Design of Electronic Semi - Automatic Clutch for Manual Actuation of Clutch in a Car

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Abstract

The proposed design modification is that, actuation of Clutch integrated with the system of electronics. There is also a wide range of clutch mechanisms available in the market. But the cost of those systems is high. The objective of this project is, to design a system that operates the clutch of a manual transmission car with assistance of electronic control. In this design, the clutch pedal is connected to two servo motors, LVDT, speed sensor, Engine Rpm sensors which are controlled by a arduino. For safety purposes, the authors have used sensors and a microcontroller for backup support. This controller is also connected to the master cylinder for emergency braking of the vehicle.

KEY WORDS: Clutch-pedal, Speed Sensor, Engine Rpm sensor, and Micro Controller.

1. INTRODUCTION

Actuation of clutch is difficult in a manual transmission vehicle, while driving through traffic. Clutch and brake pedal are important for the movement of a vehicle. Controlling three pedals makes it confusing for an amateur driver. There is also a history of accidents which have occurred due to simultaneous actuation of clutch and brake. The clutch plays a major role while driving uphill. Half clutch mechanism is important for the smooth movement of vehicles, but it also requires a sequence of operations involving both acceleration (Throttling) and clutch action. (Clerk, 1892).

A solution may seem to be the semi-automatic transmission, which is a manual transmission that does have a clutch, but one in which the driver is not required to operate in a traditional fashion. The clutch is controlled by a computer via electronics, pneumatics, and/or hydraulics, and the driver has the option to use hand paddles behind the steering wheel to change gears if they desire. Although current hand control systems can be adapted to semi-automatic transmissions, the clutch of these systems are extremely expensive and are found only in newer high performance sport and luxury cars.

When selecting a car, drivers who do not require hand controls have the choice between driving either one of two options: an automatic or manual transmission vehicle. For drivers who require hand controls, however, the only current option is a vehicle with an automatic transmission, due primarily to current adaptive driving equipment availability. While most of these drivers are satisfied with operating an automatic vehicle, the driving enthusiast, who desires total gear-change control in a vehicle, is not.

For the purpose of reducing the usage of clutch and also to reduce the mental stress while operating it, Automatic clutch and Automatic transmission were invented. Nowadays vehicle manufacturers prefer the automatic clutch for medium budget vehicles and automatic transmission system for luxury vehicles. There is a wide range of clutch mechanisms available in the market, but the cost of an automatic system is too high. The primary and ultimate aim of this project is to design a clutch that is economical in all aspects.

2. EXISTING CONCEPT OF CLUTCH DESIGN

Peoples are not like to spend huge money for the automatic transmission. Another factor to consider is the situation in which a person may suddenly lose leg function in one or both of the legs due to an accident or medical condition. Some of these drivers may already operate a manual transmission car and suddenly cannot drive it any longer due to limited driving adaptive equipment on the market today for manual transmission cars. There is a system on the market today that can automatically actuate the clutch pedal, but this system is extremely expensive. For these reasons, there is a need for adaptive controls for a manual transmission car (Richard, 2004).

Various types of clutches are there that connect the drive shaft with one or more pairs of drive mechanisms notably mounted on the shaft. Preferably the unconnected mechanism is permitted to free wheel or freely rotates relative to the shaft. This interruption, along with the gradual reapplication of power as the clutch is engaged, allows the vehicle to be start smoothly from rest, and prevents the grinding of gears during shifting. The clutch mechanism consists of several parts that work together to perform this function and is shown in Fig.1.

While the Automatic transmission uses a much more complicated mechanism in which sensors and electronics control when the clutch is engaged and disengaged, hydraulic pressure activates either a number of steel plates and friction discs called a clutch pack, much like the clutch in a manual transmission or a series of transmission bands that tighten and release around the clutch housing. When either of these systems is engaged, power is transferred from the engine to the transmission, and the vehicle moves. These types of transmission systems require somewhat large space, high maintenance, and high initial cost.

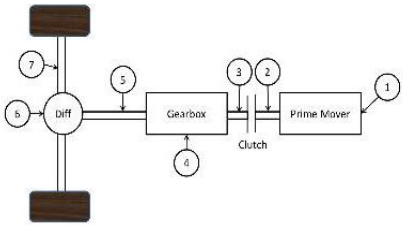

Figure.1. Outline of transmission system with a clutch

Mechanical linkage system of clutch consists of: pressure plate is a metal spring-loaded friction surface that is bolted to the flywheel. It has a metal cover, heavy release springs, a metal pressure surface, and a thrust ring or fingers for the release bearing. The thrust ring or fingers release the clamping force of the springs when the clutch is disengaged (Thomas, 1970).

