



Comparative study on various transmission models in automobiles

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Abstract

This paper provides an insight on various transmission systems with the detailed description of four models, i.e. Manual transmission (MT), Automated Transmission (AT), Semi-AT and Continuously Variable Transmission (CVT). The models are compared depending on their features, diagram and power train. The advantages and disadvantages of these transmission systems are also discussed in order to facilitate better design approach in transmission systems. A new prototypal is also proposed which overcomes drawbacks of existing transmission systems.

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Key words: Continuously Variable Transmission, Power train

1. Introduction

Transmission system in a vehicle helps to transmit mechanical power from the Engine of the vehicle 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. Analysis of different transmission systems is described here.

1.1 Manual Transmission (MT)

A manual transmission, also known as a manual gearbox, stick shift, n -speed manual (where n is its number of forward gear ratios), standard, MT, is a type of transmission used in motor vehicle applications. It uses a driver-operated clutch engaged and disengaged by a foot pedal (automobile) or hand lever (motorcycle), for regulating torque transfer from the engine to the transmission; and a gear selector operated by hand (automobile) or by foot (motorcycle).

1.2 Automatic Transmission(AT)

An automatic transmission, also called auto, self-shifting transmission, n -speed automatic (where n is its number of forward gear ratios), or AT, 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 number of forward gear ratios is often expressed for manual transmissions as well

1.3 Semi-Automatic Transmission (SAT)

A semi-automatic transmission (SAT) (also known as a clutch less manual transmission, automated manual transmission, trigger shift, flappy-paddle gear shift, or paddle-shift gearbox) is an automobile transmission that does not change gears automatically, but rather facilitates manual gear changes by dispensing with the need to press a clutch pedal at the same time as changing gears.

1.4 Continuously Variable Transmission(CVT)

Conventional automatic transmissions use a set of gears that provides a given number of ratios (or speeds). The transmission shifts gears to provide the most appropriate ratio for a given situation: Lowest gears for starting out, middle gears for acceleration and passing, and higher gears for fuel-efficient cruising.

2. Result and Discussion

2.1 Manual Transmission

In this type of transmission, the selection of gear ratios on manual transmissions is accomplished by manually shifting a gear selector mechanism that disengages one gear and selects another. Most modern types of this transmissions have five or six forward (and one reverse) gears.

This type of transmission is connected to the engine via a clutch, which if disengaged (by pressing the foot pedal or hand lever), removes torque from the system. With the clutch engaged, power is delivered to the transmission through an input shaft that is separated from the primary cluster, and which can rotate at a different speed to the cluster. The cluster is comprised of gears that can be moved to either engage, or disengage from fixed gears on the secondary shaft, which is normally located below the cluster gears, and supported by roller bearings in its casing.

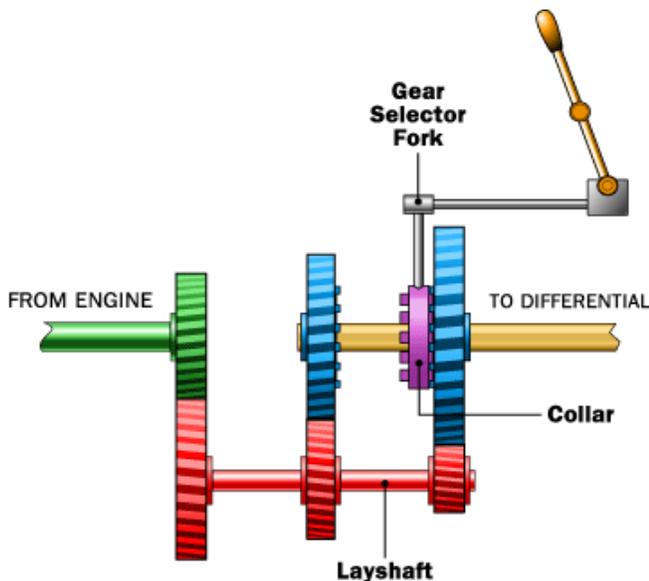


Figure 1: Manual Gear transmission system [4]

Advantages

- Extremely robust, and can handle high torque loads.
- Very reliable, and relatively easy to service, maintain, and repair.
- The solid link between driving wheels and the engine provided by this transmission provide a valuable driving aid to drivers in the off-road environment, by allowing the use of engine braking while descending slippery slopes where the use of ABS brakes could be dangerous.
- Cheapest to repair

Disadvantages

- Learning curve – can be difficult to operate for drivers who are accustomed to automatic

2.2 Fully Automatic Transmission

In an automatic transmission, the hydraulically operated control systems are managed electronically by the vehicle's computer instead of the clutch and gear stick. All the driver has to do is shift the selector from Park (P) or Neutral (N), into Drive (D), and the gear shifting will take place automatically and smoothly, without any additional input from the driver under normal driving conditions.

