 Lead acid battery

The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents shortens the useful life to about 3 to 5 years for an automobile battery. Of the different types of secondary cells, the lead-acid type has the highest output voltage, which allows fewer cells for a specified battery voltage. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery.[13]

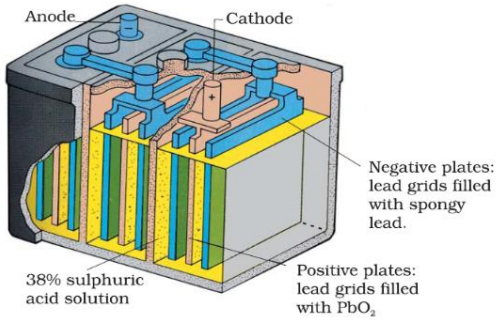


Figure No. 4: Construction of battery

Figure No. 5: Battery

4.2.2Microcontroller board

A microcontroller board is a microcontroller built onto a single printed circuit board. This board provides all of the circuitry necessary for a useful control task: a microprocessor, I/O circuits, a clock generator, RAM, stored program memory and any necessary support ICs. The intention is that the board is immediately useful to an application developer, without requiring them to spend time and effort to develop controller hardware.
As they are usually low-cost, and have an especially low capital cost for development, single-board microcontrollers have long been popular in education. They are also a popular means for developers to gain hands-on experience with a new processor family.

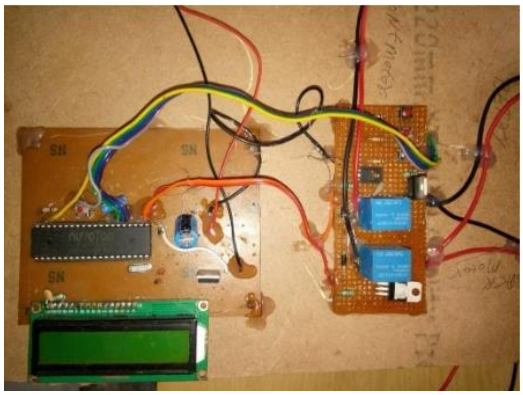


Figure No. 6: Microcontroller board

Figure No. 7: Resistor

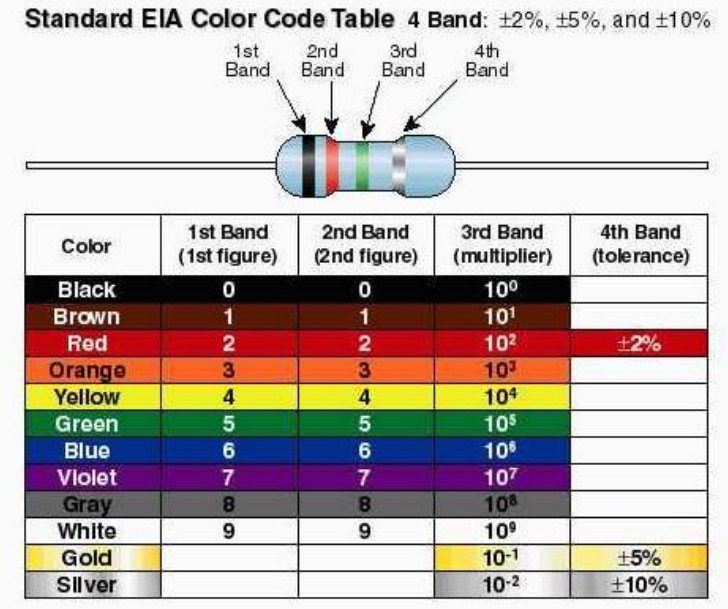
i. **Resistor-** A resistor is a two-terminal electronic component that produces a voltage across its terminals that is proportional to the electric current through it in accordance with Ohm's law:
V = IR

Resistors are elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome).

The primary characteristics of a resistor are the resistance, the tolerance, the maximum working voltage and the power rating. Other characteristics include temperature coefficient, noise, and inductance. Less well-known is critical resistance, the value below which power dissipation limits the maximum permitted current, and above which the limit is applied voltage. Critical resistance is determined by the design, materials and dimensions of the resistor.
Units:-
The ohm (symbol: Ω) is the SI unit of electrical resistance, named after Georg Simon Ohm. Commonly used multiples and submultiples in electrical and electronic usage are the milliohm ($1x10^{-3}$), kilo ohm ($1x10^{3}$), and mega ohm ($1x10^{6}$).

Operation-
Ohm's law
The behaviour of an ideal resistor is dictated by the relationship specified in Ohm's law:

Ohm's law states that the voltage (V) across a resistor is proportional to the current (I) through it where the constant of proportionality is the resistance (R).



