iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** V **Month of publication:** May 2023

DOI: https://doi.org/10.22214/ijraset.2023.51388

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

Modelling and Simulation of Automatic Transmission

Thuvaraga Pandi S[1], Joshua V[2], Surya S[3], Vishnurameshkumar R[4]
[1, 2, 3]*4th Year,* [4]*Assistant Professor, Automobile Engineering, Dr.Mahalingam College of Engineering and Technology*

Abstract: ***The simulation and modelling of vehicle control shift components, which take place through the gearbox of gears while deciding on the shift's features, is one of the many elements that determine a vehicle's characteristics. The efficiency of fuel combustion, the durability of the gearbox, the vehicle's operability, and the comfort of the driver are all factors that are impacted by modelling and simulation when used to design automobiles. This thesis uses MATLAB software to construct a model and simulate simpler models for gear-shift methods, taking into account driving variables such road slope, vehicle speed calculations, and other aspects to evaluate the gearbox system's behaviour. The research showed that decreasing the throttle input enhanced the engine's torque while decreasing its speed.***

I. INTRODUCTION

When it comes to shifting, there is currently a steady and considerable increase and improvement in the good scope for automobiles with automatic transmissions. The ability to control and handle gearbox switching components such as freewheels and clutches has a considerable impact on changeover comfort.

To do this, an Electronic Control Unit (ECU) is used (Nezhadali and Eriksson, 2015).

There are numerous automotive setups, but the "Automatic Transmission (AT)" is one of the most common. These systems use planetary gear sets to achieve several gear ratios by integrating components from different planetary gears (Yi et al., 2017).

The primary topic of this research is Matlab/Simulink transmission integration. The shifting state of the gearbox output shaft and crankshaft is determined by combining.

II. OBJECTIVE

A significant growth in legal requirements and customer concern about the automobile sector has been observed in recent years, taking into consideration the emissions created by the automotive industry.

Simulations were given an important role in the progress of the automotive sector. The programming resources, which are contained in their own packages, are generated by car makers to be utilised later for trails and testing as computer performance improves and novel modelling techniques become available.

III. LITERATURE REVIEW

1) Vishnu P. R. and colleagues (2016)[1]This approach takes time to shift gears and sometimes the gears do not mesh well, reducing the life of the gears. This automatic transmission was avoided by using pneumatic gear transmission.
2) John A Buzacott,L Eo Hanifin(2000),AIIE Transactions[2]"Models of automatic transfer lines with inventory banks a review and comparision".
3) Gregory M Pietron,William E Tobler(2003),SAE Technical Paper,"Review of wet friction component models for automatic transmission shift analysis".
4) Peng Dong,Yanfang Liu(2018),Automotive Innovation"Progress in automotive transmissiontecgnology".
5) Sireesha Tamada,DebrajBhattacharjee,Pranab K Dan(2020),International journal of vehicle Performance,"Review on Automatic transmission control in electric and non electric automotive powertrain"

IV. METHODOLGY

Combustion engines operate at high speeds, which are inefficient and inappropriate for starting, stopping, or travelling slowly. The gearbox's goal is to manage the engine's speed and torque ratios, giving the car a greater range of driving options.This is referred to as overdrive because the torque can be reduced as the rpm is increased. The next two equations illustrate the obtained speed eng and torque Teng on the prop shaft about gear i with ri ratio (Guiju et al. 2014).

