SEMI-AUTOMATIC GEAR SHIFTING MECHANISM IN TWO-WHEELERS

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UKA TARSADIA UNIVERSITY

in Partial Fulfilment of the Requirements for the Degree of

Bachelor of Technology

in

Automobile Engineering

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MAY 2019

CERTIFICATE

This is to certify that research work embodied in this project report entitled **"SEMI-AUTOMATIC GEAR SHIFTING MECHANISM IN TWO-WHEELERS"** was carried out by **Mr. Chauhan Umesh** (201503101310063), **Ms. Chauhan Shreya** (201503101310091), **Mr. Naik Kathit** (2015031013100109), and **Mr. Raval Krish** (201603101310015) at **Chhotubhai Gopalbhai Patel Institute of Technology** for the partial fulfilment of B. Tech. degree to be awarded by UKA TARSADIA UNIVERSITY. This research work has been carried out under my supervision and is to my satisfaction.

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I hereby certify that I am the sole author of this project report and that neither any part of this project report nor the whole of the project report has been submitted for a degree to any other University or Institution.

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This is to certify that the dissertation report entitled "SEMI-AUTOMATIC GEAR SHIFTING MECHANISM IN TWO-WHEELERS" submitted by Mr. Chauhan Umesh (201503101310063), Mr. Dharmesh Patel (201503101310037), Mr. Naik Kathit (2015031013100109), and Mr. Raval Krish (201603101310015) as per the requirement of the course work for the candidate registered for B. Tech. Automobile, of the Chhotubhai Gopalbhai Patel Institute of Technology, Bardoli is approved.

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ABSTRACT

Motorcycles are widely used around the world particularly in INDIA. The gear shifting system of the motor-cycle is conventionally manual. This report covers development of an indigenous gear shifting /changing system for the standard motorcycle. By this system the manual mechanical gear- shifting will remain unchanged because an additional electro-mechanical system is placed on the top of the lever to shift the gear and automatically control the clutch. So the system has both the option manual as well as automatic. The system uses low cost microcontrollers to make the accurate decision for shifting the gear up and down by observing the speed. The complete hardware and software has been tested and the functioning of the Semi-Automatic gear shifting system is verified. System is flexible and can be used with any motorcycle ranging from 50 to 200 cc. Motorcycle is also varies in two large section gear transmission & CVT transmission. The recently conducted survey shows that CVT are in demand compared to the gear featured bikes. CVT's do not have the concept of meshing of gears which enhances a smooth ride, but the fuel efficiency is comparatively lesser when compared to the gear featured vehicles. Automation of gears transmission can be achieved by embedded system. Embedded system is a special purpose computer system. Embedded system is preferable because it can reduce the number of electrical components and probability of failure is minimum. Either a microprocessor or a microcontroller is used in all the embedded systems. The encoding is done by using suitable software for writing assembly level language in microcontroller which is stored in ROM of microcontroller. Embedded 'C' language is used to encode microcontroller or microprocessor counts the revolutions per minute. According to the RPM counted by sensor the embedded system will decide which gear is preferred for the smooth drive of vehicle and according to the output calculated by system the gear are changed. It can also eliminates the shortcoming such as 'Knocking' and subsequently increases engine life span, Hence by Automating the gear transmission in a gear featured bike, ease in driving and also to maintain the efficiency of the bike can be achieved.

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1 . INTRODUCTION

There are already some inventions done of gear box for motorcycle for transmitting the torque from engine crankshaft to the rear wheel of the motorcycle. The gear box is used to vary the torque as per the different driving conditions. The gearbox increases the required torque for start the ride and put the motorcycle in to motion. After the start or the running of the motorcycle there is no need of high torque, so now gear box will transmit the optimum torque to the rear wheel at high speed. For the operation of gearbox and shifting the gear there is need of some effort of driver of motorcycle. A foot lever is used to shift the gears in a motorcycle. Also, a clutch is placed between the engine and the transmission in order to engage and disengage the flywheel with the transmission. So for smooth driving of motorcycle there is need to time these two operations perfectly. This gear shifting becomes a tiresome process for most new drivers. This can also help in reducing accidents.

General operations for driving a bike is: selector selects the gear, pull the clutch towards you using your left hand, and revolution of the engine with certain r.p.m will be there without moving the bike forward. Releasing of the clutch while the transmission is "in gear" (i.e., not in neutral), and you'll move the bike forward.

In any other normal motorcycle the gear box is used for transmitting the torque from engine crankshaft to the rear wheel of the motorcycle. It can vary the torque according to the different driving conditions i.e. gear box increases torque at the start of the vehicle as it required for the vehicle to put in motion. After the vehicle is in motion there is no need to high torque so it will transmit optimum torque to the rear wheel for that instance of speed. Some other factors are also used while shifting the gear such as foot gear paddle used for shifting the gear and hand clutch for engaging and disengaging of flywheel. In short smooth driving of motorcycle there is need to time these two operations perfectly. And this entire cycle for gear change is can be so much tiresome for somebody particularly new driver. Therefore automated gear shifting system not only reduces accidents but also increases engine and fuel efficiency.

In our embedded system both gear paddle and clutch is actuated by using Electro-mechanical based microcontroller system. Since the whole arrangement is placed outside of the system, there is no need to do modification in the engine.

1.1 Introduction to transportation and transmission

Transportation decisions impact many aspects of urban life. Young and old alike are affected by the viability and relative ease of travelling to destinations on foot, by bike, transit, or reliance on private vehicles. Transportation investments are arguably the single largest shaper of urban spaces and of development patterns. The safety, speed, and comfort for a particular mode of travel are a function of the investments that have been made in specific types of travel options. Regions, and parts of regions, vary considerably in terms of their supportiveness of travelling in ways that are health promoting (active) and environmentally sustainable.

Transmission system transmits mechanical power from the engine to give kinetic energy to the wheels. It is an interconnected system of gears, shafts, and other electrical gadgets that form a bridge to transfer power and energy from the engine to the wheels. The complete set up of the system helps to maintain the cruising speed of the vehicle without any disturbance to the performance. The oldest variant of the transmission system in India is the manual transmission that has undergone various modifications and alterations to form the present day automatic transmission.

A transmission or gearbox provides speed and torque conversions from a rotating power source to another device using different gear ratios. The transmission reduces the higher engine speed to the slower wheel speed, increasing torque in the process. A transmission will have multiple gear ratios with the ability to switch between them as speed varies. This switching may be done manually or automatically. Directional control may also be provided, such as forward and reverse gears.

In motor vehicle applications, the transmission will generally be connected to the crankshaft of the engine. The output of the transmission is transmitted through chain drive, which in turn gives motion the rear wheel.

Most modern gearboxes are used to increase torque while reducing the speed of a prime mover output shaft. This means that the output shaft of a gearbox will rotate at slower rate than the input shaft, and this reduction in speed will produce a mechanical advantage, causing an increase in torque.

1.2 Types of transmission

There are two major types of transmission, namely manual gear transmission and automatic gear transmission.

1.2.1 Manual gear 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.

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 1-1: 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 1-2: 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.

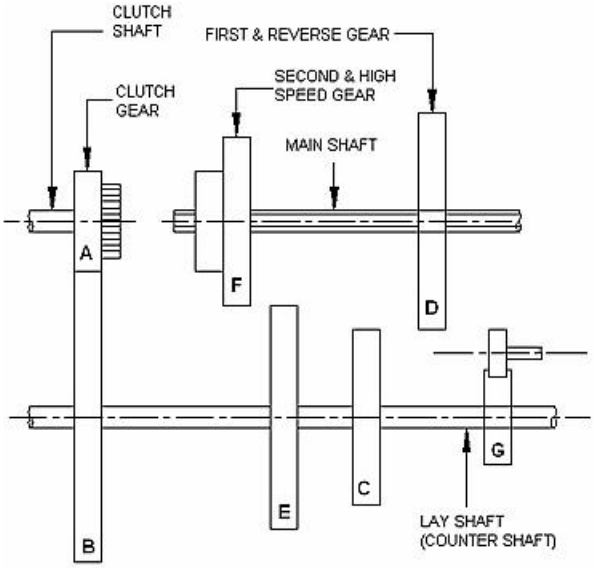

Figure 1:1 Sliding Gear Transmission

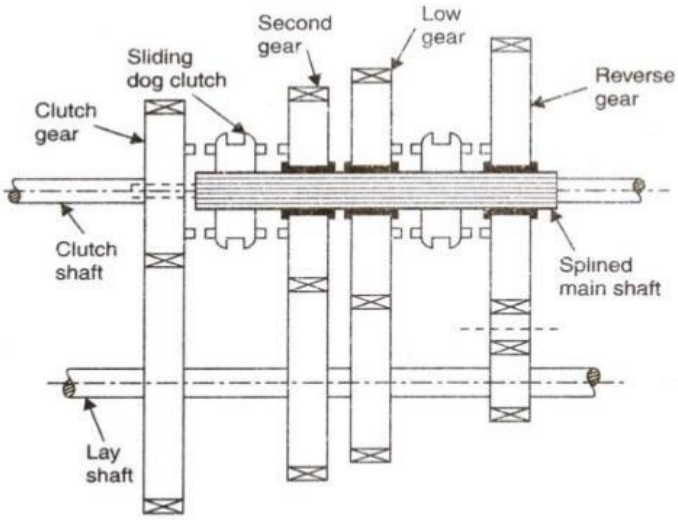

Figure 1:2 Constant Mesh Transmission

1.2.2 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.