Color	1st Band (1st figure)	2nd Band (2nd figure)	3rd Band (multiplier)	4th Band (tolerance)
Black	0	0	10^0	
Brown	1	1	10^1	
Red	2	2	10^2	±2%
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	
Blue	6	6	10^6	
Violet	7	7	10^7	
Gray	8	8	10^8	
White	9	9	10^9	
Gold			10^{-1}	±5%
Silver			10^{-2}	±10%

Figure No. 8: Colour coding of Resistor

Equivalently, Ohm's law can be stated:

$$\frac{V}{R} = I$$

This formulation of Ohm's law states that, when a voltage (V) is maintained across a resistance (R), a current (I) will flow through the resistance

ii. **Capacitor-** A capacitor (formerly known as condenser) is a passive electronic component consisting of a pair of conductors separated by a dielectric (insulator). When there is a potential difference (voltage) across the conductors, a static electric field develops in the dielectric that stores energy and produces a mechanical force between the conductors. An ideal capacitor is characterized by a single constant value, capacitance, measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them.
Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass, in filter networks, for smoothing the output of power supplies, in the resonant circuits that tune radios to particular frequencies and for many other purposes.

OPERATION

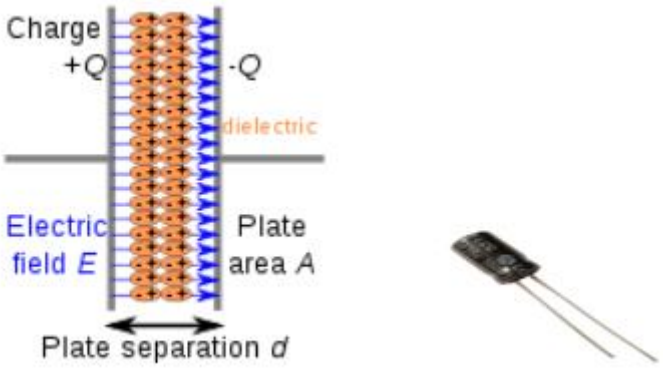


Figure No. 9: Capacitor

n ideal capacitor is wholly characterized by a constant capacitance '**C**', defined as the ratio of charge ±'**Q**' on each conductor to the voltage '**V**' between them: $$C = \frac{Q}{V}$$

Sometimes charge build up affects the mechanics of the capacitor, causing the capacitance to vary. In this case, capacitance is defined in terms of incremental changes: $$C = \frac{\mathrm{d}q}{\mathrm{d}v}$$

In SI units, a capacitance of one farad means that one coulomb.

iii. **LCD display**- LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

Pin diagram-

Table No. 4: LCD display Pin description

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6

14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

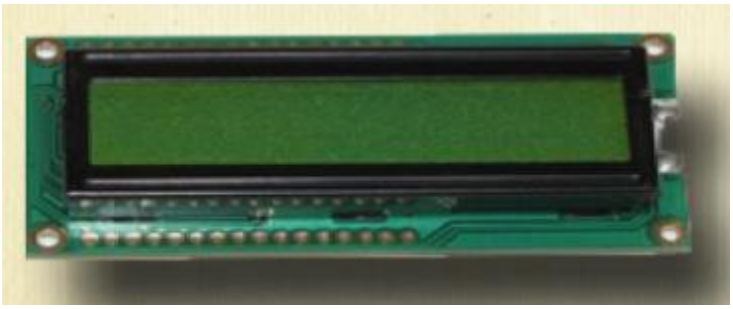


Figure No. 10: LCD display

Transistor- A transistor is a semiconductor device commonly used to amplify or switch electronic signals. A transistor is made of a solid piece of a semiconductor material, with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the controlled (output) power can be much more than the controlling (input) power, the transistor provides amplification of a signal. Some transistors are packaged individually but most are found in integrated circuits.

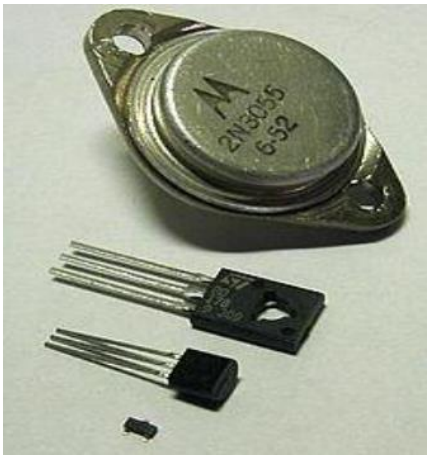


Figure No.11: Assorted discrete transistors.

The transistor is the fundamental building block of modern electronic devices, and its presence is ubiquitous in modern electronic systems.

