e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

FABRICATION AND EVALUATION OF A HYBRID CLUTCH MECHANISM

Girish Adole*1

*1Mechanical Engineering, MVP's KBT College Of Engineering, India.

DOI : https://www.doi.org/10.56726/IRJMETS45538

ABSTRACT

This project focuses on the idea to get rid of the need for manual clutching by introducinga power drive which receives control signals from sensors mounted on the brake, Tachometer and gear lever and hence retrofitting this system to existing manual transmission cars. The absence of manual clutching proves to be an ergonomic advantageto drivers. The compromise is not made on fuel efficiency and the gear shifts and no jerk is felt which is much observed in AMT. The touch sensor mounted on the head of the gear lever transmits a signal whenever the hand is placed over it, for shifting gears. A linkage between the brake and the clutch ensures that the clutch pedal is depressed when the brake pedal gets pressed. A signal from the tachometer of the vehicle also ensures thatthe clutch actuates to disconnect the drive from the wheels whenever the speed of the engine drops below a certain minimum value. This ensures that the engine does not cease when the vehicle is brought to a halt, with the engine running. Similarly, multipleoccurrences of these events are taken into consideration and the control action is determined for such situations. The actuator connected to the clutch would replace the pressing of clutch pedal manually. The actuator would be Powered by the alternator of the car. The greatest advantage of this system is we can convert our Manual transmission Car to Hybrid Clutch Transmission.

Keywords: Hybrid Clutch, Arduino, Touch Sensor.

I. INTRODUCTION

According to present day technology, the conventional four-wheeler car may either use a manual transmission or an automatic transmission. However, a car that uses a combination of both these mechanisms would be termed as semi-automatic transmission. The power that is produced in the crankshaft of a multi-cylinder internal combustion engine is transmitted to the wheels after a stage of speed increase or speed reduction. However, at times, the drive from the engine needs to be temporarily disengaged from thewheels so that gear meshing may be smooth and also that the two sides of the drive may independently rotate. For this purpose, a clutch plate along with a pressure plate is used. When the gear ratio is to be changed, the gear lever has to be adjusted, but prior to that, the clutch pedal is pressed. The clutch pedal is connected to the clutch plate through mechanical or hydraulic linkages.

A clutch forms an integral part of the power-train in an automobile. The clutching action becomes necessary as the engine rotates at a fairly constant speed whereas the final drive speed is variable and subject to change depending upon instantaneous conditions. Hybrid clutch give effective mileage and fuel economy so this is help for new comers to learn carin easy way.

II. LITERATURE REVIEW

1. Dual Clutch Transmission of Automobile Mr. Amol A. Parihar, Mr. Amit C. Gunge, Mr. Udhav M. Parbhane

This research paper shows dual clutch transmission (DCT) with two input shaft, high quality gear shifting. In this paper shows that proper clutch engagement is achieve with a fast clutch system, smooth gear shifting, and without loss of fuel.In computer simulation it is observed that output torques were reduced by 32.5% with the help of the proposed clutch-to-clutch control law. Driver experience is just one of the many advantages of a DCT. With shifting take a min 8 milliseconds, many feel that the DCT offers the most dynamic acceleration of other than any vehicle. Also, efficiency of fuel increase by 10% as compare to manual clutch transmission.

2. Optimal Speed Regulation Control of the Hybrid Dual Clutch Transmission Shift Process wei Huang, Jianlong Zhang, Jianfeng Huang, Chengliang Yin and Lifang Wan

This research paper shows dual clutch transmission (DCT) with integrated electric motor in pure electric drive mode. This paper talk about hybrid DCT To shorten the torque interruption time and reduce the wear during engagement, the key point is to adjust the oncoming gear speed to the output shaft speed.

This study provides a speed regulation control framework based on model predictive control (MPC) and disturbance observer (DO), where the MPC controller is designed to achieve a good tracking performance and the DO is to eliminate effects from disturbances. Experiment results show that the combined control method can realize a fast and robust motor speed regulation process. In addition, the method used in this paper is also applicable to CLAMT systems in other electric vehicles.

3. Operation Simulation and Control of a Hybrid Vehicle Based on a Dual Clutch Configuration Walid M. Elzaghir

This paper shows fuel-efficient vehicles that consume less energy, emit fewer emissions and have enhanced overall performance. Hybrid Electric Vehicles (HEVs) with dual clutch transmissions (HDCT) are used to improve fuel efficiency and dynamic performance for both diesel engines and high-speed gas engines. DCTs also provide reduced shift shocks and shift time that result in better driving experience. And also, firstly automatic transmission provides better result as compare to manual transmission. In this transmission system proposed Model Reference Adaptive Control (MRAC) was applied to a parallel hybrid electric vehicle with dual clutch transmission (HDCT). The simulation results confirmed that the MRAC outperformed the conventional operation method for an HDCT with reduced vehicle jerk and the torque interruption and with improved fuel efficiency.

4. Modeling and Prototyping of Automatic Clutch System for Light Vehicles S Murali et al 2017

This paper make emphasis on the elimination of use of air compression for in case of pneumatic clutch and also elimination of requirement to operate clutch manually. The work is purposefully break down into three phases. The first stage deals with identification and design of components required for the clutch operating system. In the second stage, ANSYS software is used to develop and analyse the conceptual design. CATIA software is used to arrive on Optimal design from the analysis which can be generated and drafted. The final stage of the work involved in making and validating the prototype of the clutch operating system. This work involved in development, analyzation and validation of the conceptual design through simulation software. Then the developed conceptual design of an automatic pneumatic clutch system is tested with proto type.

5. Development of automatic clutch actuator for automated manual transmissions. S. E. MOON, H. S. KIM and S. H. HWANG

In this paper, the prototype of an electro-mechanical type automatic clutch actuator is implemented using a DC motor and crank mechanism. The prototype, with the advantages of low cost and simple construction can fit into a small vehicle. The parameters of the crank mechanism, DC motor and gear ratio are systematically selected and designed using load analysis. The test rig is developed to perform the basic function test for this automatic clutch. The developed automatic clutch proto type is validated be experimental data employing the test rig.

6. My Rio based Automated Gear Transmission for Manual Gear Cars. Josephine Selle J, K Gokul Vasan, V Devendran, K Jeganadhan

This paper focuses on the idea of automated gear transmission system. Technology plays a vital role in developing new ideas in the automobile industry. Currently optimization techniques and artificial intelligence have enhanced lot of features in the cars of higher end in terms of safety. Though these cars perform better authentically, they are less affordable and cannot be implemented for low-cost cars. This project is an attempt to implement —automatic gear transmission (AGT) for manual cars, without altering the basics design of the automobile. The purpose of AGT is to avoid major accidents that occur due to nervousness and when the speed goes over control during the accidents such mis happenings can be eradicated when AGT is applied in particularly three modes such as normal track, hill climbing and reverse mode of operations. The success of this project would be greatly benefited for the smart India process.

7. Automatic Clutch Actuation Using Touch Sensor Based Gear Lever And Interconnected Brake. Srivatsan, Naveen, Siddharth Narayanan, Shyam Narayan S

This paper focuses on the idea to eliminate the need for manual clutching by introducing a power drive which receives control signals from sensors mounted on the brake, tachometer and gear lever. A control unit determines the exact moment when the clutch is to be actuated based on the output from multiple sensors. The absence of manual clutching proves to be an ergonomic advantage to drivers. The compromise is not made on fuel efficiency and the gear shifts as frequently as required. The touch sensor mounted on the head of the gear lever relays a signal whenever the hand is placed over it, for shifting gears. A linkage between the brake and the clutch ensures that the clutch pedal is depressed when the brake pedal gets pressed, but with a small delay time. A signal from the tachometer of the vehicle also ensures that the clutch actuates to disconnect the drive from the wheels whenever the speed of the engine drops below a certain minimum value. This ensures that the engine does not cease when the vehicle is brought to a halt, with the engine running. Similarly, multiple occurrences of these events are taken into consideration and the control action is determined for such situations. The actuator connected to the clutch would replace the pressing of clutch pedal manually, and deliver precisely the correct amount of force in the direction at the required time to simulate clutching.