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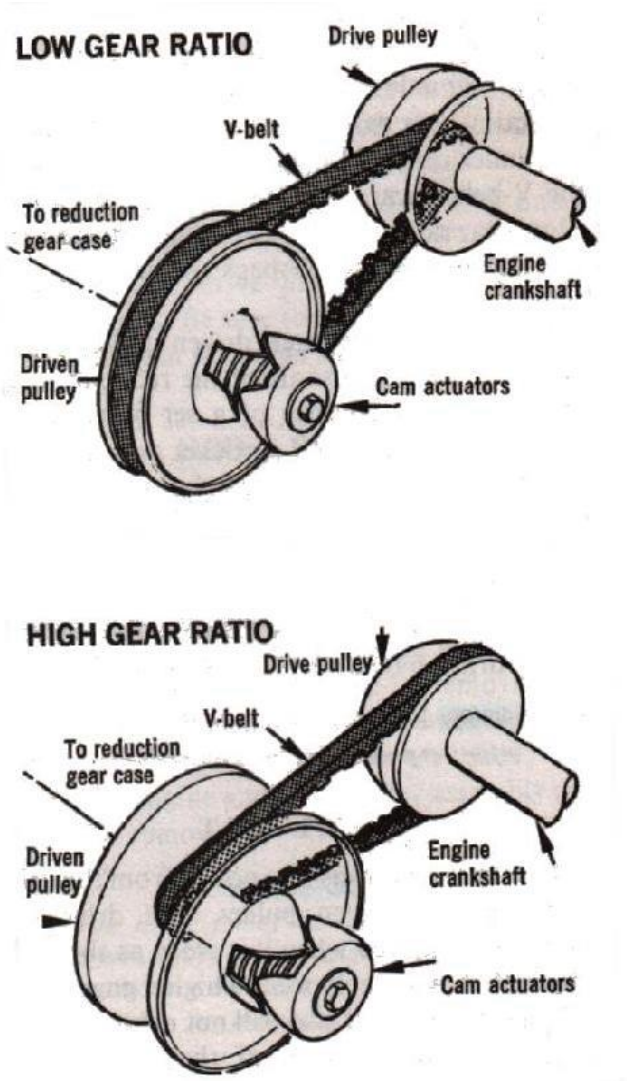

Figure 1:3 Constant Variable Transmission Low and High Gear Ratio

1.3 Comparison between Manual and Automatic Transmission

1.3.1 Manual Transmission

1. 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.
2. Manual transmissions normally do not require active cooling, because not much power is dissipated as heat through the transmission.
3. 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.

4. 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.

1.3.2 Automatic Transmission

1. 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.
2. 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.
3. 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.
4. There is no clutch pedal and gear shift in an automatic transmission car. Once you put the transmission into drive, everything else is automatic.
5. 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.

1.4 Automation of Manual Gear Transmission

1.4.1 Overview

The topic of our project is to develop a automatic transmission system with has finite number of gearshifts, which transmits the power automatically with respect to speed of the vehicle. 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 project is to transmit the gears without the human interference and to attain efficient, safe and easy driving in cost effective way.

1.4.2 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, SCADA, etc.

1.4.3 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 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 lots of Electronic components.
- Build in with rich features.
- Probability of failure is reduced.
- Easy interface.

2 .LITERATURE REVIEW

2.1 Paper of literature

A. Kahraman, 2008[1] A. Kahraman has "Power assisted gear shifting mechanism for Automobile". The main objective of this project is to create a mechanism to reduce the inconvenience caused when changing gears in the car. The gear shifting is by hydraulic force achieved by a simple modification to the gear box. The setup consists of power Steering pump, piston cylinder assembly and a set of fluid valves. The car with this project will have a series of buttons in the format of 4 forward, a reverse and a neutral. The power for gear shifting is got from hydraulic fluid. The power for fluid is from the power steering pump. The project design comprises of designing the following parts: 1. Hydraulic circuit 2. Electronic circuit 3. Mechanical components. The main driving force for the gear shifting is by the hydraulic fluid. The gear shifting along with the clutch operation works with the pressing of buttons. On pressing the button corresponding to the gear, three operations take place: 1. Engine rotation 2. Clutch engagement 3. Pump rotation. When the car is switched on the engine rotates, on pressing the button clutch engages. Now electromagnetic clutch engages the pump. Due to the pump rotation the hydraulic fluid is pumped from reservoir to the inlet solenoid valve. Through this valve the fluid pushes the piston in the cylinder. This motion causes the gear shifter rod to engage the gear which is fitted to the piston. In order to avoid slippage of gear a limit switch is used to sense the Position of selector rod and cut off the supply. To bring the car to neutral position we press the N button. Now the outlet solenoid valve energizes so the fluid in the cylinder rushes back to the sump with the aid of spring tension. If the next higher gear has to be selected, the same operation takes place on pressing the next button. Thus we conclude from this paper is that the gear shifting is by hydraulic force achieved by a simple modification to the gear box. The setup consists of power steering pump, piston cylinder assembly and a set of fluid valves. Further, automatic clutch can be incorporated with this unit to make it fully automatic.

Vishnu P.R [2] Vishnu P.R has the discussion in this paper is regarding a gear shifting mechanism to make the shifting process easier and reliable. This mechanism uses two pneumatic double acting cylinders, programmable logic controller (PLC), an electric

motor, limit switches. According to this discussion, the control unit chooses optimum gear shifting ratio without operating it manually with the help of relays. Components used in this project are: 1.Manual 4-Speed Gear box 2.Relay 3.Pneumatic Cylinder 4.Microcontroller 5.Proximity Sensor 6.Directional Control Valve 7.Electric Motor .The Basic principle of working of this model is that the compressor sends the pressurized air to the solenoid valves through the hoses of 6mm diameter whereas the solenoid valve acts as temporary storage of air and acts as passage. The air from the solenoid valves passes to the pneumatic cylinders which act as working medium for actuating cylinders. When air enter into the cylinders the pistons starts reciprocating that is extraction and retraction. The retraction is done manually by operating switches on the solenoid valves by closing the air inlet**.** On the other hand the relays send the precise signals to the solenoid valves. The input for these relays is the speed of the wheel or vehicle which is sensed by sensor proximate to the wheel. The shifting of gear is done by altering the speeds by rotating the rotor in the speed regulating board i.e. accelerator in case of automobile. Thus, from this we concluded that this project has involved the development and implementation of automatic transmission for bike. The application of this mechanism leads to making the driving process easier and comfortable, reducing the risks of miss-shifting. This invention relates to control mechanisms and more particularly to mechanisms for controlling the selection and establishment of various gear relations of automotive vehicle transmission gearing. Our Invention relates to gear shift mechanisms particularly such as are used on automotive vehicles. It has for one of its principal objects to provide a gear shift mechanism pneumatically operated, through the instrumentality of which the various gears in the mechanism may be made operative.

Ray Hombre (United States Patent, 1975) [3] Ray Hombre has it claims a semi-automatic electric gear shifting apparatus for use in shifting gear boxes of motorcycles by rotating spindle connected to ratchet type gear shifting means switching in the form of a pair of push button switches mounted on the handle bar which connects electrical drive to an electrical power source. This apparatus provides for use of an electrical drive for accomplishing the force required to move the gear shifting lever arm through the desired rotational arc and thereafter returning lever arm to the original neutral position so that the next gear changing stroke may be performed. Invention replaces the manual

operation of the gear shift lever arm of a motorcycle by providing a precise movement of the lever arm in a predetermined manner and through a precise arc, thus providing a more uniform and reliable means of shifting gears. the selective pressing of the electrical switches on the handle bar is all that is required to effect the gear change, without the use of the gear disengaging clutch because the movement of the gear shifting arm is sufficiently rapid so as to not damage the gears while effecting the gear shift. The operator operates the electrical drive means by energizing said drive means to perform the shifting stroke and de-energizing said electrical drive means to return the lever arm to its original neutral position. Switching means in the form of a pair of push button-switches mounted on the handle bar operably connects said electrical drive means to an electrically connected to said power source through said switches, said electrical drive means including a solenoid, an actuating rod operatively connected to said solenoid, said actuating rod in turn being connected to a gear shifting lever arm through a toe pedal of the motorcycle, said lever arm being connected to a gear shifting spindle of the motorcycle gear mechanism, the connection between said lever arm and said spindle being such that when one of said switches is actuated said lever arm is moved by said solenoid to rotate said spindle in a first direction to change gears and when the other of said switches is activated said lever arm is moved by said solenoid to rotate said spindle in a second direction to change gears. The semi-automatic electric gear shifting apparatus for motor cycles wherein an electric drive comprises a double acting electric solenoid. Thus main objective of this Patent is useful means for electrically shifting gears in a gear box having a ratchet type gear shifting means. More particularly, it is an object of this invention to provide a semi-automatic electrical gear shifting apparatus for use on motorcycles having ratchet type gear shifting means.