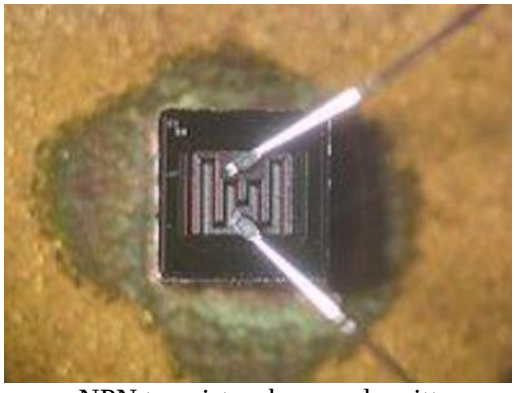


Figure No.12: High-frequency NPN transistor, base and emitter connected via bonded wires.

A bipolar (junction) transistor (BJT) is a three-terminal electronic device constructed of doped semiconductor material and may be used in amplifying or switching applications. Bipolar transistors are so named because their operation involves both electrons and holes. Charge flow in a BJT is due to bidirectional diffusion of charge carriers across a junction between two regions of different charge concentrations. This mode of operation is contrasted with unipolar transistors, such as field-effect transistors, in which only one carrier type is involved in charge flow due to drift. By design, most of the BJT collector current is due to the flow of charges injected from a high-concentration emitter into

the base where they are minority carriers that diffuse toward the collector, and so BJTs are classified as minority-carrier devices.

Microcontroller- Microcontrollers are microprocessors with peripheral devices and memory embedded in a single chip. They are used in almost all modern-day appliances controllers and so it is produced in millions. The most popular microcontroller architecture is Atmel 89C51. There are many numbers of IC manufacturers offering microcontrollers based on this architecture. Atmel is one of them. The microcontroller 89C51 from Atmel is chosen for this project.[15]

AT89C51 MICROCONTROLLER

AT89C51 is an 8-bit microcontroller and belongs to Atmel's 8051 family. ATMEL 89C51 has 4KB of Flash programmable and erasable read only memory (PEROM) and 128 bytes of RAM. It can be erased and program to a maximum of 1000 times.

In 40 pin AT89C51, there are four ports designated as P_1, P_2, P_3 and P_0. All these ports are 8-bit bi-directional ports, i.e., they can be used as both input and output ports. Except P_0 which needs external pull-ups, rest of the ports have internal pull-ups. When 1s are written to these port pins, they are pulled high by the internal pull-ups and can be used as inputs. These ports are also bit addressable and so their bits can also be accessed individually.

Port P_0 and P_2 are also used to provide low byte and high byte addresses, respectively, when connected to an external memory. Port 3 has multiplexed pins for special functions like serial communication, hardware interrupts, timer inputs and read/write operation from external memory. AT89C51 has an inbuilt UART for serial communication. It can be programmed to operate at different baud rates. Including two timers & hardware interrupts, it has a total of six interrupts.

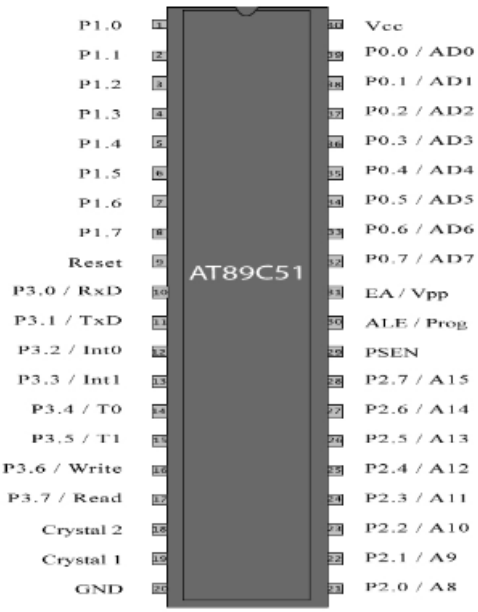


Figure No.13: AT89C51 Pin Diagram

Table No. 5: AT89C51's Pin Description

Pin No	Function			Name
1-8	8 bit input/output port (P_1) pins			$P_1.0$, $P_1.1$, $P_1.2$, $P_1.3$, $P_1.4$, $P_1.5$,$P_1.6$
9	Reset pin; Active high			Reset
10	Input (receiver) for serial communication	RxD	8 bit input/output port (P_3) pins	$P_3.0$
11	Output (transmitter) for serial communication	TxD		$P_3.1$
12	External interrupt 1	Int0		$P_3.2$
13	External interrupt 2	Int1		$P_3.3$
14	Timer1 external input	T_0		$P_3.4$
15	Timer2 external input	T_1		$P_3.5$