8. Semi-Automatic Clutch in Heavy Vehicles N. Prasanth, M.Arun, R.Balagurubaran1, D.Sabarish1, Dr.R.Kirubashankar

Automobiles are the major mode for the transportation, in this current era. Due to the technological advancements, there were lot of new upgrades, new safety features available which comforts the driver and also the passengers. Many modern vehicles were introduced with new features like automatic door locking system, Temperature tabiliser, window closing systems, power steering system, Anti-lock Braking Systems, ESP‘s etc. Manual engagement of clutch while shifting between the gears in traffic areas is a hectic job for drivers. This project is proposed to avoid the necessity of pressing the cutch plates while changing gears. The semi-automatic clutch system comprises a switch in the gear rod knob. With this switch the driver controls the clutching operation. The controlling is done with a Propotional Control Valve and the actuation by a double acting cylinder. The positioning of the clutch is done by the pneumatics by using metering out circuit. Hence engaging of the clutch is done semi-automatically by this mechanism and the retraction of the pneumatic cylinder is achieved smoothly. Instead of pressing the clutch manually, the engagement and disengagement of the clutch is done semi automatically. Driver indeed will be experiencing more comfort in two pedal systems than in common three pedal systems.

9. Research of the Friction Clutch Automatic Control Performance at the Stand Aleksandr Blokhin, Lev Barakhtanov, Alla Koshurina, Aleksandr Taratorkin and Pavel Lubichev.

The paper describes the research conducted at the NNSTU named after R. E. Alekseev on development and creation of multi-clutch manual transmission withautomatic control. We propose the general scheme of the transmission and clutchcontrol, design model of the clutch control mechanism, general equations that allow us to choose necessary drive parameters, and the data of the experimental studies, obtained on the specialized stand. With heavy city traffic or when drivingon broken terrain, we must shift gears every 15-25 seconds. As a result, in vehicles equipped with multi-stage mechanical transmission, every 100 km oftrack may account for 1000-1500 shutdowns of the friction clutch. This leads to the driver‘s fatigue and deterioration of his well-being, but also to an increase in errors while driving. This is especially true in the control of heavy trucks, trains and buses. Providing of safety and high performance of heavy vehicles in theseconditions may be affected by automation of the control of mechanical speed transmission, especially of a gearbox and a clutch. Therefore, nowadays theautomatic control of transmission associated with the desire to facilitate andsimplify the process of driving is developing faster and faster. For road vehiclesthe systems of automatic and semi-automatic (command) transmission and clutch control is being developed. Now electro-pneumatic drives of transmission control have increasing development in the multi-stage mechanical transmissions. This is due to the fact that trucks and buses have compressors required for the control of the brakes, doors and so on. The aim of this work is the development of new technical solutions for creation of mechanisms of the friction clutch automatic control for potential heavy-duty trucks and buses.

10. MULATION OF DUAL CLUTCH TRANSMISSION Hipparge V.K., Dhamangaonkar P. R

A dual clutch transmission is nothing but combination of two automatic manual transmissions. It combines the fuel economy and performance of a true manual with the everyday convenience of an automatic and can be drive in either manual or automatic mode. The double clutch structure also means that engine power flow to the wheels is uninterrupted. These reasons have triggered the rapid growth and popularity of DCT's in the automobile sector. In this paper simulation model of dual clutch transmission is developed by using MATLAB-Simulink. For analyzing performance benefits of transmission system, generally design model is tested and its experimental results are obtained. Instead of doing experimental work to analyze performance of transmission simulation model will predict the performance of transmission which will reduce time as well as cost to analyze the results. Simulation is focused on the performance benefits of DCT.

11. Modeling and prototyping of automatic clutch system for light vehicles S. Murali, S. Vishal

In this research paper recycling or regenerating the waste in to something useful is appreciated all around the globe. It reduces greenhouse gas emissions that contribute to global climate change. This study deals with provision of the automatic clutch mechanism in vehicles to facilitate the smooth changing ofgears. This study proposed to use the exhaust gases which are normally expelled out as a waste from the turbocharger to actuate the clutch mechanism in vehicles to facilitate the smooth changing of gears. At present, clutches are operated automatically by using an air compressor in the four wheelers. In this study, a conceptual design is proposed in which the clutch is operated by the exhaust gas from the turbocharger and this will remove the usage of air compressor in the existing system. With this system, usage of air compressor is eliminated and the riders need not to operate the clutch manually. The first stage of the work deals with identification and design of components required for the clutch operating system. In the second stage, the conceptual design is developed and analysed by using ANSYS software. Optimal design is arrived from the analysis which can be generated and drafted by using CATIA software. The final stage of the work involved in making and validating the prototype of the clutch operating system. In this system, there is one proximity sensor provided with the gear lever to have a smooth operation of clutch. The gear changing lever is connected with relay switch to facilitate the operation of clutch automatically by means of pneumatic cylinder which is powered by existing battery. The clutch shaft is connected with vacuum cylinder. There is an unloader valve fitted in the line before the reservoir and whenever the pressure reaches the maximum, the unloader valve releases and diverts exhaust gas to the catalytic converter. Whenever the gear is changed, the relay switch operates a pneumatic cylinder which causes the air coming out of turbo charger to be sucked, compressed and sent to the vacuum cylinder. This causes the piston moves inside the vacuum cylinder and thus the clutch disengages. The automatic clutch with pneumatic cylinder relates to an automatic transmission more particularly, the invention describes a transmission for producing an automatic movement forlight-weight vehicles, such as cars and other type of four wheelers.

12. Design of a semi-automatic transmission Yogendra Prahladray Buch

The automobile transmission is a very broad subject involving design of many major mechanical components such as gears, shafts, clutches, seals, springs, bearings, etc. It also involves a study of hydraulics and fluid pumps. Therefore, this magnifies the scope of literature to be surveyed. To develop a systematic approach, it was decided to review the overall history of automotive transmissions. Held deserves to be mentioned first for reviewing operationally, most of the transmissions up to 1942. 5 He includes several transmissions with magnetic clutches, with electric drives and also many hydrostatic, hydramatic, variable throw and pneumatic transmissions. He knowledgeably and in length discusses constructional details of many friction clutches and to a lesser extent of control devices. Judge discusses the details of developments up to 1962. He, therefore, describes the operational and constructional features of various automatic transmissions. In a small chapter, he discusses how a semi-automatic transmission provides an effortless operation, the transmission in which the clutchpedal is dispensed with and still the choice of gear selecting is left to the driver.He goes a bit farther and summarizes the most recent developments in transmissions. The idea of the present design resembles Zahnradfabrik-- Friedrichshafen, i.e., Z-F hydromedia semi- 6 automatic transmissions, described briefly there. To complete the study of existing transmission designs, Larew's work was studied which, in addition to describing planetary automatic transmissions with their control systems, also discusses the operational characteristics of Ford-0-Matic, Cruise-0-Matic, etc. transmissions. An improved version of a constant mesh transmission was found to be the best choice for the proposed objective. This required five separate clamping devices and so to be most compact, hydraulically controlled plate clutches were selected. Hydraulic control offers advantages in simplicity of construction; smaller size and better accessibility.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

13. Recent advancements in Dual Clutch Transmission Modelling and Simulation. Paul Walkera, Nong Zhanga, Jeku Jeyakamurana, Ric Tambab, Simon Fitzgerald.