David L. Browning (United States Patent, 1993) [4] David L. Browning has an invention relates to the shifting of a bicycle chain and, more particularly, to computer controlled automatic shifting of a bicycle chain. It is another invention to provide a computer-controlled bicycle shifting system which shifts the bicycle to maintain a desired speed and shifts the bicycle in response to input by a cyclist and adjusts the desired gear ratio. Multi-geared bicycles have a gear assembly at the rear wheel (rear gear assembly), and one at the pedal-crank assembly (front gear assembly). The cyclist can independently select a front gear and a rear gear. By selecting appropriate front and

rear gears, a cyclist determines a gear ratio that is suitable for the riding conditions. This system shifts the bicycle only while it is being pedaled in the forward direction. The system comprises computer, shift buttons, crank sensor, hub sensor, rear wheel sensor, rear shift selector, and front shift selector. The shifting system interfacing with a bicycle transmission system. The bicycle includes front gear assembly, rear gear assembly, transmission chain, pedal arms, and pedals. The front gear assembly includes three gears, and with teeth, respectively. The rear gear assembly includes four gears. A computer system that detects speed, hub speed, and crank speed, determines the Optimum bicycle gear selection to maintain a desired cadence, and shifts the bicycle to the optimum bicycle gear. The computer also inputs a shift up and shift down signals from the cyclist to override the computer selected gear. When the cyclist indicates a shift up or down, the computer adjusts the desired cadence. The computer determines the gear selection to ensure a uniform transition from the current gear to the next gear. The computer ensures that when shifting from the current gear to the next gear, the bicycle does not transition through a gear that is not between the current and next gears. The computer counts the number of crank and hub revolutions during a specified interval and determines the actual gear selected. In a preferred embodiment, a quadrature signal is generated when the bicycle is being pedaled. From the quadrature signal, the computer determines the direction of pedaling and signals a shifting mechanism to shift only when the bicycle is being pedaled into the forward direction. In a preferred embodiment, a cyclist signals the computer to shift up or shift down to override the computer-generated shifting. In response, the computer resets its internally maintained desired cadence so that it will shift the bicycle to the new gear whenever the bicycle is traveling at the same speed as when the cyclist signaled the shift.

Ambar G., Kundan K. (2017) [5] Ambar G., Kundan K. has the discussion in the report is about the development of a gear shifting system for the standard motorcycle with an additional electro-mechanical system is placed on the top of the lever to shift the gear and automatically control the clutch. This system does not require any modification to the engine. The equipment is mounted externally on the body of the motorcycle. This system shifts the gear up and down electromechanically like the human rider by sensing the speed of the vehicle, but the system shifts the gear at exactly the correct speed, which produces the smooth gear changing sequence. The engine runs smoothly without

any knocking, which increases the engine life. This proposal is different from the one used in cars as it uses electromechanical actuators. The system uses microcontrollers to make the accurate decision for shifting the gear up and down by observing the speed, and it controls the clutch transmission. Magnets will be placed on a rear wheel and r.p.m sensor will be placed. As the wheel rotates magnets attach to the wheel also rotates. The Hall Effect sensor which works on the principle of Hall Effect will generate the voltage. When magnetic field will pass perpendicular to the field, this voltage will be sent to the ECU and according to situation ECU will give commands to actuator; thus changing gear back and forth. It includes a DC motor with a sensor for position feedback. A linear punching actuator uses it's to and fro motion for precise control of gear lever, a Hall effect sensor to measure wheel speed, Arduino Platform. The coding for the servo motor using the Arduino software was completed. This program allows the Arduino to control the servo motor functioning according to the situation of the drive. The code that is written works on the Boolean principles. It gives a positive signal (1) whenever the gear has to be shifted. In any other case, it is (0). If, else statements are used for shifting the gears whereas time delay is used to manage the operation of clutch. The code to display in the current gear is also written. Thus, this system is flexible and can be implemented on a motorcycle available in the market without any modification. The motorcycle manufacturing can also use the system in their vehicles because it can be easily fitted to the motorcycle and there is no need of internal modification of the gear system. This will also help in improving fuel economy in addition to improving the parts lifetime.

2.2 Conclusion Derived from Literature Survey

From the review of the journals and papers we have understood that the automatic transmission vehicles are more in demand but less fuel efficient. So, automation of manual vehicles can smoothen the driving and improve efficiency. The microcontroller is major component that need to be programmed. Linear actuators can be used to punch the pedal for shifting the gears but it consumes more power from the battery. The vehicle can be provided with two modes of driving, manual and automated mode. This technology can be implemented in auto-clutch bike as well as in clutch featured bike.

3 .AIM AND OBJECTIVES

The literature review clearly indicates the gap in fabrication of the automated manual gear shifting mechanism in the conventional motor bikes, in order to bridge this gap gear shifting mechanism is designed and fabricated in the following project work.

Aim:

To design and fabricate the automated manual gear transmission in motor bikes.

Objectives:

1. To design the gear shifting mechanism and modify the vehicle according to the designed mechanism.
2. To program the Arduino according to the needs of the mechanism and build the electronic circuit.
3. To calibrate the gear shifting mechanism and also to check for the improvements in the efficiency if any.

4 .EXPERIMENTION

4.1 General Terminology

4.1.1 Electro-Mechanical Actuators

Electromechanical actuators are mechanical actuators where the control knob or handle has been replaced by an electric motor. The rotary motion of the motor is converted into linear displacement. The principle operation in most electromechanical actuators is based on the inclined plane concept. The threads of the lead screw are used as a ramp that converts the small rotational force by magnifying it over a long distance. This enables a large load to be moved over a small distance. The simplified design of the motor motion is mechanically converted into linear displacement. Variations on electromechanical actuators have been devised to achieve higher mechanical efficiency, speed operation, and increase load capacity. In most designs the lead screw and the nut are incorporated into the motion. The screw is connected to a motor or manual control knob. Other designs use a ball screw and ball nut, or have the screw connected to the motor directly via gears. The gears help to transmit the low power motion at a high revolution per minute (RPM) through the gears to magnify its torque. This is done so it can handle the weight exerted on the screw, preventing the motor from engaging the heavy load directly.

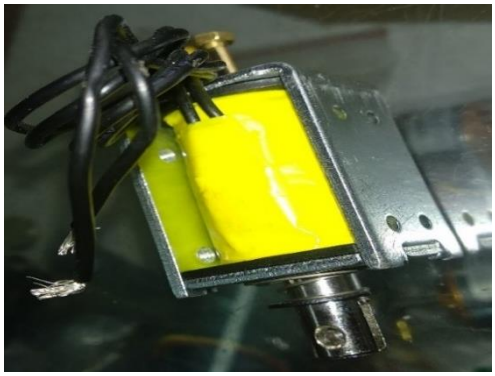

Figure 4:1 Electro-Mechanical Actuators-1

Figure 4:2 Electro-Mechanical Actuators-2

Figure 4:3 Electro-Mechanical Actuators-3

4.1.2 Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. It is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name. Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers consist of a resistive element, a sliding contact (wiper) that moves along the element, making good electrical contact with one part of it, electrical terminals at each end of the element, a mechanism that moves the wiper from one end to the other, and a housing containing the element and wiper. The potentiometer can be used as a voltage divider to obtain a manually adjustable output voltage at the slider (wiper) from a fixed input voltage applied across the two ends of the potentiometer. This is their most common use.

Figure 4:4 Potentiometer

4.1.3 Arduino Board

It is a Microcontroller board developed by Arduino.cc and based on Atmega328p /Atmega168. Arduino boards are widely used in robotics, embedded systems, and electronic projects where automation is an essential part of the system. Arduino Nano is a small, compatible, and flexible and breadboard friendly Microcontroller board, developed by Arduino.cc in Italy. It comes with exactly the same functionality as in Arduino UNO but quite in small size. It comes with an operating voltage of 5V, however, the input voltage can vary from 7 to 12V. Arduino Nano Pinout contains 14 digital pins, 8 analog Pins, 2 Reset Pins & 6 Power Pins. Each of these Digital & Analog Pins are assigned with multiple functions but their main function is to be configured as input or output. There is one limitation using Arduino Nano i.e. it doesn't come with DC power jack, means you cannot supply external power source through a battery.

Figure 4:6 Arduino MEGA

Figure 4:7 Arduino UNO

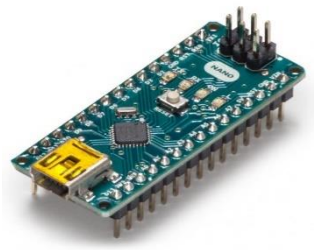

Figure 4:5 Arduino NANO

4.1.1 LCD (Liquefied Crystal Display)

LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. 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. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. 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.