16	Write to external data memory	Write		P_3.6
17	Read from external data memory	Read		P_3.7
18	Quartz crystal oscillator (up to 24 MHz)			Crystal 2
19				Crystal 1
20	Ground (0V)			Ground
21-28	8 bit input/output port (P_2) pins / High-order address bits when interfacing with external memory			P_2.0/ A_8, P2.1/ A_9, P2.2/ A_{10}, P2.3/ A_{11}, P2.4/ A_{12}, P2.5/ A_{13}, P2.6/ A_{14},P2.7/ A_{15}
29	Program store enable; Read from external program memory			PSEN
30	Address Latch Enable			ALE
	Program pulse input during Flash programming			Prog
31	External Access Enable; Vcc for internal program executions			EA
	Programming enable voltage; 12V (during Flash programming)			Vpp
32-39	8 bit input/output port (P_0) pins Low-order address bits when interfacing with external memory			P_0.7/ AD_7, P_0.6/ AD_6 , P_0.5/ AD_5, P_0.4/ AD_4, P_0.3/ AD_3, P_0.2/ AD_2, P_0.1/ AD_1, P_0.0/ AD_0
40	Supply voltage; 5V (up to 6.6V)			Vcc

Features

- 8K Bytes of In-System Reprogrammable Flash Memory
- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Programmable Serial Channel
- Low-power Idle and Power-down Modes

Relay- A relay is an electrically operated switch. A switch is used to drive the microcontroller. Relays are used, where it is necessary to control a circuit a low power signal. Relay is used to sense the gear position. In neutral position the relay provides an active low signal to the microcontroller. In any gear provide an active high signal to the microcontroller. It senses the brake activation and deactivation in which, brake activation produces active high signal and brake deactivation produces active low signal.

Relays come in various configurations for their switch contacts, as well as different DC voltages for to operate their coil. They may be as simple as an on/off switch or as complex as integrating several switches into one unit. In a "double-pole" configuration, one switch terminal toggles between two different output terminals. Regardless of the configuration, each switch on a relay can be "normally open" (NO) or "normally closed" (NC); that is, when the coil is at rest and not energized, the switch contacts are NO or NC. In an open circuit, no current flows, similar to a wall light switch in the "Off" position. In a closed circuit, metal switch contacts touch each other to complete a circuit, and current flows, similar to turning a light switch to the "On" position. In the accompanying schematic diagram, points A and B connect to the coil. Points C and D connect to the switch. Voltage applied across the coil at points A and B creates an electromagnetic field that attracts a lever in the switch, causing it to make or break contact in the circuit at points C and D (depending if the design is NO or NC).

Rated load : 12-28VDC

Coil resistance : <=100m ohms

Coil rated voltage: 3-24VDC

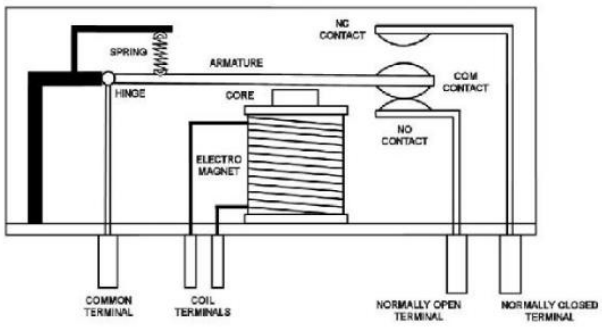


Figure No.14: Circuit diagram of relay

Relays come in various configurations for their switch contacts, as well as different DC voltages to operate their coils. They may be as simple as an on/off switch or as complex as integrating several switches into one unit. They are classified under electromagnetic switches. Two relays of 5V and 10A are used in our gear shifting mechanism.

The first relay is used for up shift of gear and the second relay is used for down shift of the gears. Relays are devices which allow low power circuits to switch a relatively high current and voltage ON/OFF. For a relay to operate a suitable pull-in and holding current should be passed through its coil. Generally, relay coils are designed to operate from a particular voltage at 5V or 12V. The NPN transistor BC547 is used to control the relay.