This paper investigates and evaluates the existing work on the modelling, simulation, and control of DCT powertrains; paying particular attention to methodology, assumptions, and the obtained results, identifying key developments and limitations related to these endeavours. This is followed up with evaluation of the analysis and modelling of relevant principles and subassemblies within the DCT. Investigating first the wet clutch, and different methods employed in its control of DCTs. Next, the synchronisation process as applied to manual and dual clutch transmissions, as well as current and past methods developed for calculating the drag torques in transmissions; and finally, the analysis of automotive powertrain dynamics is investigated. Ultimately, this study intends to provide the reader with a complete understanding of the requirements for the development of a comprehensive model of DCT equipped powertrains.

14. Automatic Clutch Engagement Control for Parallel Hybrid Electric Vehicle by Trieu Minh Vu ORCID, Reza Moezzi, ORCID, Jindrich Cyrus 1, Jaroslav Hlava 2ORCID and Michal Petru.

Automatic clutch engagement control is essential for all kinds of vehicle power transmissions. The controllers for vehicle power transmissions may include model-based or model-free approaches and must provide high transmission efficiency, fast engagement and low jerk. Most vehicle automatic transmissions are using torque converters with transmission efficiencies up to 96%. This paper presents the use of fuzzy logic control for a dry clutch in parallel hybrid electric vehicles. This controller can minimize the loss of power transmission since it can offer a higher transmission efficiency, up to 99%, with faster engagement, lower jerk and, thus, higher driving comfortability with lower cost. Fuzzy logic control is one of the model-free schemes. It can be combined with AI algorithms, neuro networks and virtual reality technologies in future development. Fuzzy logiccontrol can avoid the complex modelling while maintaining the system‘s high stability amid uncertainties and imprecise information. Experiments show that fuzzy logic can reduce the clutch slip and vibration. The new system provides 2% faster engagement speed than the torque converter and eliminates 70% of noise and vibration less than the manual transmission clutch.

15. Shifting Control and Analysis of Dual Clutch Transmission of Automobile Xiaohui Xia.

According to the DCT structure and principle, the dynamic shifting process of DCT has been analyzed, and the engine and clutch model have been established. The driver intention has been analyzed and distinguished through the fuzzy control theory, on this basis, gear shift rule has been formulated based on driver intention separately from the power performance and economy performance. Clutch and engine control strategy for DCT shifting process have been proposed, and shifting control logic also has been drawn up. DCT shifting simulation model has been established based on the MATLAB/Simulink software simulation platform. The simulation result shows that the shifting simulation model in this study meets the requirement, and the shifting control strategy has a good control effect.

III. DESIGN

The pedal is a lever pivoted at a point. The large displacement and small force is converted to small displacement and large force by fulcrum principle. This is called as Mechanical Advantage.

The force from the fulcrum is used to move a master cylinder which in turn moves aslave cylinder which provides necessary axial force to actuate the clutch plate or fork.

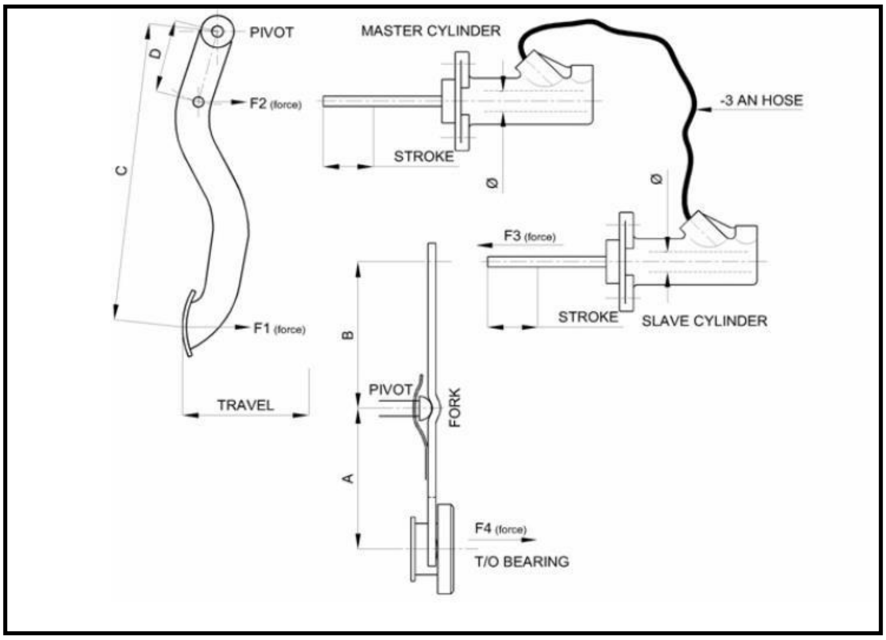


Fig 3.1 2D setup of prototype module.

A study was done based on popular models and the force necessary to actuate the clutch fork was found out to be 90 kg-force or ~ 900 N for 2.5 mm displacement according to the diaphragm spring characteristic graph. The forces to actuate each of the other links in the mechanism were worked out in reverse to calculate the exact force that would be required to move the clutch pedal. This force had to be supplied by the automating mechanism for the system to work. The clutch pedal force was found out to be 10 kg- force or ~100 N.

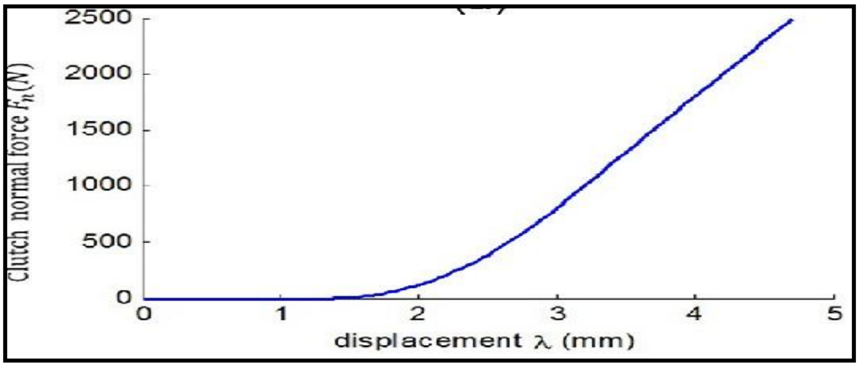


Fig 3.2 Diaphragm spring characteristics

The leverage for the clutch pedal lever was obtained as 4 by assuming the distances from the pivotal point based on ergonomic considerations and spatial constraints.

From most of the paper reviewed it was pointed out that the force required at the clutchpedal applied by leg to be in range of 10-12 kg. Considering this force as 10 kg-force.

Now, for force calculation required to be applied by the linear actuator, we take themoment about pivot point and take equilibrium condition.

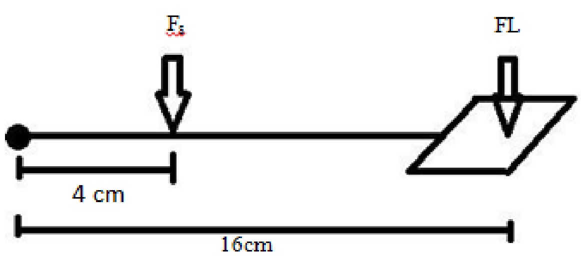


Fig. 3.3 Clutch Pedal FBD

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

F_s x 4 cm = F_L x 16 cmF_s =4F_L

Since, F_L = 10 kg- force

F_s = 4 x 10 kg- forceF_s = 40 kg- force

So, we will require a linear actuator having a capacity to apply 40 kg equivalent of force. This force can be applied through 400 N 12 V DC Linear actuators. For electrical clutch actuation to move diaphragm spring 150-kg force is required. This can be applied through 1500 N 24 V DC Linear actuator.