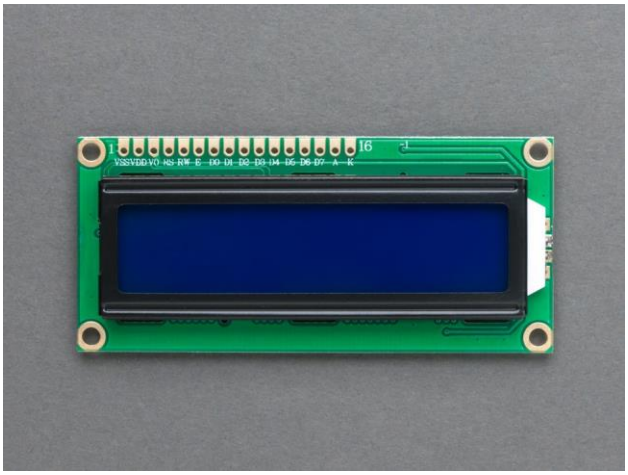

Figure 4:8 LCD (Liquefied Crystal Display)

4.1.2 Relay

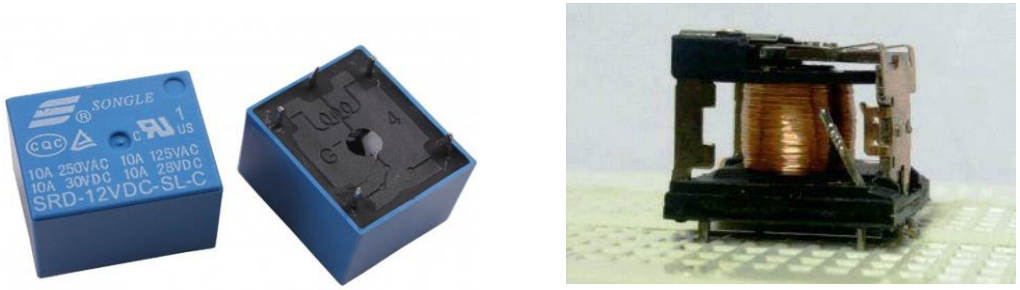

Figure 4:9 Relay

Relay is a switch which controls (open and close) circuits electromechanically. The main operation of this device is to make or break contact with the help of a signal without any human involvement in order to switch it ON or OFF. It is mainly used to control a high powered circuit using a low power signal. Generally a DC signal is used to control circuit which is driven by high voltage like controlling AC home appliances with DC signals from microcontrollers. These are high-quality Single Pole - Double Throw (SPDT) sealed 5V Sugar Cube relays. Use them to switch high voltage (240AC), and/or high current devices (7A). Features 5V DC SPDT Relay Rated up to 7A @240VAC Fully Sealed. An electromechanical relay is basically designed using few mechanical parts like Electromagnet, a movable armature, contacts, yoke, and a spring/frame/stand. All these are arranged logically to form into a relay.

Relay in NORMALLY CLOSED condition: When no voltage is applied to the core, it cannot generate any magnetic field and it doesn't act as a magnet. Therefore, it cannot attract the movable armature. Thus, the initial position itself is the armature connected in normally closed position. Relay in NORMALLY OPENED condition: When sufficient voltage is applied to the core it starts to create a magnetic field around it and acts as a magnet. Since the movable armature is placed within its range, it gets attracted to that magnetic field created by the core, thus the position of the armature is being altered. It is now connected to the normally opened pin of the relay and external circuit connected to it function in a different manner.

4.1.3 Limit Switch

Figure 4:10 Limit Switch

Limit switches are used in a variety of applications and environments because of their ruggedness, ease of installation, and reliability of operation. They can determine the presence or absence, passing, positioning, and end of travel of an object. They were first used to define the limit of travel of an object; hence the name "Limit Switch".

4.1.4 Proximity Sensor

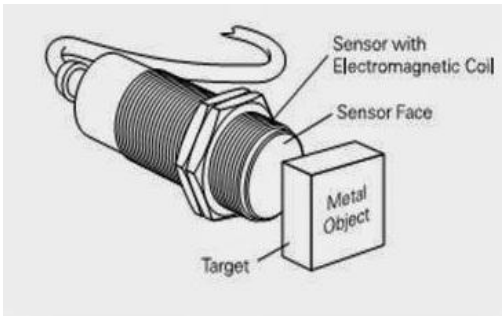

Figure 4:11 Proximity sensor

A proximity sensor is a device which detects the presence of nearby objects without any physical contact. It often emits an electromagnetic field or a beam of electromagnetic radiation (infrared), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target as shown in Figure 1-4: Proximity Sensor that senses metal objects. Different proximity sensor targets demand different sensors. For example, an inductive proximity sensor always requires a metal target. The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance. Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object.

5 .DESIGN AND FABRICATION

Introduction

In order to reach our goal of making an automatic gear transmission motor bike, different types of systems and components are used. According to this customization and fabrication of the components, proper placement and fitting of components is carried out. The details regarding various components used and the fabrication methods are explained in this chapter, it helps to have the knowledge of different components and its working.

5.1 Selection of bike

Figure 5:1 Selection of Bike

According to the literature survey, projects are done on automating the gear transmission by a system called as Continuous Variable Transmission (CVT) such as in mopeds. But the maintenance cost and mileage of such mopeds are not very user friendly, though they are easy to drive but they are not very feasible. Hence our main aim is to automate the gear transmission in motor bikes. We chose a motor bike as shown in Figure 5:1 with an automatic clutch feature in order to simplify the gear transmission when automated.

5.1.1 Bike Specification

The below Table 5.1: Highlights the specification of our project vehicle.

Table 5-1 Specification of Bike

QUICK FACTS & SUMMARY	
Body Type	Commuter
ENGINE SPECIFICATIONS	
Engine Description	97cc
Displacement	97 cc
Maximum Power	7.5bhp@8000rpm
Maximum Torque	0.73@5000rpm
DIMENSIONS & WEIGHT	
Overall Length	1885.00 mm
Overall Width	770.00 mm
Overall Height	1060.00 mm
Ground Clearance	135.00 mm
Wheelbase	1235.00 mm
curb/Wet Weight	116.00 kg
Fuel Tank Capacity	12.80 liters
SUSPENSION & WHEEL TRAVEL	
Front Suspension	Telescopic hydraulic fork
Rear Suspension	Swing-arm with hydraulic dampers

TYRE SIZE & WHEELS	
Wheel Size	2.50"x18"/2.75"x18"
Tubeless Tires	NO
Alloy Wheels	NO
PERFORMANCE & MILEAGE	
Top Speed	85 kmph
Mileage (Combined)	71 kmpl
COMFORT & CONVENIENCE FEATURES	
Electric Start	NO
Pillion Footrest	NO
Pass Light	NO
Step-up Seat/Split Seat	NO
BATTERY & ELECTRICALS	
Voltage	12V

5.2 Design

The design basically consists of a two Actuator are fitted on the gear lever and the two limit switch is joint to below the gear lever. And this two actuator and limit switch connection are joint to electric-circuit and the whole system are take power from 12-V, 5-A battery. But that actuator are selected for this load carrying capacity in Newton (N). So all data and calculations are briefly explained below.

5.2.1 Torque calculation

The torque necessary for the gear shifting to happen is calculated as shown in the below calculation steps:

Figure 5:2 Clutch operation

Figure 5:3 Forward shifting

Figure 5:4 Reverse shifting

1. Distance moved by lever after full clutch lever pressing = 8 cm

   = 0.08 m

2. Weight required for full pressing of clutch = 5.6 kg
3. Force required for full clutch lever pressing = m x g

   = 5.6 x 9.81

   = 54.93 N

4. Torque Required for Clutch operation = Force x distance

=54.93 x 0.08

=4.39 Nm.

5. Length of pedal from pivot = 25/2 cm = 12.5 cm

= 0.125 m

6. Weight required until the gear stick changes the gear for forward shift= 4.7 kg

7. Force required for forward shift of gear pedal = m x g

= 4.7 x 9.81

= 46.107 N

8. Torque required for Forward Shift = Force x distance

= 46.107 x 0.125

=5.76 Nm.

9. Weight required until the gear stick changes the gear for reverse shift = 4.6 kg

10. Force required for reverse shift of gear pedal = m x g

=4.6 x 9.81

= 45.126 N

11. Torque required for Reverse Shift = Force x distance

=45.126 x 0.125

=5.64 Nm.

5.2.2 Designing the gear shifting mechanism

Each part involved in the gear shifting mechanism were designed initially with assumed dimensions and later modified with accurate measurements. Major components such as DC Actuator, Gear pedal, Clamp and Stand are designed in the Autodesk Inventor software and assembled. From the Figure 5.5; the offset in between the Centre of DC Actuator and center of gear pedal is 60.2 mm. The total length of the pedal is 125mm. and the Actuator is 5 cm, clamp is 3cm long, circular part is 3 cm and stand is approximately 17-20 cm. above data is basically designing of mechanism parameter. The Isometric and front view of design mechanism is below.