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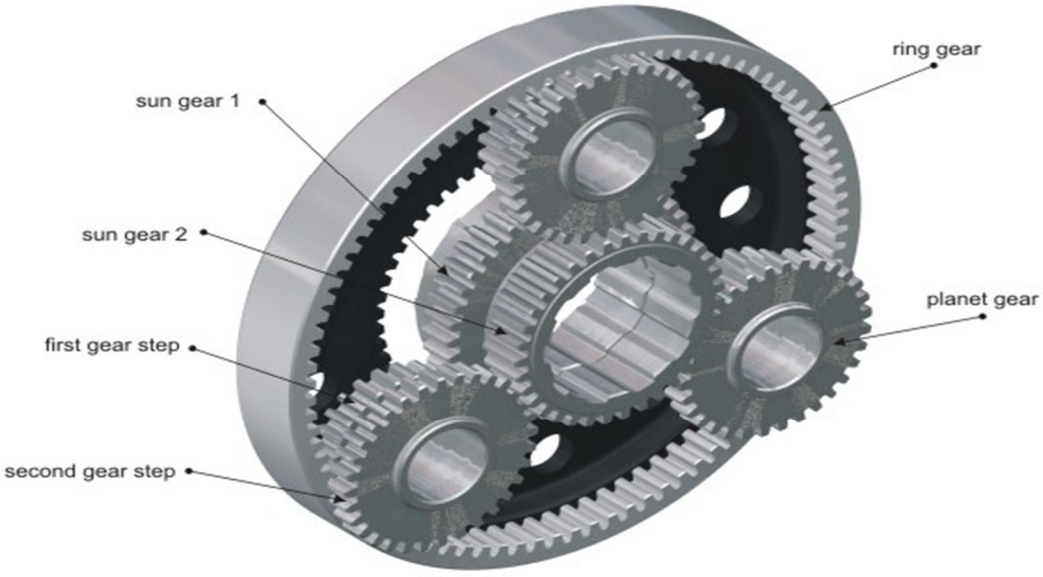
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A. Planetary-Gear Sets

In many other circumstances, commercial vehicle automatic gearboxes use a planetary-gear rail to switch between gear ratios. It is composed of multiple planter-gear classes as well as ordinary gears in some circumstances. The planter-gear kit is made up of three basic parts: sun-gear, earth gears, and the internal gear, as well as a planet carrier. Each of these pieces can be output, information, or constant. All components in a planetary gear set configuration, as illustrated in Figure 4, share a common rotational axis (Wendelius, 2012).

B. Automated-Manual Transmission

This sort of gearbox, which is manual, employs a standard gear in addition to a clutch and employs actuators, sensors, pneumatics, and processors to help manual gear usage.



C. DSG(Direct shift gears)

It is similar to a dual-clutch gearbox in that it has two clutches that open interchangeably while changing ratios. It offers smooth acceleration as well as quick shifting. New systems provide more reliable fuel systems than manual patterns. This method is known as wet gearbox, and it is projected to run for decades if the fuel is supplied on a regular basis (Automatic Revolution, 2019).

D. Clutches

Although cars with automatic transmissions do not have a clutch pedal, this does not mean that no clutches are used inside the gearbox. Inside the gear train, however, multiple clutches are used. The clutch, in instance, is made up of two plates with friction plates and a technique that either slides or presses these apart. (Zhang et al., 2015).

E. Torque Converter

The torque converter is a type of hydraulic fluid connection that connects the engine flywheel to the gearbox. When the engine is driven at a low speed while travelling, the converter initially obtains a relatively limited amount of travelling torque, allowing the automobile to stop without stalling. The stator redirects fluid as it is propelled via the impeller and decelerated through the turbine via the driving point. Despite the significant power losses, this ensures that the turbine's torque is greater than the engine's torque.