Fig.3.4. 24 V DC Linear Actuator 1500 N

Fig. 3.5 12 V DC Linear Actuator 400 N

The force that is applied to the clutch pedal has been calculated to be ~10 kg-force. A Linear Actuator with specification of 12 V DC supply having push and pull force of 14kg and with a movement stroke of 20 mm was selected, based on constraints of space and availability, to be mounted onto the vertical support. The velocity with which the clutch pedal is depressed is approximated to be 0.3 m/s.

The clutch pedal release is to be three times as slow as the speed of its depression i.e., 0.1m/s.

The Linear Actuator is selected having the same characteristics of push and pull phase, having reliable performance, sensitive action stable running and good environment adaptability.

The mode of actuation of the Linear Actuator for engaging or disengaging the clutch is decided by the electronic control unit. The electronic control unit shortly called as the ECU is a separate microcontroller unit specially intended for this application. The actuation of Linear Actuator through the ECU occurs based on the following conditions.

1. Whenever the status of the touch sensor mounted on the gear is ‗ON' and also when it is ‗OFF'.
2. Whenever the rpm of the wheels falls below 1000 rpm.

The touch sensor is basically a touch pad mounted on side of the gear knob. The touch pad is interfaced to the ECU and based on the status of the touch sensor (i.e) whether it is ON or OFF the clutch gets engaged or disengaged by through the Linear Actuator. The actuator will be forward or reverse actuated based on the time duration the touch sensor isON.

When the driver touches the capacitive sensor for changing the gear, the touch sensor is switched ON. The ECU will be programmed to actuate the Linear Actuator in a speed, sufficient for the actual engagement of the clutch pedal.

When the driver takes his hand off the gear knob touch sensor, the clutch pedal has to be disengaged. But the disengagement of the clutch pedal depends upon the status of thegear at that moment.

The engagement and disengagement of the clutch becomes a necessity, when the rpm of the wheels in the car falls below 1000. In this condition the clutch has to be engaged compulsorily. So, for this purpose, the rpm of the wheels are to be sensed. The status of the rpm is read from the tachometer which is present already, using an angular potentiometer, and based on it, the ECU is programmed for the forward or reverse actuation of the Linear Actuator.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

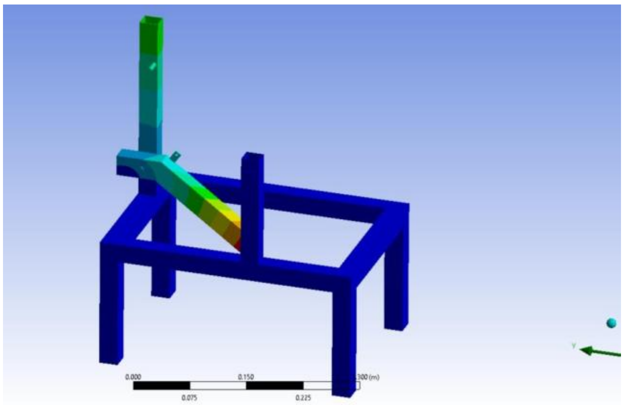


Fig.3.7 Analysis of Prototype Model (Deformation)

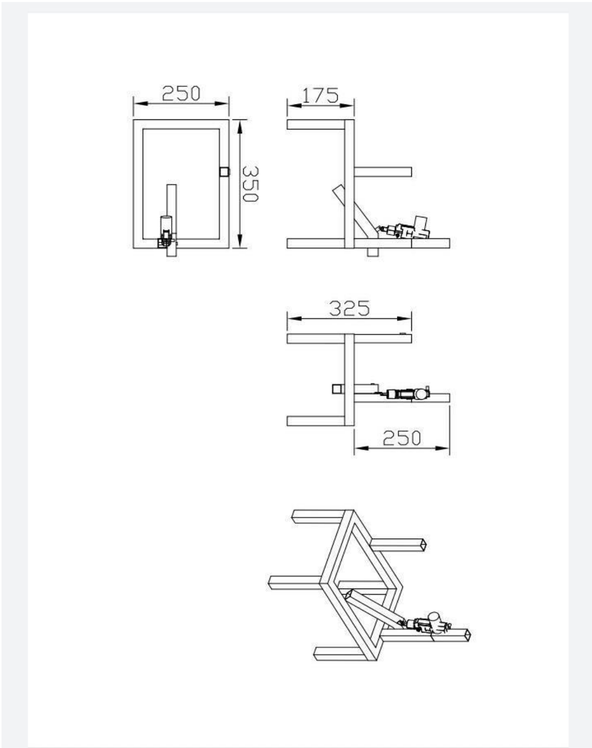
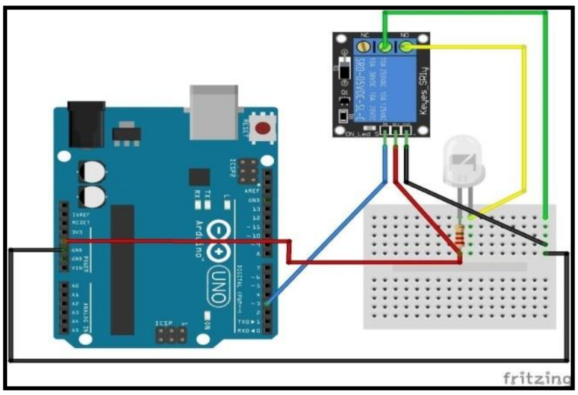


Fig 3.8 Prototype Dimensions (mm)



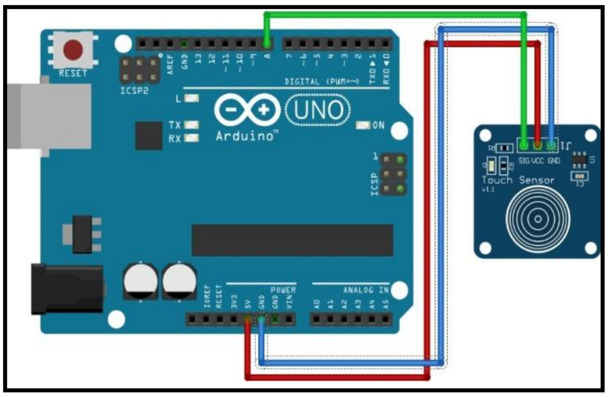


Fig. 3.9 Circuit Diagram

Fig.3.10 Circuit Diagram

Analysis And Simulation

This study comprises two main parts: I) Composite design II) Analysis using ANSYS for deformation, stress values, and strain calculations.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

Computer-aided design (CAD) is essential in design, utilizing computer systems to enhance productivity, quality, documentation, and database creation for manufacturing. CAD software can generate electronic files for various manufacturing operations. It's not just about shapes; CAD conveys materials, processes, dimensions, and tolerances according to specific conventions.

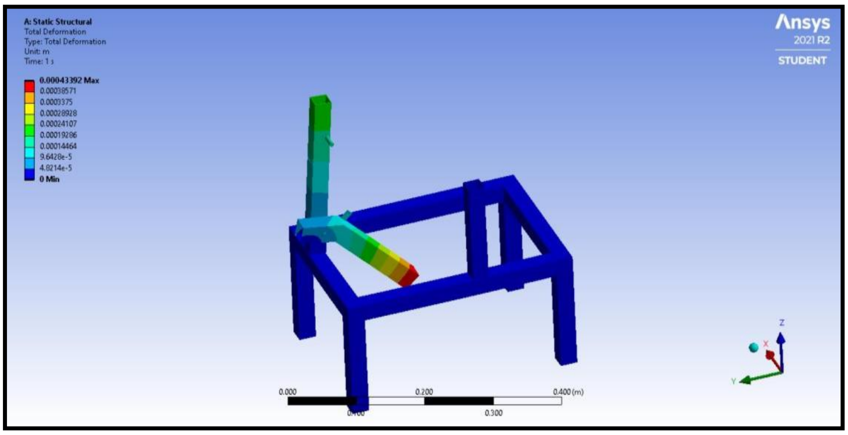


Fig. 3.11 Analysis of CAD drawing

Coordinate system: -- default --

Mass = 291.14 grams

Volume = 291135.39 cubic millimeters

Surface area = 461804.54 square millimeters

Center of mass: (millimeters)
X = 9.27
Y = 47.78
Z = 36.79

Principal axes of inertia and principal moments of inertia: (grams * square millimeters)
Taken at the center of mass.