The transistor is driven into saturation (turned ON) when logic 1 is written on the port pin thus turning ON the relay. The relay is turned OFF by writing logic 0 on the port pin. A diode is connected across the relay coil to protect the transistor damage due to back EMF generated in the relays inductive coil when the transistor is turned OFF. The LED is used to indicate that the relay is turned ON or OFF

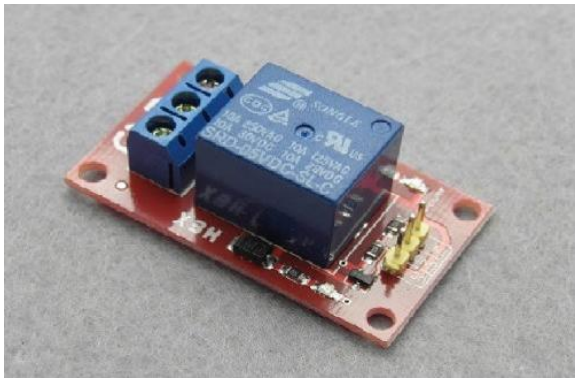


Figure No.15: Relay used to actuate gear dc motor

Since relays are switches, the terminology applied to switches is also applied to relays. A relay will switch one or more poles, each of whose contacts can be thrown by energizing the coil in one of three ways:

- Normally-open (NO) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a Form A contact or "make" contact.
- Normally-closed (NC) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. It is also called a Form B contact or "break" contact.
- Change-over (CO), or double-throw (DT), contacts control two circuits: one normally-open contact and one normally-closed contact with a common terminal. It is also called a Form C contact or "transfer" contact ("break before make"). If this type of contact utilizes a "make before break" functionality, then it is called a Form D contact.

Relays are used to and for

- Control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers,
- Control a high-current circuit with a low-current signal, as in the starter solenoid of an automobile,
- Detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers (protection relays),
- Logic functions.
- Time delay functions.

vii. **Crystal oscillator**- A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time (as in quartz wristwatches), to provide a stable clock signal fordigital integrated

circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is thequartz crystal, so oscillator circuits designed around them became known as "crystal oscillators."

Figure No. 16: Crystal Oscillator

PCB- A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive paths or tracks. The following steps can be used for a proper PCB design: -

- Cleaning
- Pattern making
- Etching
- Drilling
- Cleaning
- Soldering

a. Cleaning- In this process, the printed circuit board is cleaned with the help of a metallic wool. PCB is rubbed with this metallic wool to remove all the dust particles or grease contents. It is rubbed until all the impurities are removed. While doing this, one should hold the PCB from its edges so that any fingerprint could not come in contact with it which leads to grease content.

b. Layout- PCB layout is made on the board. For this purpose, two methods are available. One is with the help of iron and another is screen printing. Pattern is engraved on the board from the glossy paper by pressing it over the PCB. While in screen printing, Line art and text may be printed onto the outer surfaces of a PCB by putting it inside the container. In this container, the PCB is placed under the glossy paper and temperature is set at 80-degree C. After a few minutes the pattern is moved onto the PCB. Screen print is also known as the silk screen, or, in one sided PCBs, the red print.

c. Etching-The final copper pattern is formed by selective removal of the unwanted copper from the PCB. FeCl3 solution is popularly used as an etching solution. FeCl3 solution is made using water and kept in a plastic beaker. Immerse the PCB in this solution and shake it until the copper removes. Due to the reaction between the FECl3 and copper, solution will become weak and it is not recommended for further etching process. Take out the etched sheet from the beaker and allow it to dry for few minutes. Etching can also be done in the etching container. This is a fast process of doing etching. In this, a large number of PCBs can etch at a time. Thus, it is an effective and time-consuming method. After PCBs are etched, they are rinsed with water.

d. Drilling- After etching, holes are drilled through PCB. Holes through a PCB are typically drilled with tiny drill bits made of solid tungsten carbide. These holes allow the electrical and thermal connection of conductors on opposite sides of the PCB. Holes are drilled according to the size of the components. For this purpose, drill beats are available in various sizes.

e. Cleaning-After drilling, we again clean the PCB with the tri chloro-ethylene with cotton to make appear the conductive paths clearly. In absence of tri chloro-ethylene, other chemicals like petrol or acetone can be used.

f. Soldering- Components are connected through soldering. Insert all the components at their particular position and solder them with the soldering machine. Connecting wires are not required here as the tracks are made on PCB. During soldering, prevent short circuiting.

Printed Circuit Assembly

After the printed circuit board (PCB) is completed, electronic components are attached to form a functional printed circuit assembly. Component leads are inserted in holes. In surface-mount construction, the components are placed on pads on the outer surfaces of the PCB. In both kinds of construction, component leads are electrically and mechanically fixed to the board with a molten metal solder. There are a variety of soldering techniques used to attach components to a PCB.

ix. **7805 IC**-7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output

voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

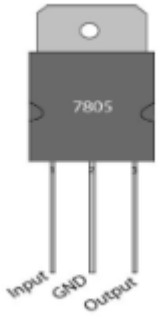


Figure No.17: 7805 IC

4.2.3 Gear box of bike

This is one of the famous types used in twenty centuries. It this gearbox, all the gears are in constant mesh with each other all the time. The gear on the main shaft rotates freely without rotating the main shaft. Three gear transmission constant mesh gear box consist two dog clutches. These clutches are provided on the main shaft, one between the clutch gear and the second gear and the other between the first gear and reverse gear. When the left side dog clutch is made to slide left by means of gearshift lever, it meshes with the clutch gear and the vehicle runs on top speed. If this clutch slide right and mesh with second gear, then the vehicle runs on second gear speed. So, in constant mesh gear box we can change the gear ratio by shifting the dog clutch. This type of gear box is more popular than sliding mesh because it creates low noise and less wear of gears.[14]

