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Research on Clutchless Quick Gear Shifter for Formula Student Vehicle

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Abstract - *The purpose of this paper is to develop a clutchless gear shifter for formula SAE car. With this proposed system, clutch is completely eliminated during shifting of gears. While shifting gears without clutch, safety of the transmission system also taken into consideration. This system also eliminates*

Weight of unnecessary shifter rod and assures a fair and smooth shift without any lag. This paper discusses the concept and design of this system.

Key Words*: *Quick gear shifter, Clutchless gear shifter, Button shifter, cliptronix, fsae

1. INTRODUCTION

Formula SAE is an international competition organized by the Society of Automotive Engineers where college students design, manufacture and compete with a formula style car. The car built by Trailblazers Motorsports team uses 2015 KTM Duke Engine that has a 6-speed sequential gearbox. The gears can only shift sequentially in order, and shifts are actuated by the rotation of a lever at the gearbox. The current shifting system is completely mechanical and is actuated by a lever mounted to the driver's left side. When a shift is needed the driver is required to remove his hand from the wheel, grab the lever, and push or pull it. This system is problematic in a few specific ways. The time taken between when the shift is needed to when it is actuated is somewhat slow due to the driver's need to remove his hand from the wheel. The lever also proved to be difficult to actuate at certain critical times as there is always some play in the linkages. On a Formula SAE competition course with many turns, frequent shifting is required to maximize performance. If a shift is needed during a turn the driver would have to make the turn with one hand on the steering wheel or simply wait until after the turn and lose time while the engine was in a bad RPM range. Both situations lead to a decrease in overall performance.

The goal of this project is to design and implement an electronic button shift system to address these issues and eliminate the detriment of the push-pull system to overall performance in a race. With button shifting, the driver would be able to actuate a shift without removing his or her hand from the steering wheel, increasing control at every point in the race. As well, the amount of energy required by the driver to actuate the shift is minimized to reduce the fatigue of the driver during a race. This would ideally lead to faster shift times, a decrease in weight, and better performance overall. The system will be designed with increased performance, light weight, and reliability as the driving parameters. When finalized, it will allow the driver to actuate a shift almost instantaneously without losing any control of the car.

Before selecting electric button shifter as a gear shifting media several different options were considered. The said objectives could be fulfilled by using hydraulic as well as pneumatic apart from electric button shifters Hydraulic and pneumatic systems has its limitations over electronic system. Since the project is related to racing vehicle hydraulic and pneumatic systems adds more weight to the vehicle. Also fluids used in hydraulic systems has tendency to catch fire which would make the driver more vulnerable to injury.

2. LITERATURE SURVEY

There are several similar projects in the market may it be hydraulic, pneumatic or electric. Each has its advantages and limitations but all of them are very effective in their operations. The shift process is divided into three stages. The duty ratio of the solenoid valve controls the motion state of the piston of the hydraulic cylinder, In the in the rapid oil filling stage ,the clutch piston gets a larger motion speed, and the slow motion in the slow contact phase of smooth shift. There is a greater pressure between the main and the driven disks of the last phase, which can transmit greater torque. Using this control mode to shift gears can not only increase the shifting speed but also ensure the smoothness of shifting. [2]

This paper is about Design and fabrication of a semiautomatic gear. Shifting mechanism for a racing car like Go Kart a. This gear shifting mechanism had been design to overcome issues like –gear shifting. problem while gear shifting, to eliminate fully manual gear shifting ,so that driver can give more attention to steering, to reduce the effort and timing of gear shifting which is more important racing basically where few milliseconds. Make you a winner or a loser. The idea of pneumatic shifter rose when there was some going on discussion on different mechanism for shifting gear .Performing some analysis on basic design and on available data design was bought onto existence [3]

This paper explains the maximum and minimum reductions per stage of planetary gear pairs and also the advantages of

using planetary gear pair system over the other systems. Also allows us to study on determination of reduction ratio of this planetary gearbox. On the basis of certain parameters like torque density weight and volume the comparison between planetary gears and helical gears is done. The detailed study of planetary gear trains helps us to determine reduction ratio for each stage. [4]

To automate the manual transmission in two wheelers hydraulic and pneumatic drives are used. But these equipment results higher weight of vehicle. Also the response of this system gives sluggish response and leakages issue. To avoid this AMT is used. Electromechanical device based on DC motors is used to automate the gear system in two wheelers. Instead of using log for gear shifting gear shifted automatically based on speed. This mechanism is reliable and quick as compare to hydraulic and pneumatic drive. The cost of this system is very low. Also it gives comfort to the rider. [5]

3. PRINCIPLE OF WORKING

The project is based on the concept of flat shifting of gear in which there is no need to use clutch for gear shifting. Normal clutch less shifting is mostly done at higher speeds and sometimes it also causes severe problems to the transmission system. Hence in order to save the time during shifting and to protect the transmission system this project is done. Following figure shows the flowchart of the system.