Ix = (0.17, 0.87, 0.47)	Px = 3934676.22
Iy = (0.68, -0.45, 0.58)	Py = 7314237.73
Iz = (0.71, 0.22, -0.67)	Pz = 7461944.74

Moments of inertia: (grams * square millimeters)
Taken at the center of mass and aligned with the output coordinate system.

Lxx = 7285214.19	Lxy = 489257.53	Lxz = 346456.57
Lyx = 489257.53	Lyy = 4783418.26	Lyz = 1390495.27
Lzx = 346456.57	Lzy = 1390495.27	Lzz = 6642226.24

Moments of inertia: (grams * square millimeters)
Taken at the output coordinate system.

Ixx = 8343848.98	Ixy = 618203.86	Ixz = 445731.16
Iyx = 618203.86	Iyy = 5202402.84	Iyz = 1902215.56
Izx = 445731.16	Izy = 1902215.56	Izz = 7331908.06

Fig. 3.12 Mass property of CAD

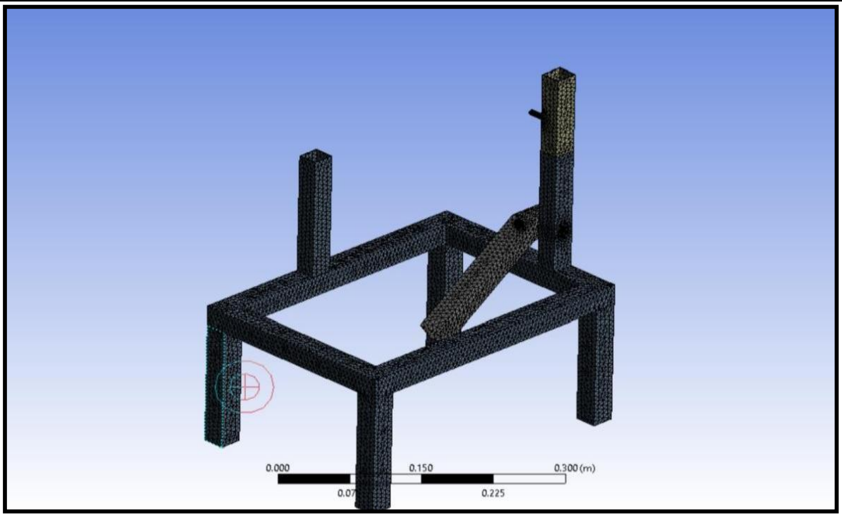


Fig. 3.13 Meshing of cad module

Mesh Details

Details of "Mesh"	
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	3.0825e-002 m
Sizing	
Use Adaptive Sizi...	No
Growth Rate	Default (1.85)
Max Size	Default (6.165e-002 m)
Mesh Defeaturing	Yes
Defeature Size	Default (1.5413e-004 m)
Capture Curvature	Yes
Curvature Mi...	Default (3.0825e-004 m)
Curvature Nor...	Default (70.395°)
Capture Proximity	No
Bounding Box Di...	0.61843 m
Average Surface ...	2.0049e-003 m²
Minimum Edge L...	1.225e-004 m
Quality	
Check Mesh Qua...	Yes, Errors
Error Limits	Standard Mechanical
Target Quality	Default (0.050000)
Smoothing	Medium
Mesh Metric	None
Inflation	
Advanced	
Statistics	
Nodes	102406
Elements	51680

Boundary Condition: -

The clutch pedal is used in the following situations:

Shifting Gears: In manual transmissions, the driver presses the clutch pedal to disengage the clutch and select a gear using the gear lever. This is done to transfer power from the engine to the gearbox. The clutch fork disengages the pressure plate from the friction plate when the clutch pedal is pressed.

Shifting at Optimum RPM: The best time to change gears is when the engine reaches the maximum RPM for a specific gear. The driver presses the clutch pedal to shift gears. The force required to press the clutch is approximately 100 N.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

Preventing Engine Stall: When braking at high speeds, the engine RPM drops rapidly, risking a stall. An RPM sensor instructs the motor to depress the clutch pedal to prevent stalling by disconnecting the clutch shaft from the gearbox output shaft.

Reducing Engine Load: To save power during idling, the clutch is disengaged. An angular potentiometer instructs the motor to press the clutch during idling, reducing the engine's load.

This system ensures efficient clutch usage in various driving conditions.

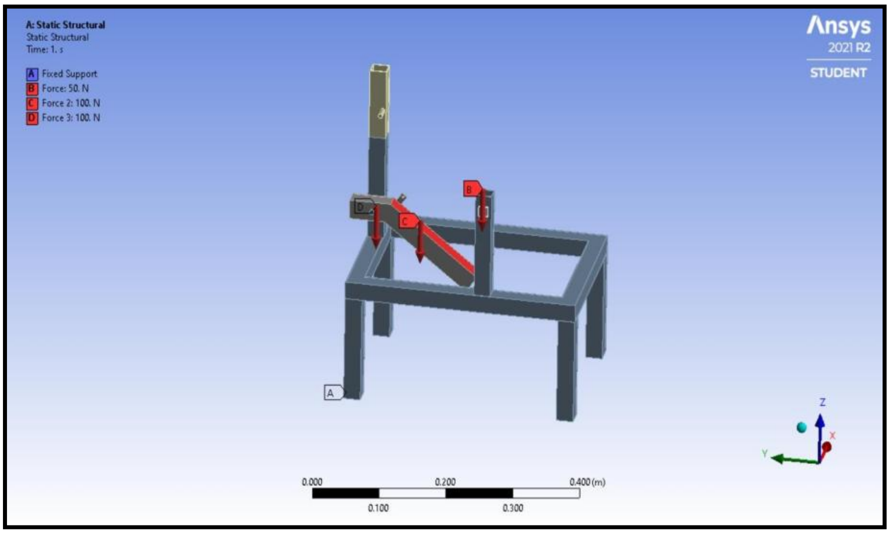


Fig 3.14 Boundary condition of CAD module

Total Deformation:

Total deformation and directional deformation are common terms in finite element methods, regardless of the software used.

Directional deformation refers to the displacement in a specific axis or user-defined direction.

Total deformation is the sum of all directional displacements of the system.