When the clutch pedal is pressed, the "Throw-out bearing" pushes the pressure plate's release fingers. The pressure plate pulls away from the clutch disc, disengaging the clutch, thus interrupting power flow. When the clutch pedal is released and the clutch is fully engaged, the release bearing is normally stationary and does not rotate with the pressure plate. Clutch operation is accomplished either mechanically or with a hydraulic pressure system. If a vehicle has a mechanically operated linkage, it will incorporate either a shaft- and-lever linkage arrangement or a cable. Systems that are made up of linkages, levers and pivot points are found primarily on older vehicles. These systems require regular lubrication and can only be designed to fit a limited range of configurations and are illustrated in Fig.2.

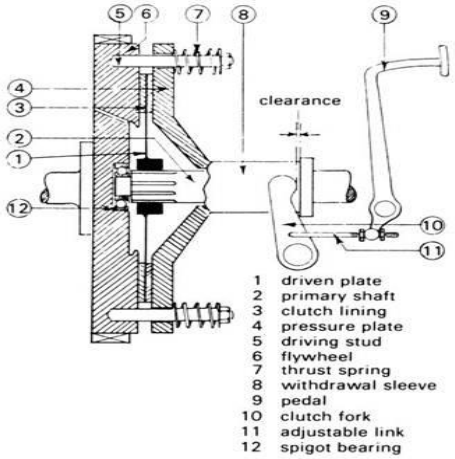

Figure.2. Outline of Mechanical Linkage clutch system

A cable operated clutch mechanism is relatively simple. A cable connects the clutch pedal directly to the clutch release fork. This simple design is flexible and compact. There is however, a tendency for cables to gradually stretch and eventually break due to age and wear (Walter, 1973; Zeidler, 1964).

Where the hydraulic clutch consists of similar operation of mechanical clutch, power transmission is interrupted when the driver applies pressure to a pedal. Several components amplify this pressure and transfer it to the clutch itself. As soon as the pedal is released, the same process occurs in reverse order. Peak torque limiters (PTLs) prevent excessive torque during engagement, which helps prevent damage to the driveline due to the clutch closing too fast. A frequency modulator keeps crankshaft vibrations from spreading to the pedal ensuring driver comfort. A typical hydraulic clutch is shown in Fig.3.

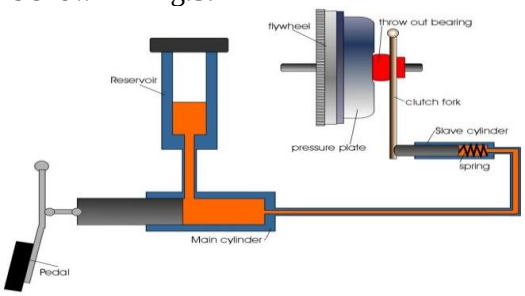

Figure.3. Outline of Hydraulic Clutch system

Proposed Design: The author's idea of innovation is to provide a clutch with electronic control system. There are two servo's used (High torque high-voltage magnetic encoder servo "Fig.4").They were selected because of their high torque output (44 kg./cm.), as well as their strong titanium gears. These servo's have eight O rings on each servo to prevent dirt and water particles from contacting internal components. This type of servo is programmable, enabling

the user to set the end points. The servo's also feature integrated heat sinks to dissipate heat though continuous operation.

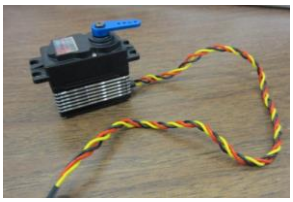

Figure.4. Aluminum Servo Motor

The first step was to design and make the mechanical components and hardware. All the components were made by hand on a mill. The entire clutch pedal assembly was removed from the vehicle, and a template was made of the assembly. This template was used to make a main bracket that would house the two servos used operate the clutch pedal. The main bracket was positioned above the clutch pedal. On the main bracket, the two servos sit parallel to one another. They have U brackets to secure the servos to the main bracket. Each servo has an arm that rotates about 90 degrees. These arms are attached to a connecting rod that is also connected to the clutch pedal. As the servos activate, the arms move the connecting rod which then depresses the clutch. "Fig.5" helps to illustrate how the system operates.

The next step was to design a electrical sensing system for the response and detection system. The power wire is connected directly to the battery of the car. This wire has a fuse built in to protect the system if there is an electrical short. The power wire is routed through the driver's side of the firewall and is connected to a main power switch with a light on it. The switch is mounted on the dashboard. After the switch is a voltage regulator. This regulator takes the car's normal output of 12-14 volts and drops it down to 8 volts and allows up to 40 amps of current to go to the servos.