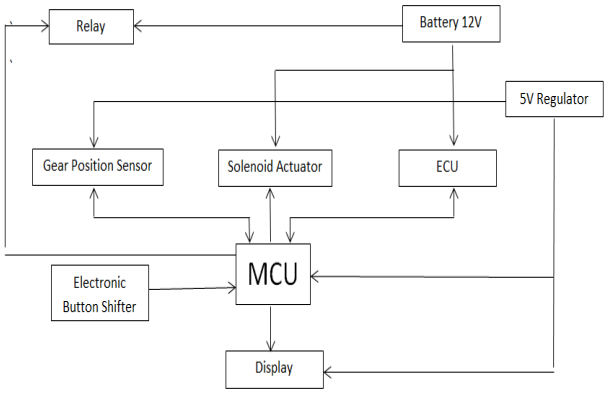

Fig -1: Circuit diagram of clutchless gear shifter

4. REQUIRED COMPONENTS

4.1 Battery:

Since the project requires electric power source to run the system, a 12V battery as selected as a power source. As for the normal working of vehicle it has 12V battery. This project uses the same battery to run the vehicle as well as electronic gear shifting.

4.2 Actuator:

A solenoid operated actuator is selected to perform shifting. It receives power directly battery and actuates the respective gear. Selection of solenoid actuator is done on how much force it can generate. Force required to shift gears can be calculated by using spring mass or load cell.

4.3 Voltage Regulator:

Some of the components used in the system works at voltage less than power supply voltage. In order to prevent any damage to these components voltage regulator is used. The purpose of a voltage regulator is to keep the voltage in a circuit relatively close to a desired value. Voltage regulators are one of the most common electronic components, since a power supply frequently produces raw current that would otherwise damage one of the components in the circuit. A voltage regulator generates a fixed output voltage of a preset magnitude that remains constant regardless of changes to its input voltage or load conditions.

4.4 Relay:

Relays are the switches which aim at closing and opening the circuits electronically as well as electromechanically. It controls the opening and closing of the circuit contacts of an electronic circuit. When the relay contact is open (NO), the relay isn't energizing with the open contact. However, if it is closed (NC), the relay isn't energize given the closed contact. However, when energy (electricity or charge) is supplied, the states are prone to change.

4.5 Gear position sensor:

A gear position sensor is a car part that monitors your shift rail's position inside your vehicle's gearbox. It was developed to observe, supervise, and inspect the position of the shift rail through a combination of two or three sensors like it in each transmission.

4.6 Display:

The function of the display for the shift system is to inform the driver or what gear they are currently in. To serve the purpose 14 segments or 16 segments LED display can be used.

4.7 MCU:

Immediately prior to shift actuation, both spark and fuel need to be restricted so that a 'flat shift' can be performed. Flat shift is a term which describes the event where the engines speed is retarded, eliminating the need for the driver to lift off of the accelerator while shifting. This function will allow for a faster and more accurate shift when compared to conventional means where the driver must lift off of the accelerator.

The microcontroller, which will serve as the intelligent control must be able to use both input and output signals to control both electrical input as well as output requirements.

Microcontroller system must communicate with the ECU regarding the RPM of the vehicle to avoid the shift by mistake of a driver as shifting buttons will be placed close to the driver's finger.

5. WORKING

For the first time to make a gear shift from neutral to first gear driver has to use clutch. This is the only time driver would use clutch to make shifts. From first gear to second driver simply has to press the upshift button on the steering wheel. As driver presses the upshift or downshift button, a signal sent to the MCU which in turn will open the normally closed relays.

These relays are placed in the circuits of spark plug and fuel injector. When made open cuts the power of spark plug and fuel injector. This causes the engine to slow down for a moment, in which the gear shifting happens. As there is no power or spark supply driver may not lift his foot off the accelerator.

At the same time MCU sends the signal to the solenoid actuator to perform the required shifting as per requested by the driver.

To safeguard the transmission system, a safety feature is also provided. When driver requests upshift or downshift microcontroller gets feedback of an engine RPM and compares it with previously saved chart and takes the decision about the shifting. If the driver requests the downshift and the RPM is higher than recommended then it does not allow downshift unless the RPM falls to the necessary limit and vice versa for upshift.

6. CONCLUSION

The main objective of this project was to reduce the shifting timing is achieved. System takes less than a second to shift the gears. Since it does not uses any mechanical links which adds the unnecessary weight is eliminated. Because of the quick shifting the vehicle performance is noticeably increased at turns as well as at straight patches.

This system also safeguards the transmission system from shift by driver's mistake.

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