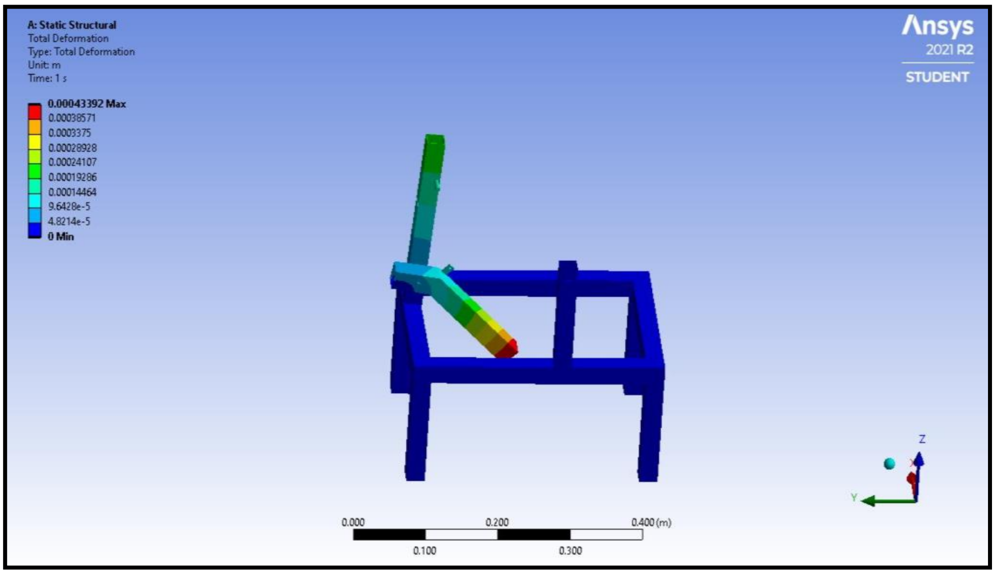


Fig. 3.15 Total Deformation Of CAD Module

Detail of total deformation

Details of "Total Deformation"	
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Total Deformation
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Results	
Minimum	0. m
Maximum	4.3392e-004 m
Average	4.4109e-005 m
Minimum Occurs On	Part1
Maximum Occurs On	Part2
Information	
Time	1. s
Load Step	1
Substep	1
Iteration Number	1

Equivalent Stress: -

Equivalent stress is related to the principal stresses by the equation:

$$\sigma_e = \left[\frac{(\sigma_1-\sigma_2)^2+(\sigma_2-\sigma_3)^2+(\sigma_3-\sigma_1)^2}{2} \right]^{1/2}$$

Equivalent stress (also called von Mises stress) is often used in design work because it allows any arbitrary three-dimensional stress state to be represented as a single positive stress value. Equivalent stress is part of the maximum equivalent stress failure theory used to predict yielding in a ductile material.

The von Mises or equivalent strain εe is computed as:

$$\varepsilon_e = \frac{1}{1+\nu'}\left(\frac{1}{2}\left[(\varepsilon_1-\varepsilon_2)^2+(\varepsilon_2-\varepsilon_3)^2+(\varepsilon_3-\varepsilon_1)^2\right]\right)^{\frac{1}{2}}$$

Where: ν' = effective Poisson's ratio

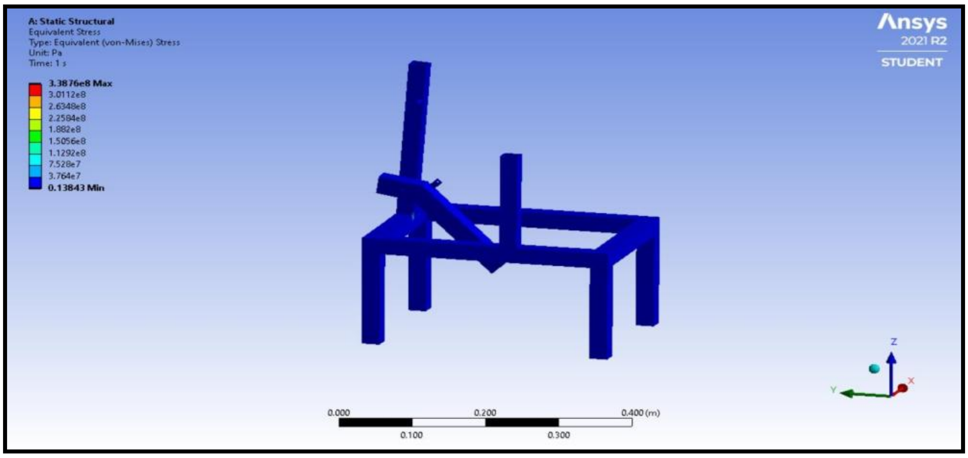


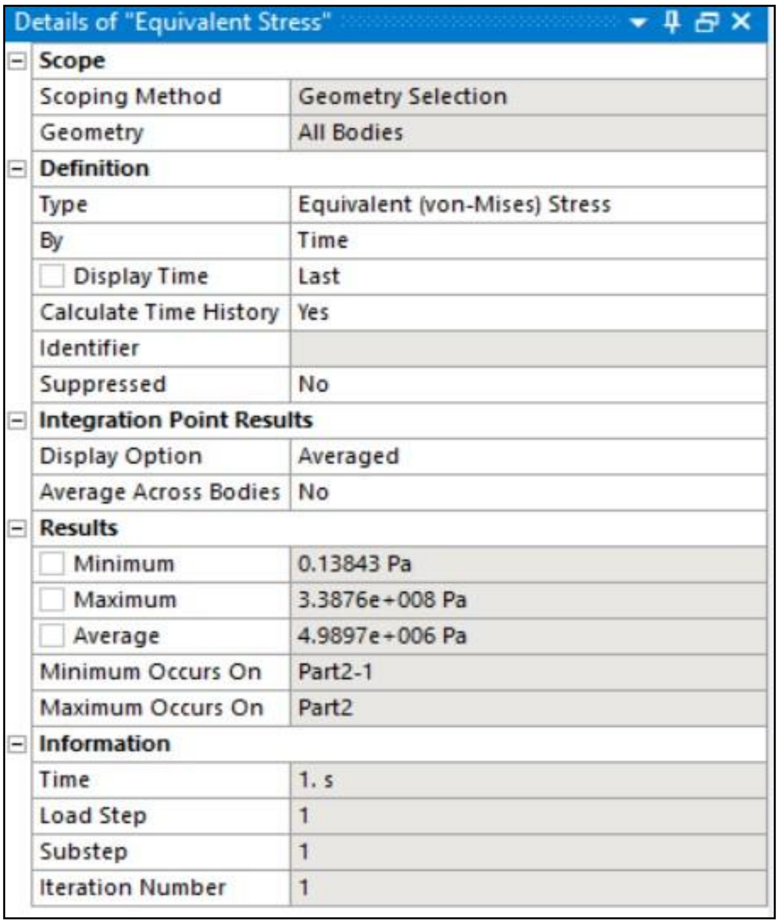
Fig 3.16 Equivalent Stress Of CAD Module

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

Stress and Deformation

Table 3.1 Detail Of Equivalent Stress

	Equivalent Stress (Pa)	Total Deformation (m)
Minimum	0.13843	0
Maximum	3.3876e8	0.00043392



Details of "Equivalent Stress"

Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Equivalent (von-Mises) Stress
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Integration Point Results	
Display Option	Averaged
Average Across Bodies	No
Results	
Minimum	0.13843 Pa
Maximum	3.3876e+008 Pa
Average	4.9897e+006 Pa
Minimum Occurs On	Part2-1
Maximum Occurs On	Part2
Information	
Time	1. s
Load Step	1
Substep	1
Iteration Number	1