2.3 Gear Selection

Gear selection in automatic transmissions depends on many operational conditions, such as vehicle speed, engine speed, performance mode (where fitted) selected as well as driver assist systems such as traction control, stability control, automatic/autonomous braking and cruise control.

Provided all necessary conditions are met, and there is agreement between the Engine Management and Transmission Control systems, pressurized transmission fluid is automatically channeled to mechanisms that drive sets of planetary gears and clutches, which are roughly analogous to the gear ratios found in in this type of transmission.

Rotational energy is provided by a torque converter, a mechanism consisting of two freely rotating parts. One half is attached to the engine and the other to the transmission input shaft. The two halves of the converter are positioned very closely together. The fluid that circulates between them is influenced by the rotational energy of the engine which in turn impacts the transmission side of the converter. Torque is transferred from the engine to the transmission thanks to the shearing strength of fluid.

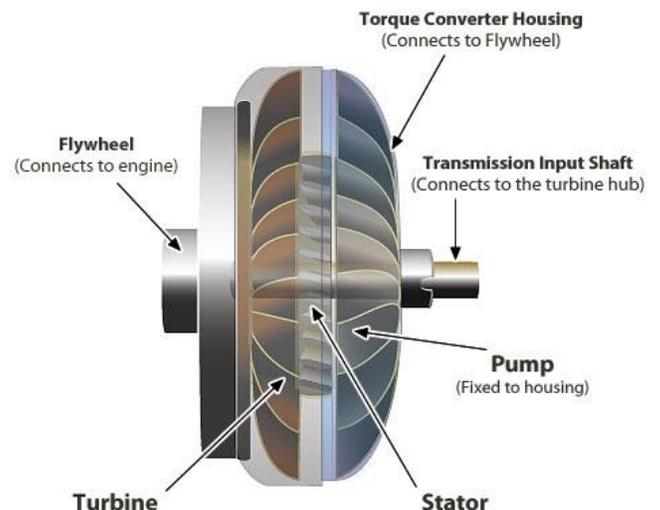


Figure 2: Fully Automatic Transmission system [4]

In older automatic transmissions, the shifting action was accomplished by internal fluid pressures overcoming spring tension – closing one circuit before opening another. This control system produced harsh, jerky shifting. Modern systems moderate the action of the controlling valve shuttles, providing almost seamless shifting.

Advantages

- Very easy to use
- Provides a comfortable driving experience
- Modern automatic transmissions match manual transmissions in terms of performance and fuel economy.

Disadvantages

- Complex and prone to failures, malfunctions, and unsatisfactory performance due to a variety of possible issues, some of which are unrelated to it itself
- More expensive than a manual transmission to maintain over a vehicle's lifetime
- Expensive to repair. Replacement is often the more cost effective option
- Unsuitable for use in off-road environments because it cannot provide engine braking

2.4 Semi-Automatic Transmission

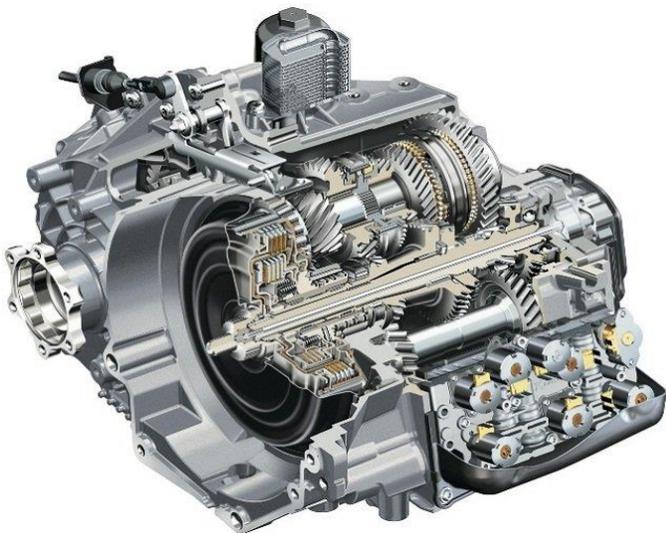


Figure 3: Semi-Automatic Transmission system [3]

Also known as an “automatic manual” or “clutch less manual” transmission, the simplest way to describe this type is to call it a hybrid between a fully automatic and manual transmission. Similar to a manual transmission, gears are changed via a simple shifter or paddles located behind the steering wheel. However, there is no need to operate a clutch pedal. Processors, sensors, pneumatics and actuators are all used to “automatically” shift the gears once the driver has signaled the change.