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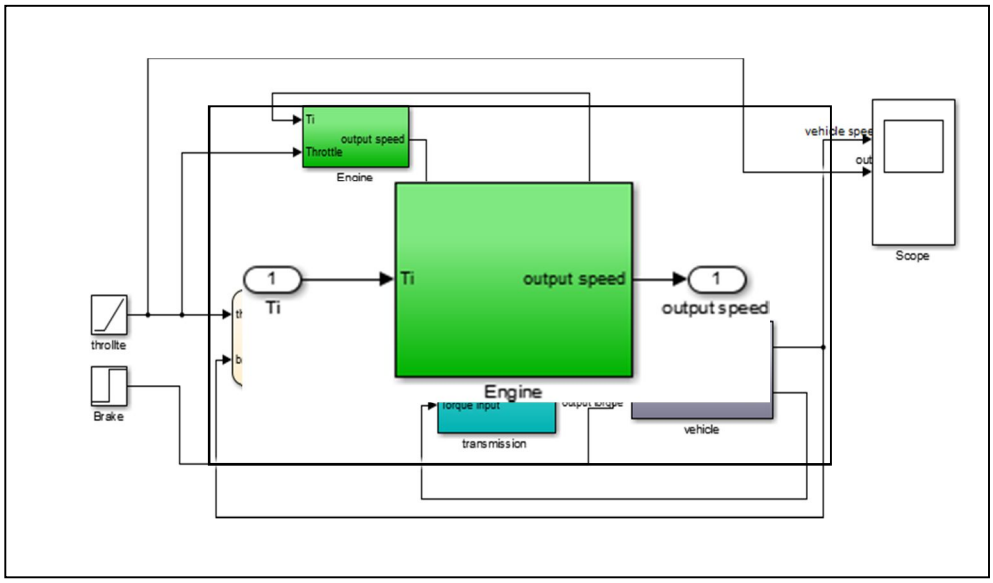
Matlab Simulink Process Flow

A four-speed gearbox is modelled using imscape DrivelineTM. Planetary gears and clutches are used in the gearbox model. In Stateflow®, the clutch control logic is represented as a state machine. Simscape Driveline powertrain model, which includes an engine, torque converter, gears, tyres, and longitudinal vehicle dynamics, is combined with the gearbox model. The entire car is put through two drive cycles, and the simulation results are displayed in Simscape.Vehicle counting, classification, and detection are important tasks in traffic management and surveillance systems. The process typically involves the following steps:

1) Model Matlab For Automatic Transmission

MATLAB Simulink was used to create a model of an automated gearbox for a vehicle.

2) Engine Model

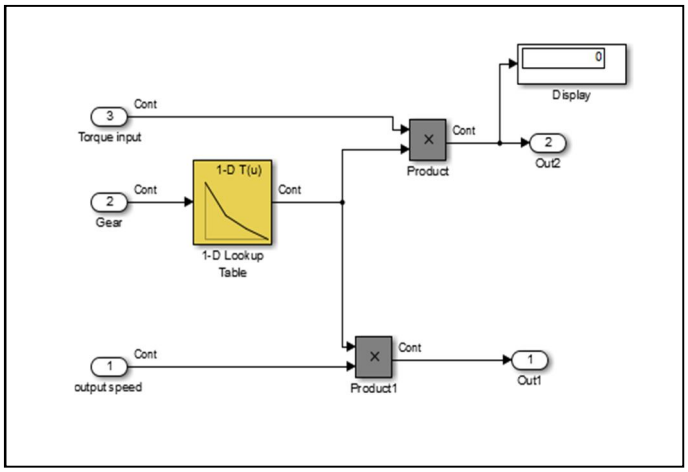


Engine models requires speed,torque ratio and specific formula to be included.

3) Transmission Gear Ratio In Matlab Model

The gear ratio is an important factor in sustaining motor performance; if the gear ratio value is incorrect, the motor will not function at the preferred speed, the quantity of energy wasted will be relatively high, and the produced torque will be adequate but not optimal.