Equivalent Strain: -

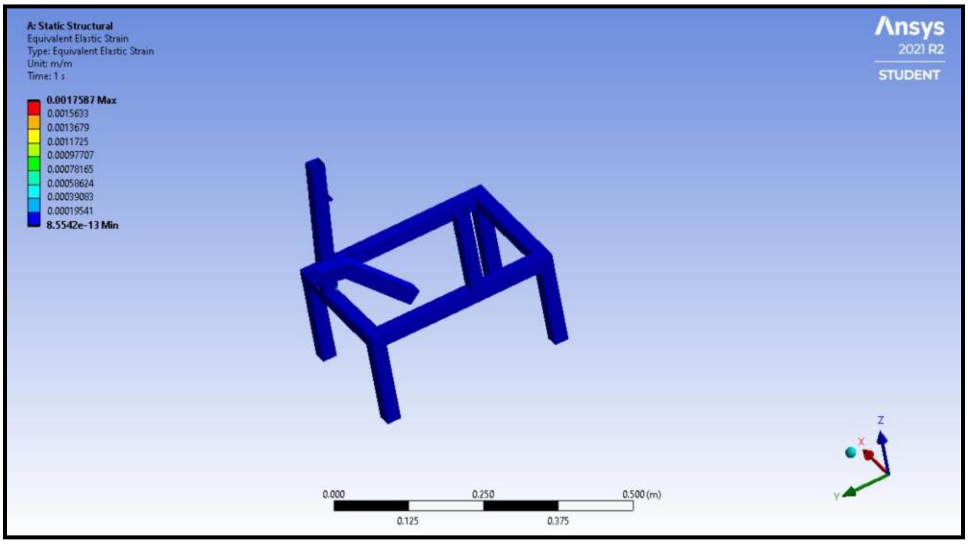


Fig 3.17 Equivalent Strain of CAD Module

IRJMETS

e-ISSN: 2582-5208

International Research Journal of Modernization in Engineering Technology and Science

(Peer-Reviewed, Open Access, Fully Refereed International Journal)

Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

Detail Of Equivalent Elastic Strain

Details of "Equivalent Elastic Strain"	
Scope	
Scoping Method	Geometry Selection
Geometry	All Bodies
Definition	
Type	Equivalent Elastic Strain
By	Time
Display Time	Last
Calculate Time History	Yes
Identifier	
Suppressed	No
Integration Point Results	
Display Option	Averaged
Average Across Bodies	No
Results	
Minimum	8.5542e-013 m/m
Maximum	1.7587e-003 m/m
Average	2.8398e-005 m/m
Minimum Occurs On	Part2-1
Maximum Occurs On	Part1
Information	
Time	1. s
Load Step	1
Substep	1
Iteration Number	1

Using Ansys software, a vehicle shifting simulation model was created and confirmed the effectiveness of the shift model, demonstrating the success of the shift control strategy.

By comparing experimental and simulated results, it's clear that the touch sensor's influence on linear actuator control impacts clutch displacement quality and performance, which is crucial for system and control algorithm design.

The Hybrid Clutch System model, with parameters determined through a physically based process, accurately replicates clutch dynamics during operation.

To validate the model and design a controller, experimental identifications were conducted using a prototype actuator. The work involved identifying and designing the clutch operating system components, developing and analyzing the conceptual design with ANSYS software, and achieving an optimal design using SOLIDWORKS software. The final step included creating and validating the prototype of the clutch operating system.

IV. EXPERIMENTAL VALIDATION

The prototype fabrication was the last phase of the detailed design. It started once the major design changes were complete, the necessary fabrication processes were defined, and the required materials and electronics were acquired.

The processes included electric arc welding and drilling, carried out in line with design specifications. Steel square pipes were cut to size, and electric arc welding was used to assemble the prototype structure, while drilling was employed to create holes in the pipes.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

Fig 4.1 Fabrication of structure

Arduino

Arduino Uno is a microcontroller board based on the ATmega328P, featuring 14 digital input/output pins (6 of which can serve as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, USB connectivity, a power jack, an ICSP header, and a reset button. It provides everything necessary to support the microcontroller. To get started, simply connect it to a computer via USB or power it using an AC-to-DC adapter or battery. It's beginner-friendly, and even if you make a mistake, you can replace the chip for a few dollars and start fresh.

The name "Uno" is Italian for "one" and was chosen to coincide with the release of Arduino Software (IDE) 1.0. The Uno board and IDE 1.0 were the standard versions of Arduino at the time, which have since evolved into newer releases. The Uno board was the first in a series of USB Arduino boards and serves as a reference model for the Arduino platform. For a comprehensive list of current, past, or outdated Arduino boards, you can refer to the Arduino index of boards.

Table 4.1 Technical Specifications of Arduino UNO R3

Board	Name	Arduino UNO R3
	SKU	A000066
Microcontroller	ATmega328P	
USB connector	USB-B	
Pins	Built-in LED Pin	13
	Digital I/O Pins	14
	Analog input pins	6
	PWM pins	6
Communication	UART	Yes
	12C	Yes
	SPI	Yes

Power	I/O Voltage	5V
	Input voltage (nominal)	7-12V
	DC Current per I/O Pin	20 mA
	Power Supply Connector	Barrel Plug
Clock Speed	Main Processor	ATmega328P 16 MHz
	USB-Serial Processor	ATmega16U2 16 MHz
Memory	ATmega328P	2KB SRAM, 32KB FLASH, 1KB

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

		EEPROM
Dimensions	Weight	25 g
	Width	53.4 mm
	Length	68.6 mm

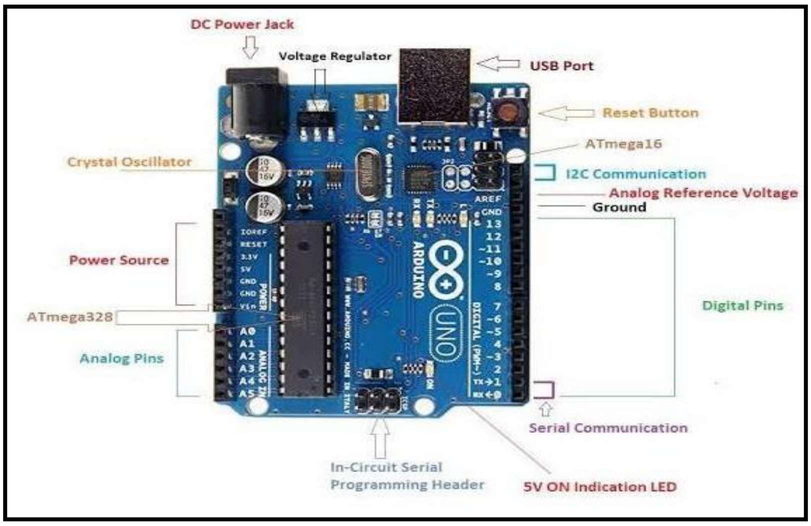


Fig 4.2 Arduino UNO

Touch sensor

Capacitive touch sensors are prevalent in portable devices, home appliances, automotive, and industrial applications. They're favored for their durability, resistance to dust and moisture, sleek design, and cost-effectiveness.

Unlike mechanical devices, touch sensors have no moving parts, making them more durable and robust.

These sensors work by forming a capacitor with an electrode. One plate is the electrode itself, while the other consists of the sensor's environment (parasitic capacitor C0) and a conductive object like a human finger (touch capacitor CT).

A measurement circuit periodically checks the capacitance, and when a conductive object, like a finger, approaches the sensor, it detects the change and triggers a response.

For instance, the Single Channel Capacitive Touch Sensor Module, using TTP223, adds capacitive touch input to projects. It's easy to power with 2-5.5V DC and is ideal for various applications. When a capacitive load (e.g., a human hand) is near the sense-pad, it activates the switch. Custom sense-pads can be made from many conductive materials and can detect touch through thin non-conductive layers.

The module's output is low in the idle state, switching to high when touched. If not touched for 12 seconds, it enters low-power mode.

This module can be discreetly installed under surfaces, including plastic, glass, and even non-metallic materials.

Fig 4.3 TTP223 - 1 Channel Capacitive Touch Sensor Module

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

Linear actuator

Linear actuators provide straight-line motion, as opposed to the rotary motion of traditional electric motors. They are utilized in various applications, including machine tools, industrial machinery, computer peripherals, valves, and more.

These actuators precisely and repeatably move objects linearly. They are chosen when a system needs linear motion rather than rotary. As most electric motors are rotary, linear actuators convert this motion.