Figure 4: Semi-Automatic based steering [4]

The basic principles of shifting mechanical gears in a semi-automatic fashion have been in use on heavy commercial vehicles for many years. The latest and best designs provide lightning-fast, almost undetectable gearshifts.

The design of these systems varies, but all semi-automatic transmissions rely on microprocessors to control the changing of mechanical gear ratios with the help of electrically operated actuators and servos. These transmissions were limited to high-end supercars at first due to their high cost, but an increasing number of manufacturers are fitting them to mid-range cars. Dual clutch systems employ two clutches, one controlling gearshifts in the even numbered gears and, another that controls the odd numbered gears and reverse. This arrangement does not interrupt the power flow from the engine. The driver still has to initiate a gearshift via a shifter or paddles located behind the steering wheel, but there is no need for the driver to operate a clutch.

Advantages

- Smoother shifting/driving experience
- No energy losses due to slippage in torque converters, or during the time lag of manual shifts.

Disadvantages

- Complex and prone to failures, malfunctions, and unsatisfactory performance due to a variety of possible issues, some of which are unrelated to the transmission itself
- More expensive to maintain than a manual transmission
- Very expensive to repair. Replacement is often the more cost effective option.

2.5 Continuously Variable Transmission (CVT)



Figure 5: Continuously Variable Transmission system [2]

Unlike the others on this page, this transmission doesn't use gears as its means of producing various vehicle speeds at different engine speeds. Instead of gears, the system relies on a rubber or metal belt running over pulleys that can vary their effective diameters. To keep the belt at its optimum tension, one pulley will increase its effective diameter, while the other decreases its effective diameter by exactly the same amount. This action is exactly analogous to the effect produced when gears of different diameters are engaged.

Gear Selection

Since one pulley is driven by the engine and the other is connected to the drive shaft, an infinite number of ratios can be produced. This enables it to always run at the most efficient speed, regardless of the load placed on it. Microprocessor-controlled sensors quantify load variations and by adjusting both pulleys, the optimum operating speed for the engine can be maintained without any input from the driver.

Advantages

- Constant, stepless acceleration throughout the engine's optimum operating range
- Provides a comfortable ride by eliminating "shift shock"
- Better fuel efficiency
- Faster response to changing driving conditions such as variations in throttle and engine speed
- Eliminates energy losses associated with torque converters.

Disadvantages

- Unsuitable for use in off-road environments because of limited torque-handling ability.
- Cannot provide engine braking

Table1: Feature based Comparison of transmission systems

FEATURES			
MANUAL TRANSMISSION	AUTOMATIC TRANSMISSION	SEMI-AUTOMATIC TRANSMISSION	CONTINUOUSLY VARIABLE TRANSMISSION(CVT)
This type of transmission is connected to the engine via a clutch, which if disengaged (by pressing the foot pedal or hand lever), removes torque from the system.	In an automatic transmission, the hydraulically operated control systems are managed electronically by the vehicle's computer instead of the clutch and gear stick.	This type of transmission consists of dual clutch systems which employ two clutches, one controlling gearshifts in the even numbered gears and, another that controls the odd numbered gears and reverse	In this type of transmission, the system relies on a rubber or metal belt running over pulleys that can vary their effective diameters. To keep the belt at its optimum tension, one pulley will increase its effective diameter, while the other decreases its effective diameter by exactly the same amount.

3. Proposed prototype

Considering all the features of various transmission systems, a new prototype is proposed by overcoming the drawbacks of existing models.

The transmission can be connected to engine and a shift mode can be inserted for selecting semi-automatic or automatic transmission. The engine can be manufactured in such a way that a fault detection instrument can be placed at various locations of the engine so that the particular part where the fault has occurred can be checked and repaired.

The engine can be manufactured in such a way that it should be suitable for off-road conditions by improving torque handling capacity.

4. Conclusion

This paper provides a general overview of working of different transmission systems. It also describes the features, advantages and disadvantages of transmission models with the understanding that the key system considerations help when designing the new type of transmission systems.

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