Advantages of the Constant Mesh Gearbox over the Sliding Mesh Gearbox:

1. In Constant Mesh Gearbox we can use gears like Helical or Double Helical gear, which are quieter in operation compared to spur gears. Also gears are in constant mesh.
The gears of sliding mesh gearbox are frequently engaging and disengaging, so it may cause the failure of gear teeth earlier than gears of constant mesh gearbox which are in constant meshing.
2. Any damage that results from faulty manipulation occurs to the dog clutch teeth in constant mesh gearbox, and not to the teeth of the gear wheels like in sliding mesh gearbox.
3. Once the dog clutches are engaged, there is no motion between their teeth of dog clutch. But when gear teeth are engaged, the power is transmitted through the sliding action of the teeth of one wheel on those of the other. The teeth have to be suitably shaped to transmit the motion properly.
4. If the teeth on the wheel are damaged during sliding operation, the motion will be imperfect and noisy in case of sliding mesh gearbox.

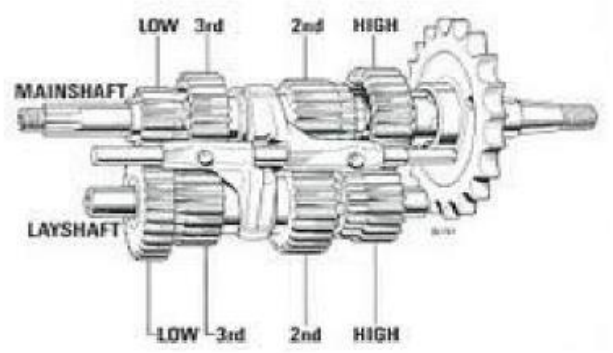


Figure No.18: Gear arrangement

Figure No.19: Gearbox of bike

4.2.4 High torque motor

The power window motor combines two mechanical technologies to perform their task: -

- A combination electric motor and worm gear reduction provides power to the clutch shifting rod.
- A neat linkage converts the rotational output of the motor into the back-and-forth motion of the rod.

TECHNICAL SPECIFICATIONS: -
Rated torque: 53 in-lb
Stall torque: 177 in-lb
Unload high speed: 50rpm, 1.5A (12VDC)
Unload low speed: 35rpm, 1.0A (12VDC)
Maximum wattage: 50W/12VDC
Motor noise: <45dB
Spindle/Post thread size: M-6Wiper Motor Speed (Approximate)

Figure No.20: High torque motor

4.2.5 DC Motor

The DC motor has two basic parts: the rotating part that is called the armature and the stationary part that includes coils of wire called the field coils. The stationary part is also called the stator. The armature is made of coils of wire wrapped around the core, and the core has an extended shaft that rotates on bearings. The ends of each coil of wire on the armature are terminated at one end of the armature. The termination points are called the commutator, and this is where the brushes make electrical contact to bring electrical current from the stationary part to the rotating part of the machine. The stator coils will be referred to as field coils they are connected in series or parallel with each other to create changes of torque in the motor.

For the power transmission to the input shaft of engine through magnetic clutch is done by 0.5 HP DC motor by belt drive and pulley mechanism. This is varying speed motor which maximum speed 5000 rpm which is control by regulator.

Figure No.21: DC Motor

Table No. 6: Cost of the components

Name of part	Cost (approx) Rs.
Lead Acid Battery	**800**
DC Motor	**120**
Microcontroller board	**1800**
Gear box	**4500**
Frame	**600**
High torque motor	**1000**
Total cost of components	**8820**

5.1 Working of this model

In this model we transfer motorcycle engine power to the rear wheel through auto gear shift transmission. We use Hero Honda Splender gear box, a 12-volt motor as input drive, power window motor of Maruti Suzuki alto car to operate gear lever of gear box and control unit to control the functions of the system. Power supply is given by a 12-volt battery for dc motor and 9-volt battery is used for power supply to microcontroller board.

Speed of the dc motor is increased or decreased by the button on the control board. As we increase or decrease the speed of motor the microcontroller senses the activity it gives signal to power window motor to operate the lever of gear box. Through this process proper gear is automatically selected. LCD display shows the speed of the motor and corresponding gear selected.