Their design offers accurate control, low maintenance, and energy efficiency. They're easier to install than hydraulic or pneumatic alternatives, cost-effective, and space-saving.

Electric motors connect to linear actuators with flexible couplings or belts, allowing various motor sizes for different requirements. When paired with sensors or smart technologies, they provide safe, secure, and precise motion, reducing manual labor.

Linear actuators feature linear and rotary bearings, making them stand-alone devices that are easy to integrate into existing machinery. For increased load capacity and stability, multiple actuators can be synchronized using shafts or belts, such as in an XY gantry-style stage.

Fig 4.4: Linear actuator

Relay

Relays are electrically operated switches with input terminals for control signals and output terminals for operating contacts. They can have various contact forms, like make or break.

Relays are used to control circuits with low-power signals or to manage multiple circuits with one signal. Initially, they were used as signal repeaters in telegraph circuits, and later in telephone exchanges and early computers for logical operations.

A power relay module is an electromagnetically operated electrical switch, controlled by a low-power signal from a microcontroller. It consists of a coil, yoke, armature, and contacts.

When an electric current passes through the coil, it generates a magnetic field, causing the armature to move and change the contact positions. This action helps open or close electrical circuits. Relays are vital for protecting electrical systems and equipment from overcurrents or overvoltages. They are also used to control high-voltage circuits with low-voltage signals in various applications. In essence, relays ensure safe and automated operation of electronic equipment without direct high-voltage contact during electrical issues.

Fig 4.5 1 Channel 5V Relay Module

V. RESULT

New environmental and fuel efficiency regulations, along with advancements in electronics and manufacturing, have led to automated transmission technologies. Today, many automobile manufacturers offer both automatic and manual transmission cars.

Transmissions transfer power from a car's engine to the drive shaft and wheels. A clutch is a critical component used to transmit power from the engine to the gearbox transmission system.

In a car, the clutch is essential because the engine runs continuously, while the wheels do not. To stop the car without turning off the engine, the wheels must be disengaged from the engine. The clutch accomplishes this by smoothly connecting the spinning engine to the non-spinning transmission, controlling the slippage between them.

VI. CONCLUSION

This project aims to create a user-friendly method to automate clutch operation, reducing the need for manual effort. The flexible design allows easy integration into existing cars with minor modifications, enhancing driving comfort while maintaining fuel efficiency.

The system can be attached or detached as a sub-system, offering serviceability and customization. It includes a manual override mechanism, ensuring accessibility to the clutch pedal for human operation.

Effective for improving manual transmission vehicles, the project showcases the importance of modeling and control design for an automatic clutch system. Simulation-based analysis helps set system specifications, reducing trial and error design and associated costs. The experimental prototype with high-capacity actuators demonstrates the system's feasibility in automobiles.

VII. FUTURE WORK

This project introduces an electrical clutching subsystem using a linear actuator, DC motor, and dummy clutch to engage and disengage the clutch. A prismatic pair is employed for this purpose.

This system is integrated with our previous mechanism. When the touch sensor is pressed, it triggers the actual disengagement of the clutch, temporarily halting the transfer of rotational energy.

The electronic component consists of a 24 V DC linear actuator and a DC motor. The linear actuator responds to a press button attached to the clutch pedal's backside, enabling actuation.

VIII. REFERENCES

[1] Mr. Amol A. Parihar, Mr. Amit C. Gunge, Mr. Udhav M. Parbhane ―Dual Clutch Transmission of Automobile‖. IJMER Volume 6, pp 4-6, Nov.2016

[2] wei Huang, Jianlong Zhang, Jianfeng Huang, Chengliang Yin and Lifang Wan―Optimal Speed Regulation Control of the Hybrid Dual Clutch Transmission Shift Process‖. World Electric Vehicle

Journal, pp 13- 16 January 2020

[3] Walid M. Elzaghir —Operation Simulation and Control of a Hybrid Vehicle Based on a Dual Clutch Configuration|| pp 47-56 2018

[4] S Murali et al 2017 —Modeling and Prototyping of Automatic Clutch System for Light Vehicles|| IJAT, pp 2-7 Nov. 2011

[5] S. E. MOON, H. S. KIM and S. H. HWANG —Development of automatic clutch actuator for automated manual transmissions|| IJAT pp 9-13 June 2005

[6] Grewe T.M., Conlon, B.M., Holmes, A.G., (2007), —Defining the General Motor 2- Mode Hybrid Transmission,|| SAE Paper pp 23-27 2007-01

[7] L. Petit, C. Prelle, E. Dore, F. Lamarque, and M. Bigerelle, —A four discrete-position electromagnetic actuator: Modeling and experimentation,|| IEEE/ASME Trans. Mechatronics, vol. 15, no. 1, pp. 88–96, Feb.2010

[8] L. Glielmo, L. Iannelli, V. Vacca, and F. Vasca, —Gearshift control for automated manual transmission,|| IEEE/ASME Trans. Mechatronics, vol. 11, no. 1, pp. 17–26, 2006.

[9] M. Montanari, F. Ronchi, C. Rossi, A. Tilli, and A. Tonielli, —Control and performance evaluation of a clutch servo system with hydraulic actuation,|| Control Eng. Practice, vol. 12, pp. 069–079, 2004

[10] A. J. Turner and K. Ramsay, —Review and development of electromechanical actuators for improved transmission control and efficiency,|| SAE, Tech. pp 13-22. 2004-01, 2004.

[11] G. Lucente, M. Montanari and C. Rossi, —Modelling of an automated manual transmission system||, Mechatronics, vol. 17, pp.73–91 ,2007.

[12] E. Galvagno, M. Velardocchia and A. Vigliani, —Analysis and simulation of a torque assist automated manual transmission||, vol. 25, 2011.

[13] Z. J. Liu, D. T. Qin and J. J. Hu, —Design and application of heavy truck AMT system||, Transactions of the Chinese Society for Agricultural Machinery, vol. 42, no. 8, pp. 7–14, 2011.

[14] J. He, H. Jin and H. Y. Chen, —Simulation research on control strategy of electromechanic clutch during vehicle starting||, China ACTA ARMAMENTARII, vol. 32, no. 8, pp. 931 – 938, 2011.

[15] M. Montanari, F. Ronchi, C. Rossi, A. Tilli, and A. Tonielli, —Control and performance evaluation of a clutch servo system with hydraulic actuation,|| Control Eng. Practice, vol. 12, pp. 1369–1379, 2004

[16] J. Fredriksson and B. Egardt, —Nonlinear control applied to gearshiftingin automated manual transmission,|| in Proc. 39th IEEE Conf. Decisionand Control, pp. 444–449, 2000.

[17] Ajinkya Joshi, Nirav P. Shah|| Modeling and Simulation of a Dual Clutch Hybrid Vehicle Powertrain|| Vehicle Power and Propulsion Conference, IEEE, pp 98-107, 2009

[18] Kuroiwa H., Ozaki N., Okada T., Yamasaki M. (2004), —Next-generation fuel- efficient automated manual transmission||, Hitachi Review, pp 205–209, 2014

[19] Kasuya S., Taniguchi T., Tsukamoto K., Hayabuchi M., Nishida M., Suzuki A., Niki H., AISINAW New High Torque Capacity Six-Speed Automatic Transmission for FWD vehicles, SAE Technical Paper, pp 9-13, 2005

[20] Kulkarni M., Shim T., Zhang Y., Shift dynamics and control of dual-clutch transmissions, Mechanism and Machine Theory 42, pp 168-182, 2007

[21] Link M, Vos B, Eggert E, Nasdal R. The automated shift transmission (AST) – possibilities and limits in production-type vehicles, SAE Paper, pp 12-16, 2001.