4) Gear Ratio



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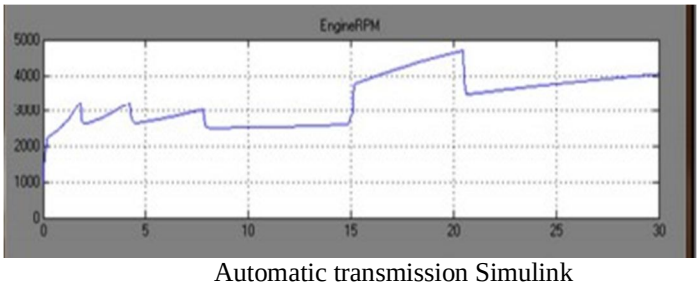
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The car and its engine gained speed before time t = 2s. The vehicle engine's speed was reduced, and it regained its high acceleration value. Upshift points 2-3 as well as 3-4 occurred at 4 and 8 seconds. At this point, the vehicle's speed remains constant. At t=15 seconds, the input throttle reached 100%, and the gearbox switched to third gear, resulting in a significant increase in engine speed from 2600 RPM to 3700 RPM. When the throttle is depressed, the engine accelerates to 100 mph before shifting to overdrive at t= 21 seconds. The vehicle might change into fourth gear.

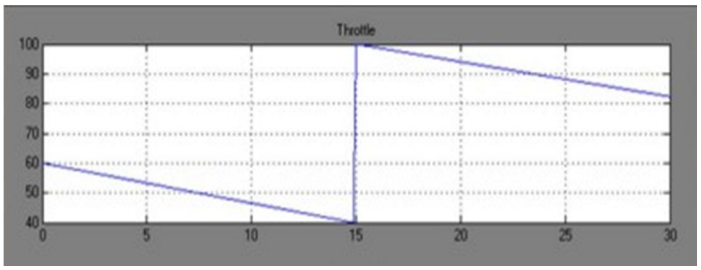
Time (in second)	Input throttle %
0	60
15	40
150	0
250	0

V. RESULTS

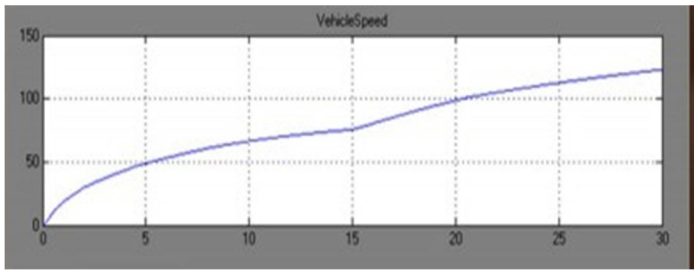
According to the gear ratio and torque ,engine R.P.M the matlab Simulink provides result diagram for each gear shift



Automatic transmission Simulink



Vehicle input throttle graph



Vehicle speed

VI. CONCLUSION

There are many configurations used in automobiles, but the Automatic Transmission (AT) is among the most commonly used schemes. These systems provide terrestrial sets of the gear that achieve a variety of gear ratios by connecting various planetary gear set components. At the time of gearshift, the coupling procedure is carried out by connecting brakes as well as oil-immersed clutches, also known as change parts. Using planetary gear set mixtures during the process of transmission allows for varying gear proportion to be obtained, while transmission's lightweight construction allows it to be used in all standard passenger cars.

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In recent years, there has been a substantial and significant growth in consumer and regulatory standards pertaining to the automobile industry. Further, the new carbon dioxide emission standards, the EU and customers continue to emit NOx1 and various particulates. Simulations have recently been given an important and significant role in the growth of the automotive industry. After modelling all of the vehicle automation system's units, all of the parameters are varied and adjusted for the desired performance. The torque of the engine and the engine speed are then investigated, and a graph regarding the variable speed of the engine and the engine torque is formed.