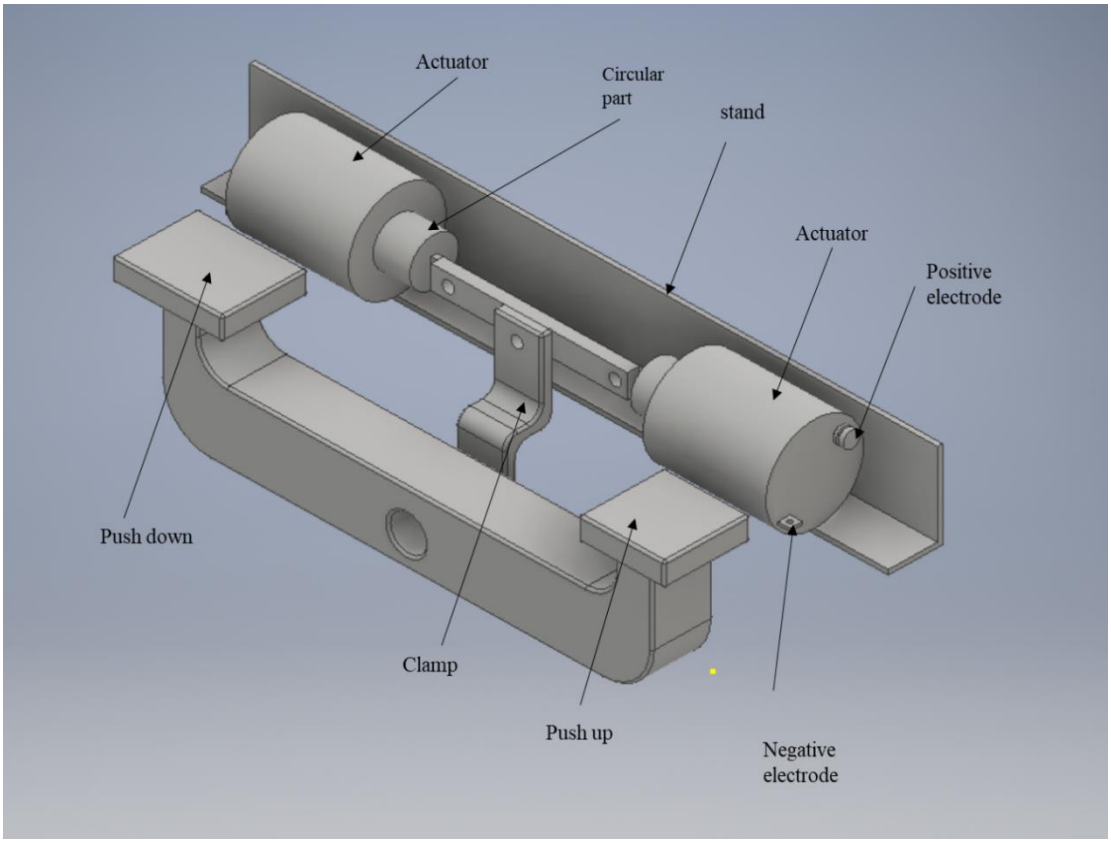

Figure 5:5 Isometric view of the Automated Gear Shifting

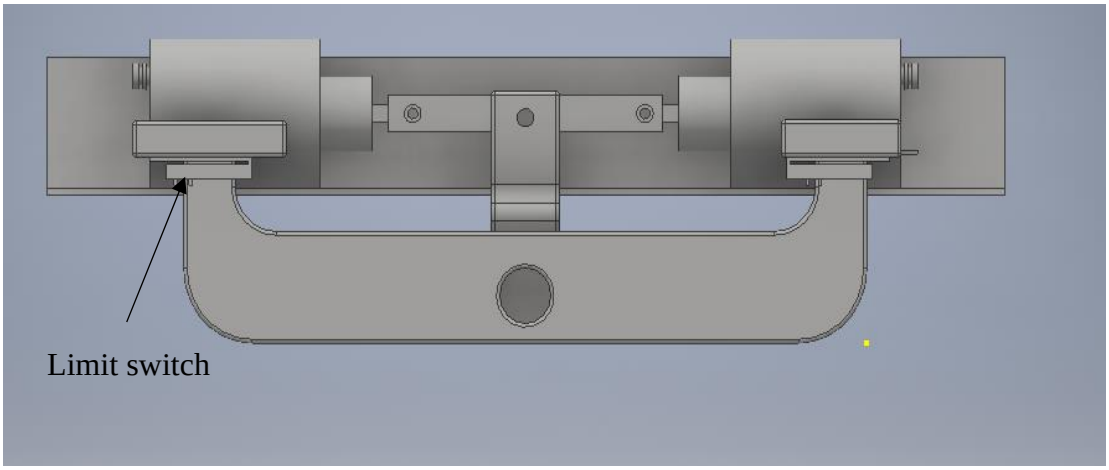

Figure 5:6 Front view of the Automated Gear Shifting

5.3 Fabrication

5.3.1 Electro-Mechanical Actuator

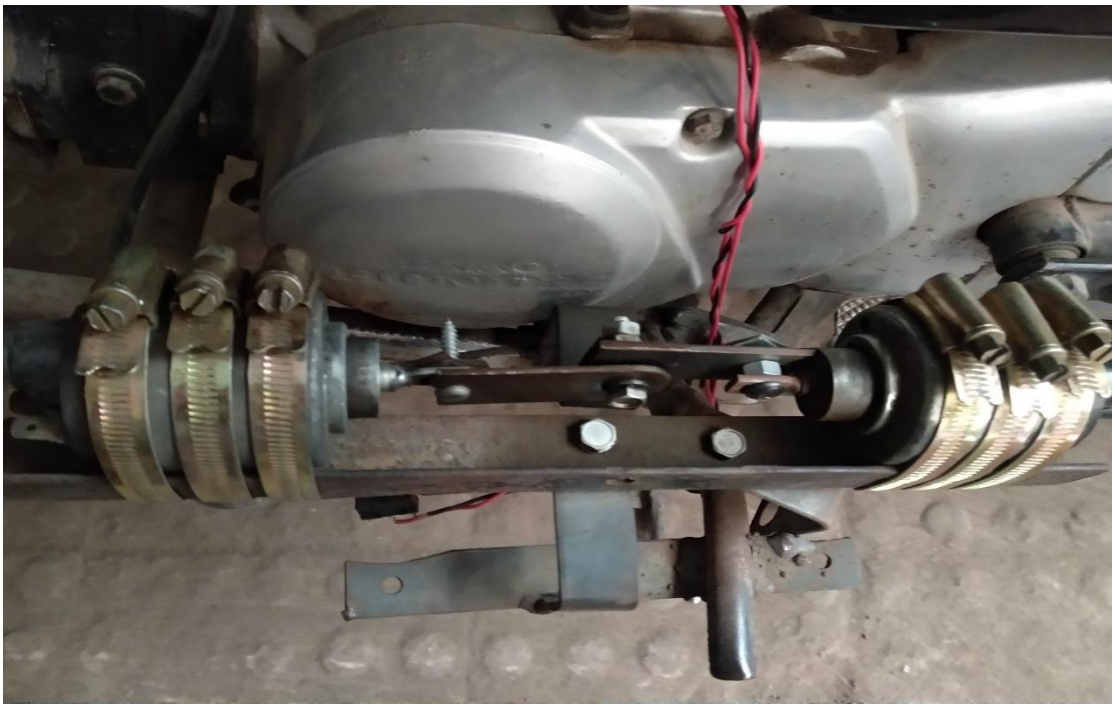

Figure 5:7 Top view of Automated Gear Shifting

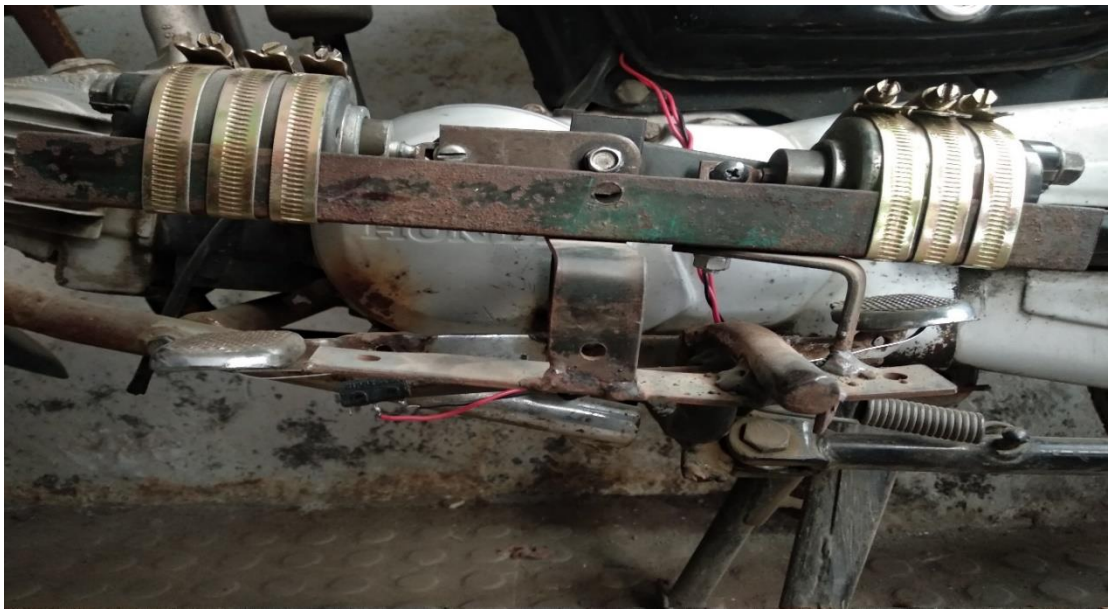

Figure 5:8 Electro-Mechanical Actuator or Limit Switch

Electro-mechanical actuator: It is power a 12V, 5A. A suitable geared DC Actuator is used to move the gear pedal. Necessary modifications are made to the gear pedal to obtain the shifting with respect to the DC Actuator. The DC Actuator is connected to 12V power supply and torque capacity is 6 Nm. The DC Actuator fabricated to the motor bike is shown in the Figure5.7, 5.8. It is operated by giving the power supply from the motor bike battery.

The DC Actuator is connected to the relays. Relay 1 and 2 are actuated with respect to the program to move DC Actuator in linearly move (up shift) and (down shift) motion. The DC Actuator is meshed with the clamp on gear pedal. The gear pedal is connected with gear box. When the DC Actuator move linearly with fitted clamp, it converts the linear motion to rotary motion. This inclination is sufficient to push the pedal down with push switch to achieve the up shift during driving. Similarly, the DC Actuator move and push the pedal up with push switch to achieve the down shift during driving.

5.3.2 Electronic circuit

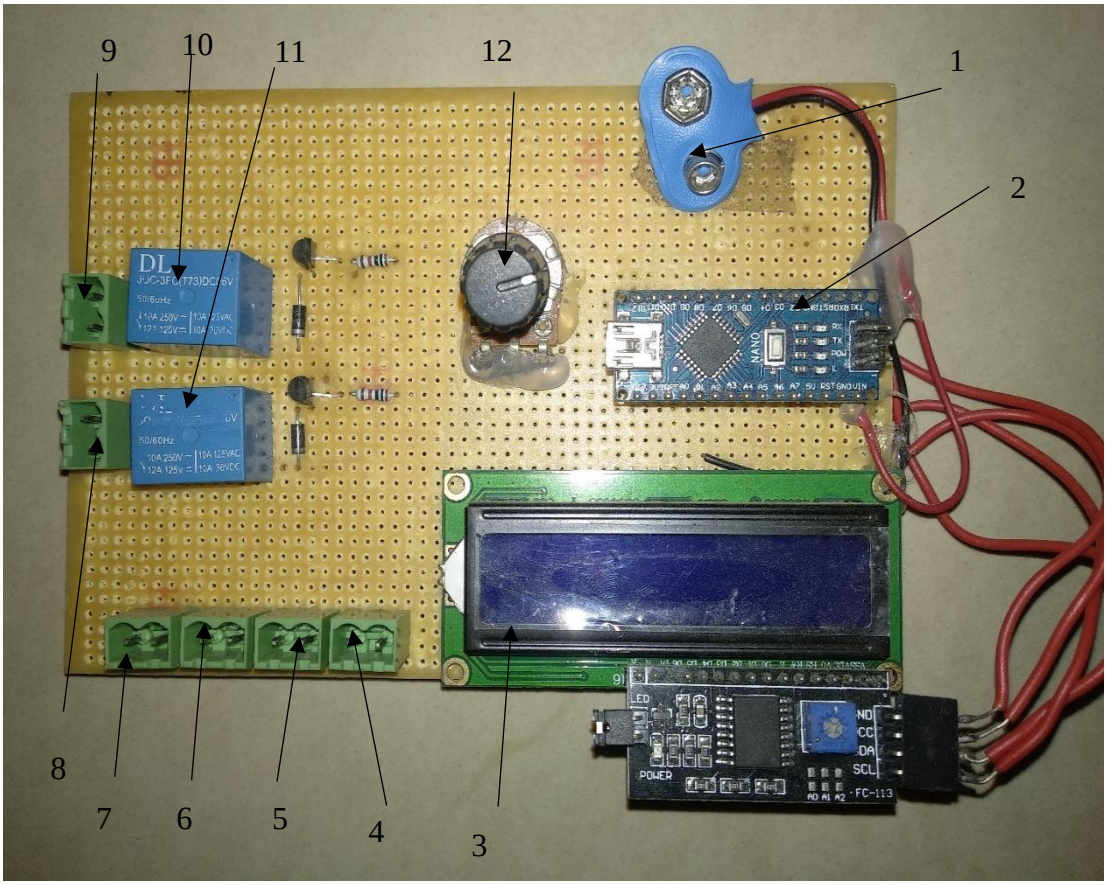

Figure 5:9 Electric Circuit

Figure 5.9 shows the electronic circuit, with all components connected as required for gearing shifting technology. The power supply for the external battery source. All the components are connected using different types of wires. The electronic components are fixed within the box of the motor bike.