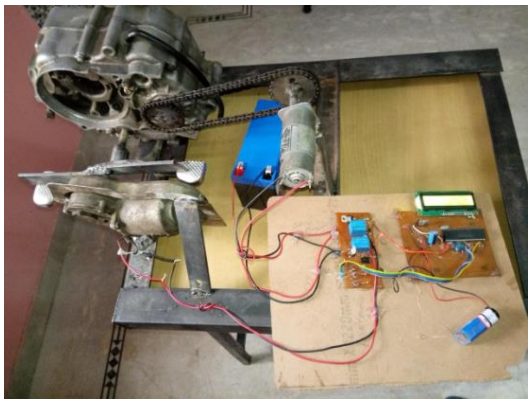


Figure No.22: Experimental Setup

Gears are shifted with speed range as follows-

Table No. 7: Gear are shifted with speed range

Speed of the motor (rpm)	Gear selected
0-50	1
50-100	2
100-125	3
125-150	4

5.2 Microcontroller programming for this model-

```
#include<reg51.h>

sbit motor=P0^0;

sbit sw1=P2^4;

sbit sw2=P2^5;

sbit sw3=P2^6;

sbit r1=P2^0;
```

```
sbit r2=P2^1;
sbit rs=P1^5;
sbit en=P1^4;
void Delay1KTCYx(unsigned int d)
{unsigned int u,v;
for(v=0;v<=d;v++)
for(u=0;u<1000;u++);}
void clk() {en=1; Delay1KTCYx(1); en=0;}
void dsplychr(unsigned char dat);
void lcdcmd(unsigned char dat);
void initlcd(unsigned char address);
void lcddat(unsigned char dat);
void dsplystrng(unsigned char *ptr);
void delay(unsigned int x)
{unsigned int i,j;
    for(i=0;i<=x;i++)
    for(j=0;j<=500;j++);}
void DDelay(unsigned char x,unsigned char y);
void main()
{unsigned char  i=0xff,j=0xff,k=0xff,l=0xff;
        unsigned char speed=0,x=0;
        TMOD=0x11;
        TH0=0;
        TL0=0;
        initlcd(0x80);
        dsplystrng("DC MOTOR SPEED CONTROL USING PWM");
        Delay1KTCYx(200);
        P3=0;
        P0=0;
        P2=0xF0;
        lcdcmd(1);
        while(1)
```

```
{while(sw1==1 && sw2==1 && sw3==1)
        {if(speed==0)
                {motor=0;
                lcdcmd(1);lcdcmd(0x80);
                dsplystrng("MOTOR OFF    ");lcdcmd(0xc0);
                dsplystrng("NEUTRAL     ");
                while(sw1==1 && sw2==1 && sw3==1);}
                if(speed==0)
                P0=0;
                else
                {if(sw1==1 && sw2==1 && sw3==1)
                        {motor=0;
                        DDelay(i,j);}
                        if(sw1==1 && sw2==1 && sw3==1)
                        {motor=1;
                        DDelay(k,l);}
                                if(speed)
        motor=1;
        delay(10);
        if(sw1==0)
        motor=~motor;
                x=~x;
                if(x==0)
                speed=0;
                else
                speed=1;
                while(sw1==0);
                        else if(sw2==0)
                        if(speed<4)
                speed++;
                r1=1;
                r2=0;
```

```
delay(50);
r1=0;
r2=0;
while(sw2==0);
        else if(sw3==0)
                if(speed>0)
speed--;
r1=0;
r2=1;
delay(50);
r1=0;
r2=0;
while(sw3==0);
        if(speed!=0)
                switch(speed)
                                        case 4:  i=0xFD;
                        k=0;
                        j=0xFF;
                        l=0;
                        break;
                case 3:  i=0x50;
                        k=0x00;
                        j=0xaa;
                        l=0x40;
                        break;
                case 2:  i=0xA1;
                        k=0x87;
                        j=0x55;
                        l=0x80;
                        break;
                case 1:  i=0x43;
                        k=0xE5;
```

```
                                        j=0x00;
                                        l=0xB0;
                                        break;
                                default:break;
                                lcdcmd(1);lcdcmd(0x80);
                        dsplystrng("SPEED LEVEL = ");
                        lcdcmd(0xc0);
                        dsplystrng("GEAR =      ");
                        lcdcmd(0x8E);
                        dsplychr(48+speed);
                        lcdcmd(0xc6);dsplychr(48+speed);
        void DDelay(unsigned char x,unsigned char y)
TF1=0;
TL1=x;
TH1=y;
TR1=1;
while(TF1==0);
TR1=0;
TF1=0;
void initlcd(unsigned char address)
        rs=0;
        P1=(0x03);
        clk();
        Delay1KTCYx(200);
        P1=(0x03);
        clk();
        Delay1KTCYx(20);
        P1=(0x03);
        clk();
        Delay1KTCYx(2);
        P1=(0x02);
        clk();
```

```
        Delay1KTCYx(100);
        lcdcmd(0x28);
        Delay1KTCYx(200);
        lcdcmd(0x0C);
        Delay1KTCYx(5);
        lcdcmd(0x01);
        Delay1KTCYx(5);
        lcdcmd(0x06);
        Delay1KTCYx(5);
        lcdcmd(address);
        Delay1KTCYx(5);
void dsplychr(unsigned char dat)
        P1=((dat>>4)&0x0f);
        rs=1;
        clk();
        P1=(dat&0x0F);
        rs=1;
        clk();
void lcdcmd(unsigned char dat)
        P1=((dat>>4)&0x0f);
        rs=0;
        clk();
        P1=(dat&0x0F);
        rs=0;
        clk();
void dsplystrng(unsigned char *ptr)
        unsigned char i=0;
        while(*ptr!=0&&i<16)
                        dsplychr(*ptr);
                ptr++;
                i++;
```

```
if(i==16)
lcdcmd(0xC0);
while(*ptr!=0&&i<32)
        dsplychr(*ptr);
    ptr++;
    i++;
```