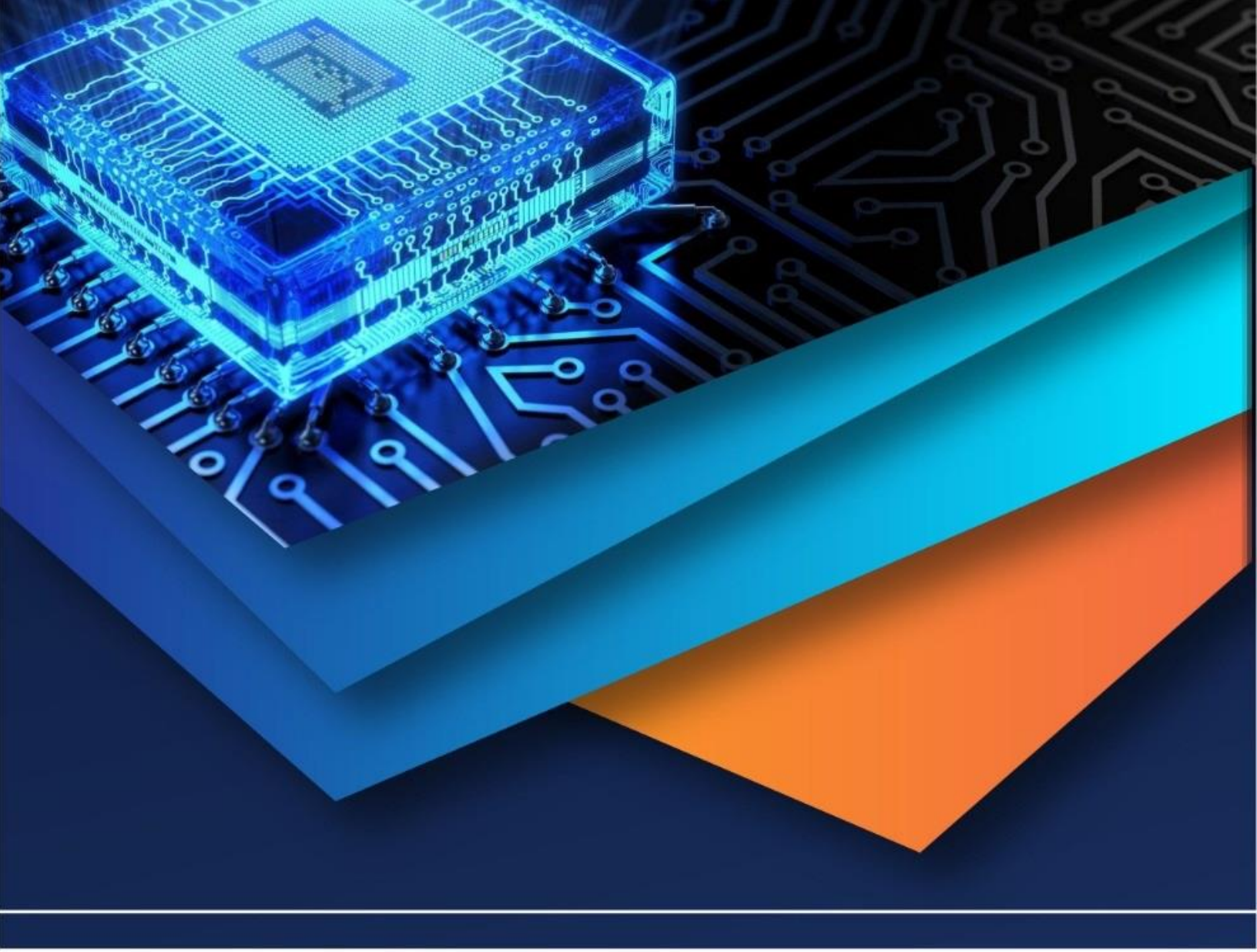
Depending on the findings of this thesis and the improvements that have arisen in the systems of the transmission, the following recommendations should be considered in the future: It is easy to find clutch control functions which satisfy the criteria for the comfort of the gearshift in terms of force. Since the actuators of the Hydraulic clutch are used in most automatic gearboxes, they produce extra dynamics, making the functions of the clutch control more difficult to implement. In order to solve this issue, the hydraulic regulation of the gearbox clutches should also be modelled.

The measurements in the vehicle are compared with the results obtained from the simulation using MATLAB Simulink, in order to obtain a comprehensive investigation of the validity of the models that were designed

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