Table 5-2 Component in the circuit

Component no.	Particulars
1.	External battery source
2.	Arduino NANO
3.	LCD
4.	Clutch Switch
5.	Up Switch
6.	Down Switch
7.	Neutral Switch
8.	Gear down Switch
9.	Gear up Switch
10.	Gear up Relay
11.	Gear down Relay
12.	Potentiometer

5.3.3 Potentiometer

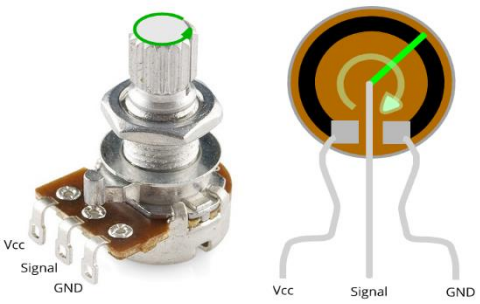

Figure 5:10 Potentiometer

Potentiometer is in the very output voltage. It is the programmable device for help of Arduino software. That device is used in this project for work as speedometer. That speed ratio is 0-10kmh, 10-20kmh, 20-30kmh, 30-60kmh. that speed ratio is very and the change a gear position with help of programmable electric circuit.

5.3.4 Arduino Board

Arduino board is the output voltage 5V and the Arduino is main device for our project. It is the Arduino board is programming in Arduino software. That programing is hear not specified but explain below programing logic flow chart. That project in use Arduino NANO type. They choose Arduino NANO because of our project programing is short and minimum device is operate in electric circuit. It is shown fig. 5.11 below.

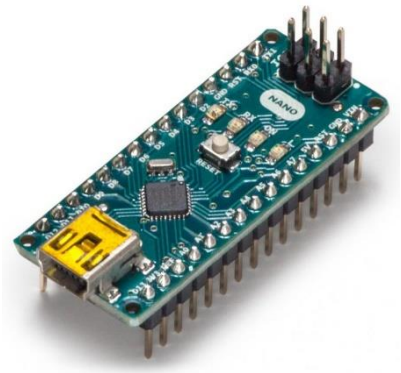

Figure 5:11 Arduino NANO

The programing software used in this project is Arduino. Its symbol is shown fig. 5.12 below.

Figure 5:12 Arduino Software

5.3.5 LCD (Liquefied Crystal Display)

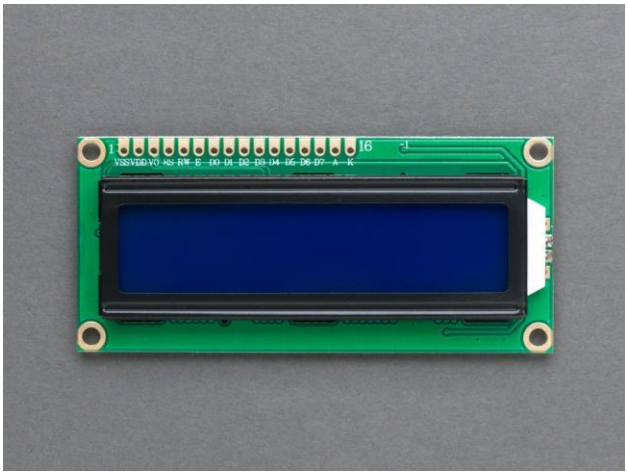

Figure 5:13 LCD (Liquefied Crystal Display)

LCD (Liquefied Crystal Display) is the 16x2 display. It is power supply for external power source. It is take power of 5V. It is the LCD is display for programing logical output. It is display a speed is unit kilometer per hour and current gear position.