From the regulator, two groups of wires split off: they go to the servo controller and the servos. The servo controller is mounted on the dashboard and generates the control signal that goes to the servos. The arduino board gets response from the LVDT fixed on the Brake pedal, Engine speed (RPM) sensor to actuate the servo then the pedal follows. The circuit shows in Fig.6

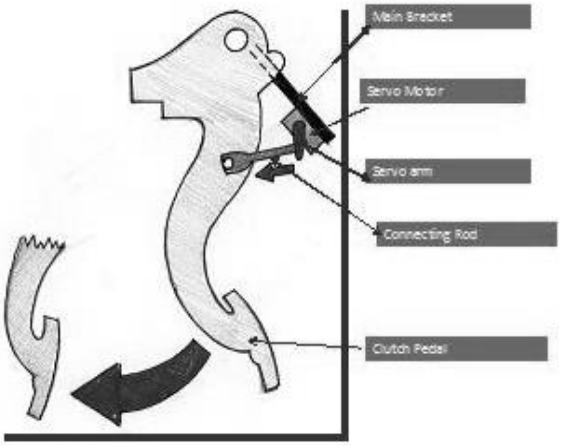

Figure.5. Outline of Proposed Design

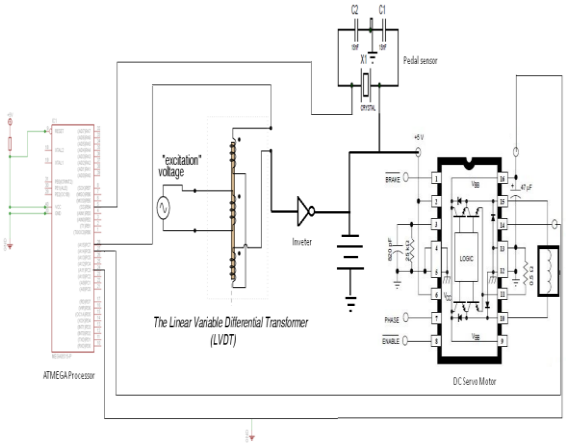

Figure.6. Electronic Circuit Of Clutch

Back-Up Safety System: This system uses two additional sensors for the backup actuation and to facilitate easier functioning of the pedal. This backup along with electronic actuation, by the signal from sensors, is called the "Secondary Condition" "Fig.6". This condition consists of a microcontroller (ECM), a brake pedal sensor, Engine Rpm sensor.

The position of the Brake pedal is detected by the LVDT. Due to the swinging action of the arm, the LVDT core rod is pushed. It enables the output to be varied with the precision. The ECM reads the signal from the LVDT and switches on the magnetizer (Servo motor or solenoid), in the event of any failure or problem in mechanical linkage of the clutch.

The Engine rpm sensor (sensor-2) is provided at the engine output shaft, it senses the speed of engine with relate to RPM. The sensor absorbs the thrust force the signal to the ECM. At the same time, if the engine speed comes about to the rated speed (1000 rpm idle) the servo motor actuate the arm to engage the clutch.

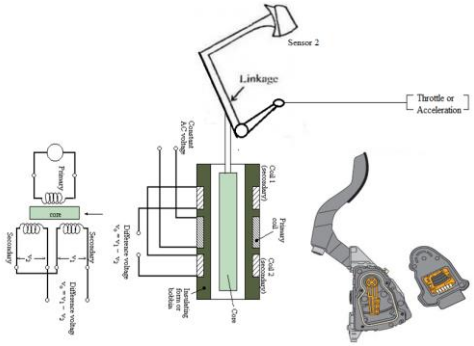

Figure.7. Brake Pedal sensor

Electronic Flow Diagram: The electric current flows from battery to the ECM, LVDT, Sensor-2. The LVDT and the sensor-2 send the signal to the ECM using electric pluses. According to the set of condition mapped in the ECM it operates the clutch. The system is provided for the overcome of automatic clutch in modern cars, which cannot be used in the existing car due to the economy. By the change in the mechanism it is possible to achieve the same efficiency of automatic transmission in the clutch mechanism.

3. RESULTS AND DISCUSSIONS

This system provides a compact sequence of operation and safety. Economy of this system is guaranteed by the presence of electrical feedback system.

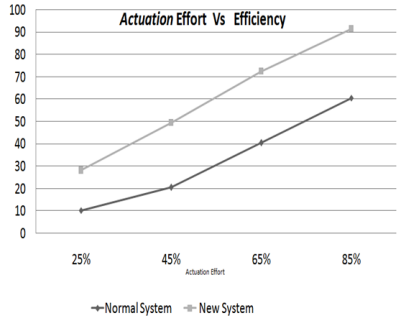

Figure.8. Variation of actuation effort with efficiency

The graph shows the difference between normal system and the new designed system. It is about 91% of efficiency is achieved by the new design.

Cost Analysis: As it is a modification design we can either modify it on Conventional cars or start it at the factory level. Modification of existing cars can prove very costly and complicated since the ECU is already pre-programmed with normal actions. Change of this setup will be very complicated and time Consuming. Hence the suggestion would be to manufacture new set of vehicles with all these design modifications.

4. CONCLUSIONS

Hence the idea of design modification of clutch can greatly reduce the amount of effort that happen out of panic. If employed correctly then proper gear-speed relationship can be obtained which will increase the fuel efficiency. In depth research was done by the team prior to starting this project to ensure the reliablity and performance, which paid off in the end. Special attention was given to the design of the brackets, so that they do not flex or fail from applied force.

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