6 CONCLUSIONS

After achieving the desired gear shifting technology, we ever able to get a smooth ride in all city conditions. We have found that there is an improvement in the fuel efficiency. This gear shifting technology has improvised the auto-clutch featured bike into automatic transmission vehicle. The complete gear changing mechanism has been controlled by the acceleration of the bike. The vehicle can be used in manual mode by switching off the power supply to the electrical components. A switch has been provided for this optional mode.

The programmed embedded 'C' codes, in the microcontroller, were optimized and were the key source for changing gears in city limits as well as highways. Maintaining a proper pulse range, as in the program, or a constant speed of the vehicle resulted in better fuel efficiency. Fuel efficiency has been improved by 2km to 4km. After implementing this technology, we have come to a conclusion that no human operation is necessary, other than accelerating, to ride the motor bike.

This mechanism gives the safety to the gear box from failure. This invention has also some drawbacks like they require the proper safety for electric devices in engine because in engine heat generate and it causes the short-circuit also.

7 REFERENCES

1. https://en.wikipedia.org/wiki/Automatic_transmission
2. Nature and Science, 1(1), 2003, Zhuand Xu, Experimental Study on Intelligent Gear-Shifting.
3. P. Alexander, T. Sudha, M. Omamageswari. "AUTOMATIC GEAR TRANSMISSION IN TWO WHEELERS USING EMBEDDED SYSTEM" Volume 3, Issue 2, July-December (2012), pp. 164-175.
4. R. Hembree, "SEMI-AUTOMATIC ELECTRIC GEAR SHIFTING APPARATUS FOR A MOTORCYCLE". United States 15 July 1975.
5. U. M. Friedrich Raff, "SHIFTING ARRANGEMENT 'FOR AN AUTOMATIC TRANSMISSION OF A MOTOR VEHICLE". United States 3 Sep 1991.
6. David G. Funk, "PUSHBUTTON SOLENOID SHIFTER". United States of America patent 6070485, 6 Jun 2000.
7. P. Alexander M.E, "AUTOMATIC GEAR TRANSMISSION IN TWO WHEELERS," vol. 3, no. 2, 2012.
8. Oliver J. Tysver, "AUTOMATIC GEAR SHIFTING MECHANISM FOR MULTISPEED.
9. MANUALLY POWERED VEHICLES". United States 28 Dec 1999. Francis G. King, "AUTOMATED MANUAL TRANSMISSION SHIFTER WITH ELECTRONIC CONTROL ACTUATORS EXTERNAL OF THE VEHICLE". United States of America Patent 4554824, 26 Nov 1985.
10. Robert E. LaWrie, "AUTOMATED MANUAL TRANSMISSION SHIFT SEQUENCE CONTROLLER". United States 1 Feb 2000.
11. Pierre A. G. Lepelletier, "MULTISPEED AUTOMATIC TRANSMISSION FOR AUTOMOBILE VEHICLES". United States 21 April 1992.
12. Luigi Glielmo, "Gearshift Control for Automated Manual Transmissions," IEEE /ASME, vol. 1, p. 11, 2006.
13. http://www.theelectricalportal.com/2015/07/lead-acid-battery.html
14. https://www.quora.com/What-is-the-advantges-of-a-constant-mesh-gear-box-over-the-sliding-mesh-gear-box
15. https://en.wikipedia.org/wiki/Microcontroller
16. Automobile engineering book by Kirpal Singh Vol 1