5.3.6 Relay

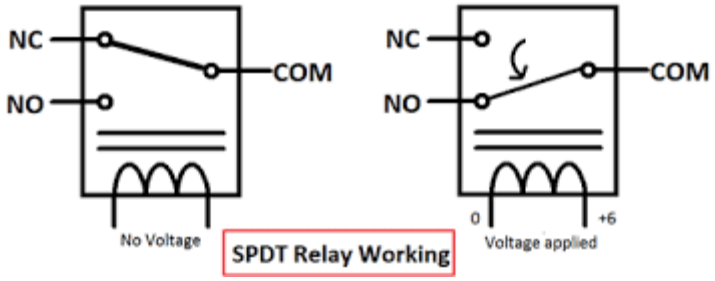

Figure 5:14 Relay

Relay is used for operation of gear up and gear down switches and switches operates the actuator. And relay supply input power is throughout resistance and capacitor. Its whole working is to control electric circuit with the help of programming.

5.3.7 Limit Switch

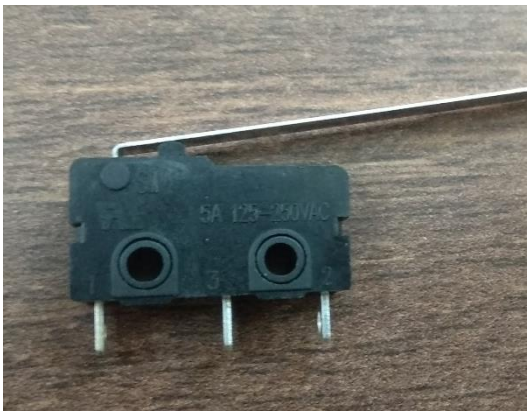

Figure 5:15 Limit switch

A limit switch is used to operate the gear lever for down shift so limit switch is working and the count of pushes on the switch is done by it. Here, Limit switch work as calculating for punching lever. And it is fitted below the gear lever on both side.

5.3.8 Battery

Figure 5:16 Battery

It is the 12V, 10A high power Battery is used in this project. This high rated power output have been chosen because the actuator need more amount of power for its linear motion. Normally the battery of a motor bike is used but Honda CD 100 motor bike uses a 12V, 3A battery which is insufficient for actuator operation.

5.4 Electric circuit schematic diagram

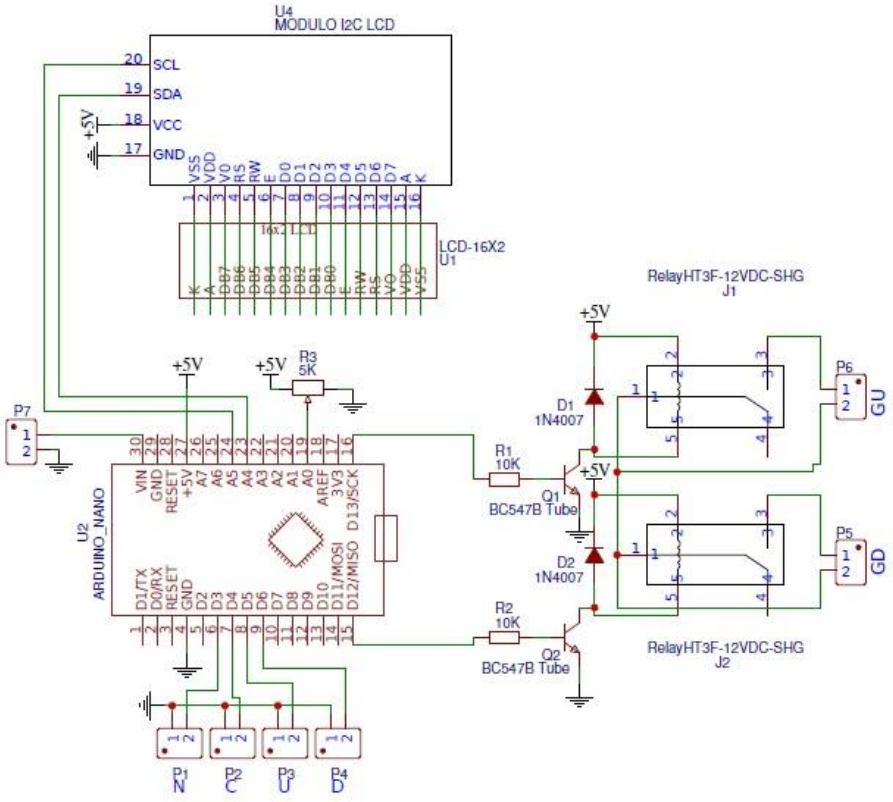

Figure 5:17 Electric circuit schematic diagram

The connection of different devices with circuit board is done with help of above schematic diagram and below presents a table of connection Code.

Table 5-3 Component Connection Designator

Name of Component	Designator	Quantity
LCD-16X2	U1	1
ARDUINO_NANO	U2	1
MODULO I2C LCD	U4	1
2Pin Connector	P1,P2,P3,P4,P 5,P6,P7	7
Relay-5v	J1,J2	2
Diode-1n4007	D1,D2	2

Transintor-BC547	Q1,Q2	2
Resistor-10K	R1,R2	2
POTENTIO-5K	R3	1

5.5 Program flowchart

The Embedded ‘C’ Program is written into the microcontroller to make the manual transmission to an intelligent transmission. The ‘C’ program is complicated too be understood at a single glance. So, for understanding the concept, the embedded program is represented in a basic flowchart. It includes the gear changing cycle of our project concept. This cycle is with respect to the delay time of 5 seconds. The flowchart starts when the electronic circuit is switched on by starting up the bike. The input from the potentiometer is represented in the flowchart. The input is in term of pulses per 5 seconds time count. The gear position is decided by the pulse range which are segregated in four different ‘IF’ conditions. The position of the gear is actuated when one of the conditions is satisfied. For example, if the pulse range is 27 per 5 seconds then the third ‘IF’ condition is satisfied and the gear 3 is actuated (YES) by switching on the relay. The input is counted for every 5 seconds so the program is represented as closed loop in the flowchart. If the pulse range is not satisfied in the ‘IF’ condition (NO) then the range is compared with the next ‘IF’ condition.

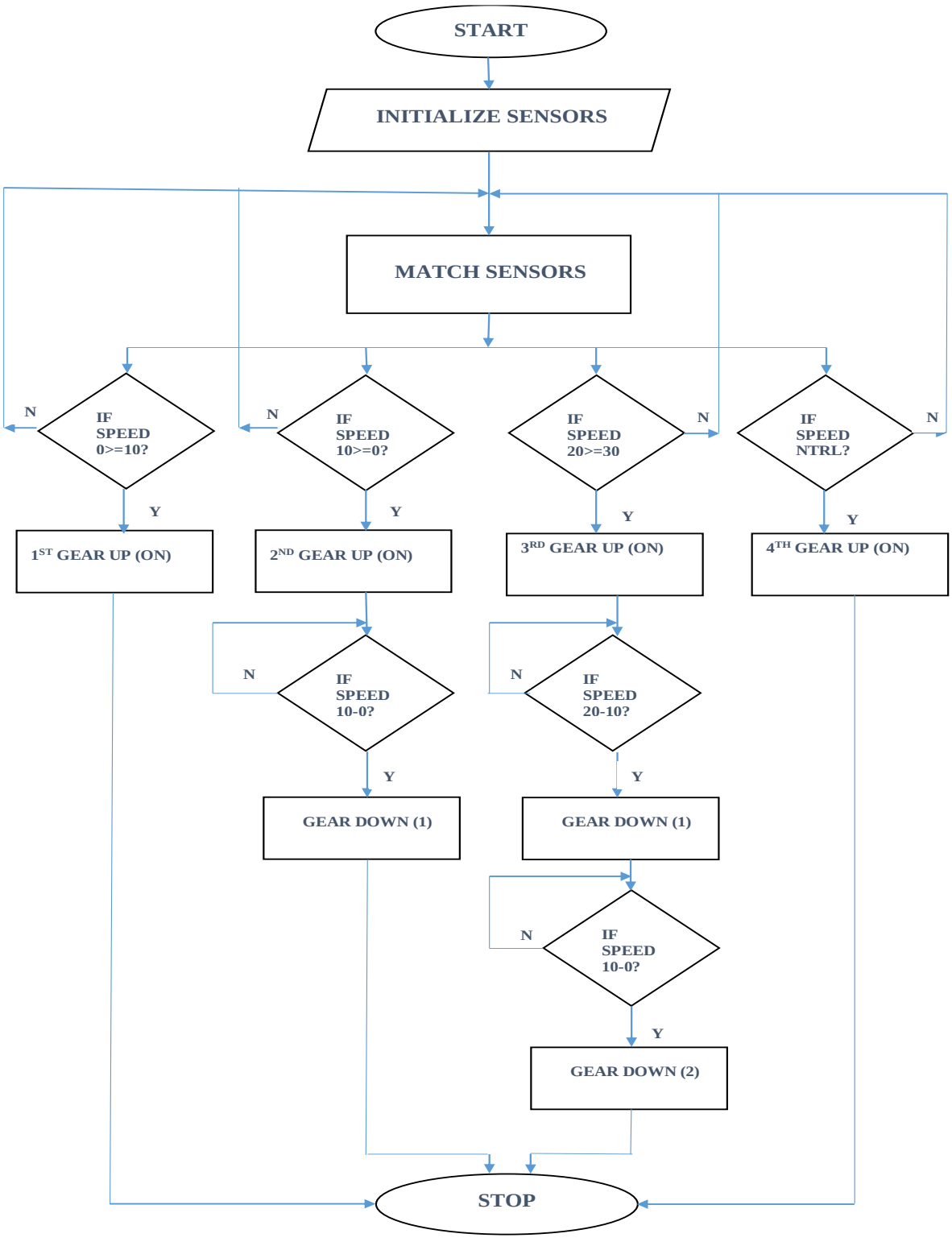

Figure 5:18 Program logic flowchart

6 .RESULT AND DISCUSSIONS

Introduction

It is important to check the performance of the vehicle after implementing the new technology, which can shift the gears with human interference as shown in Figure 6.1, 6.2. The gear shifting was observed while riding the bike. The gears changed with respect to the potentiometer speed output. The bike was brought to first gear with the help of semi-automatic system, from neutral. As the bike uses external speed indicating device instead of using a speed sensor. The pulses per 5 seconds were counted and the position of the gear is decided. At higher speed, the relay 1 was actuated and the DC Actuator operates. This resulted in the up shift of the gear automatically. The top gear position (4^{th}) is reached as there is change in speed ratio of the bike. There was not much vibration produced during the gear change. By maintaining constant speed of the bike, a constant gear ratio is maintained which was a major factor for fuel efficient ride. As the speed of the bike was reduced uniformly, the gear shifted down with a delay time. There is a delay time in between each gear position to smoothen the gear down mechanism. Once the change speed ratio was brought down to zero, the dc actuator was successful brought to the neutral gear.

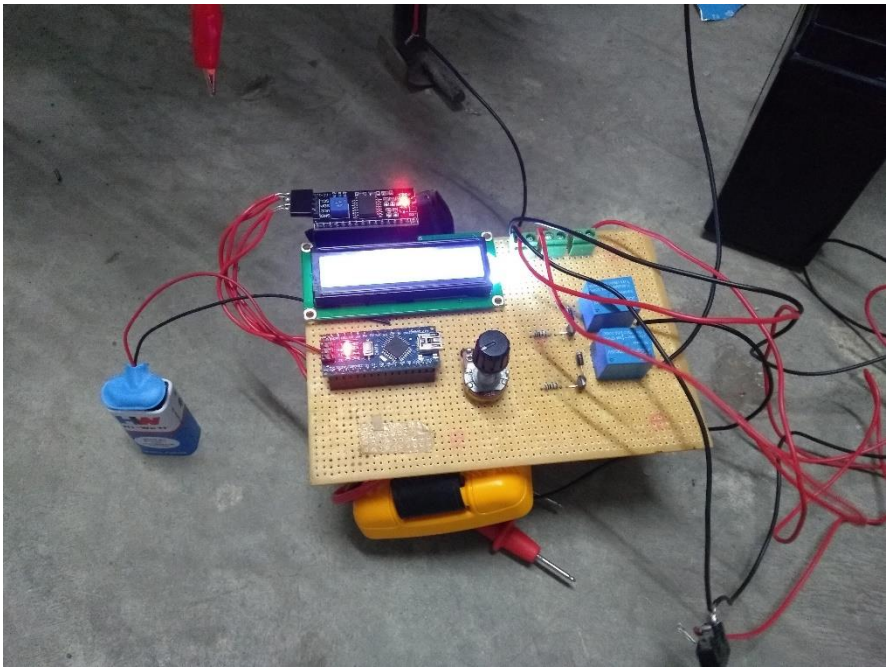

Figure 6:1 Working Electric Circuit

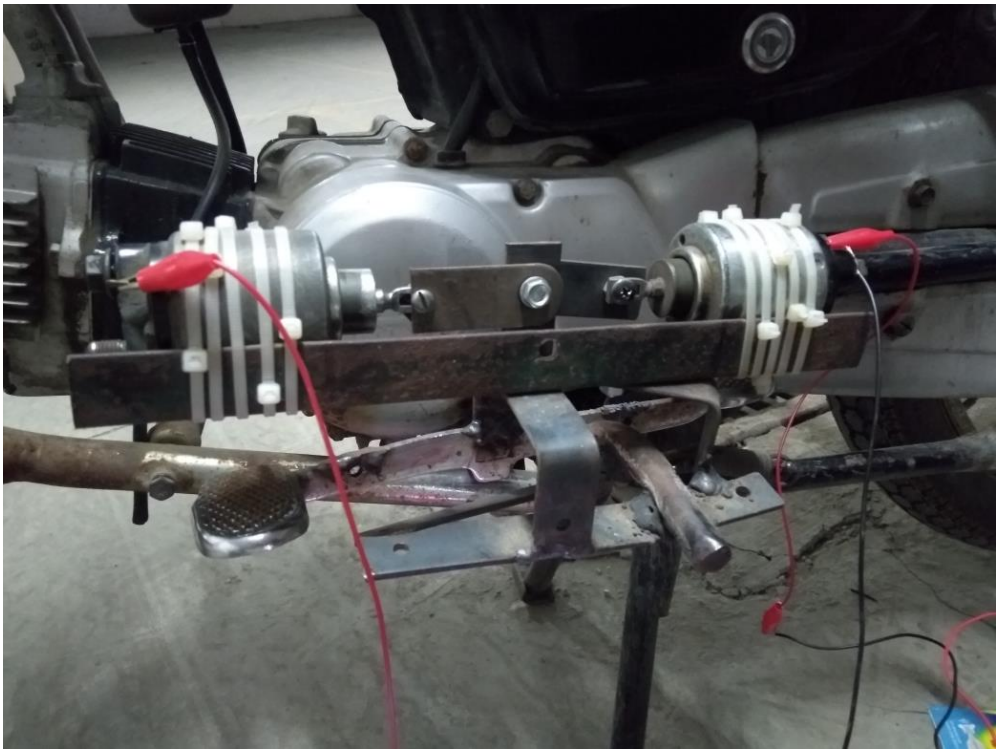

Figure 6:2 Working Project

6.1 Semi-Automated Driving Mode

The complete electrical circuit was given the power supply from the bike's battery and the shifting mechanism between the dc actuator and gear pedal was attached. The Arduino NANO was programmed according to desired gear changing technology by trial and error method. The pulse ranges programmed for each gear position were sufficient to obtain constant gear ratios. Some observations while driving in automated mode are listed below.

- Automatic up shift of gear was observed without any interference other than change speed ratio.
- Delay time was observed between each gear positions.

The ride was smooth during traffic condition since the gear shifting was dependent upon the wheel speed.

After observing and analysis the two different mode of the bike, we could see that the main objective was succeeded (checking for improvement in fuel efficiency). The complete 'C' program in the microcontroller and the fabrication resulted in better

performance of the bike and The field test results of up shifting and down shifting are listed in the Table 6-1 and Table 6-2 below.

6.1.1 Field Test Results

Up shifting conditions:

Table 6-1 Up shifting condition

Sr. No.	Initial Gear	Speed(Km/h)	Gear Changing From	Gear Changing To
1.	First	0-10	First	Second
2.	Second	10-20	Second	Third
3.	Third	20-30	Third	Fourth
4.	Fourth	30-60	No Shifting	

Down shifting conditions:

Table 6-2 Down shifting condition

Sr. No.	Initial Gear	Speed(Km/h)	Gear Changing From	Gear Changing To
1.	Fourth	60-30	Fourth	Third
2.	Third	30-20	Third	Second
3.	Second	20-10	Second	First
4.	First	10-0	No Shifting	

7 .CONCLUSION AND FUTURE WORK

7.1 Conclusion

After achieving the desired gear shifting technology, we ever able to get a smooth gear shifting in all 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 change speed ratio 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 range, as in the program, or a constant speed of the vehicle resulted in better fuel efficiency. After implementing this technology we have come to a conclusion that less human operation is necessary for easy work.

7.2 Future Work

7.2.1 Implementation in all gear featured bikes

The automated gear shifting mechanism can be obtained in any auto-clutch featured bike by installing the necessary electrical circuit and by fabrication. Also this mechanism can be achieved in clutch featured bikes by automating the clutch initially. The cost of installation will be comparatively high in clutch featured to wheelers. Automobile companies can manufacture bikes with this new concept on customer's demand.

7.2.2 Using Torque sensor

Our concept of automatic gear shifting, in bikes, was with respect to the speed of the wheel. The proximity sensors can be replaced by the torque sensor as another approach. Minor changes are required in the electrical circuit and in the embedded 'C' program when torque sensor is used. The torque produced in the wheels can be taken as input source for the microcontroller to decide the gear positions. This sensor is costlier compared to the Potentiometer and proximity sensor.

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