Design And Development of Self Handbrake System

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Abstract- *The primary consideration for any driver is safety when operating a vehicle. The crucial component of this system is the hand brake system's disengagement as the vehicle moves. The hand lever used to operate a conventional handbrake system is manual. It has been noted that under this system, manual errors may cause the system to stay engaged while the car is moving. Additionally, it is dangerous for both safety and system components. The main objective of this project is to design the automatic hand break release for the vehicle. In this project, the vehicle hand brake can be applied automatically after the vehicle is turned OFF. Here we have an ignition key connected to the micro controller, whenever the ignition key is turned ON the hand break is released and when the ignition key is turned OFF hand break is applied. This process is done by using the braking system connected to the solenoid valve.*

Keywords- Handbrake, Pneumatic Cylinder, Solenoid valve and Limit Switch.

I. INTRODUCTION

The primary objective of this project is to develop an automatic hand brake release system for vehicles, aiming to enhance convenience and safety for drivers. The system functions by automatically applying the hand brake when the vehicle is turned off and releasing it when the ignition key is turned on. When the ignition key is turned on, signalling the vehicle's activation, the hand brake is automatically released. Conversely, when the ignition key is turned off, indicating the vehicle's deactivation, the hand brake is applied. This seamless process is facilitated by the braking system, which is connected to a solenoid valve controlled by the microcontroller.

By automating the hand brake release process based on the status of the ignition key, this project endeavours to streamline vehicle operation and contribute to overall driver convenience and safety.

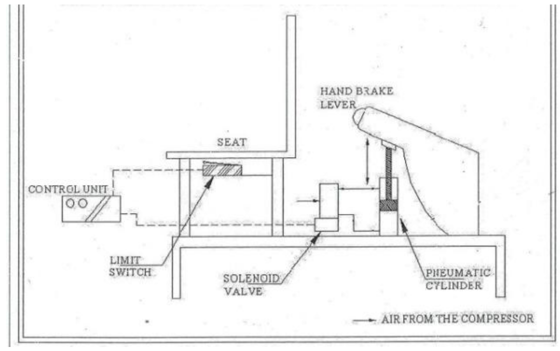


Fig. 1 LAYOUT OF SELF HAND BRAKE

II. METHODS

A. METHEDOLOGY

1. Objective

The primary objective of this project is to enhance vehicle safety and user convenience by automating the handbrake system. The manual operation of handbrakes can sometimes lead to human errors, resulting in accidents or vehicle damage. Byautomating this system, weaim to mitigate such errors and improve overall safety.

2. Literature Review

To gain insights and ideas for our project, we conducted an extensive review of existing literature and similar projects in the field of vehicle automation and safety systems. This review provided us with valuable information on the challenges, solutions, and best practices associated with self-handbrake systems.

3. Conceptualization and Design

Based on the identified objective and findings from the literature review, we developed the concept for our self-handbrake system. This concept was translated into a detailed system architecture, outlining the components, interactions, and working principles of the system. We carefully selected suitable components such as the pneumatic cylinder, solenoid valve, limit switch, and ignition key to fulfill the requirements of our design. Additionally, we designed the mechanism for pneumatic cylinder operation to ensure smooth and reliable handbrake engagement and disengagement.

4. Material Selection and Frame Design

In consideration of the project requirements and design specifications, we meticulously selected materials such as mild steel tube rod, sheet metal, and PU tubes. These materials were chosen for their strength, durability, and compatibility with the project's mechanical and pneumatic components. Using AutoCAD in 3D modelling, we designed a rectangular frame with precise dimensions (650mm x 290mm) to accommodate the components and provide structural support for the self-handbrake system.

Properties:

i. Mild Steel Tube Rod (18mm thickness):

- Strong and durable material suitable for structural components.
- Easily weldable for fabrication of complex shapes and structures.
- Moderate corrosion resistance with proper surface treatment.

ii. Sheet Metal (17x17mm for seat):

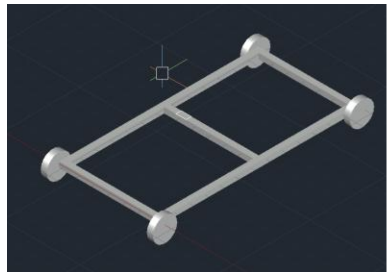
- Highly formable material, allowing for easy shaping and manipulation.
- Offers a good balance of strength and weight for structural and aesthetic applications.
- Surface finish can be customized to achieve desired textures and appearances.

iii. Polyurethane (PU) Tubes (6x4mm):

- Flexible and elastic material, capable of bending and stretching without breaking.
- Resistant to abrasion and wear, ensuring longevity and reliability.
- Exhibits good resistance to chemicals, suitable for pneumatic systems with fluid exposure.

5. Fabrication and Assembly

With the design finalized, we proceeded to fabricate the rectangular frame using arc welding processes. This ensured that the frame met our design specifications and provided the necessary structural integrity. We then assembled the selected components onto the frame, following the system architecture and design guidelines. Attention to detail was paramount during this phase to ensure proper alignment and functionality of the self-handbrake system.



Frame design in AutoCAD

6. TESTING

To verify the performance and adherence to project requirements, the self-handbrake system underwent rigorous functional testing. We simulated various scenarios, including ignition ON/OFF and driver seated/absent, to validate system responses and safety features. Special attention was given to testing safety features to prevent unintended activation or release of the handbrake, ensuring user safety and system reliability.

7. DOCUMENTATION AND REPORTING

A comprehensive documentation was prepared to capture the entire development process, including design decisions, fabrication steps, software development, testing results, and optimization efforts. This documentation served as a valuable reference for future iterations of the self-handbrake system and for sharing knowledge with stakeholders and the wider community. Additionally, a detailed project report was compiled, presenting the methodology, findings, conclusions, and recommendations for future improvements.

B. COMPONENTS

1. SOLENOID VALVE

In this project we have used 5/2 solenoid valve, serves as a critical component in the automatic operation of the handbrake system. It has two positions that control the flow of compressed air to the double-acting cylinder, which in turn activates or deactivates the handbrake lever. When the solenoid valve is energized, it switches the valve position to release the handbrake, and when de-energized, it switches the position to engage the handbrake.

Fig.2 SOLENOID VALVE

2.LIMIT SWITCH

The limit switch is strategically placed beneath the driver's seat to detect the presence or absence of the driver. When the driver is seated and the ignition is on, the limit switch signals the controller to deactivate the handbrake, allowing the vehicle to move. Conversely, if the driver leaves the seat or the ignition is turned off, the limit switch triggers the controller to activate the handbrake, preventing unintended movement of the vehicle.

Fig 3.LIMIT SWITCH

3. PU (POLYURETHANE) PIPE

In this project we used 2 polyurethane pipes of 6x4mm where the one end of the pipe is connected to the ports of the cylinder and the other end is connected to the two position ports of the solenoid valve.

Fig.3 PU PIPES (6x4mm)

4. PNUEMATIC CYLINDER

The double-acting cylinder is connected to the 5/2 solenoid valve via PU pipes. It receives compressed air from the solenoid valve and translates it into linear motion to engage or disengage the handbrake lever. The cylinder's piston alternates between two strokes, extending to engage the handbrake and retracting to disengage it, based on the direction of airflow controlled by the solenoid valve

Fig.5 PNUEMATIC CYCLINDER(16x10mm)

5. IGNITION KEYSET

In this project we have used a small ignition key set where one terminal of the keyset is connected to the common terminal of the limit switch and the other terminal of the keyset is connected to the Normally Opened (NO) terminal of the limit switch.

Fig.6 IGNITION KEYSET

III. 3D MODEL

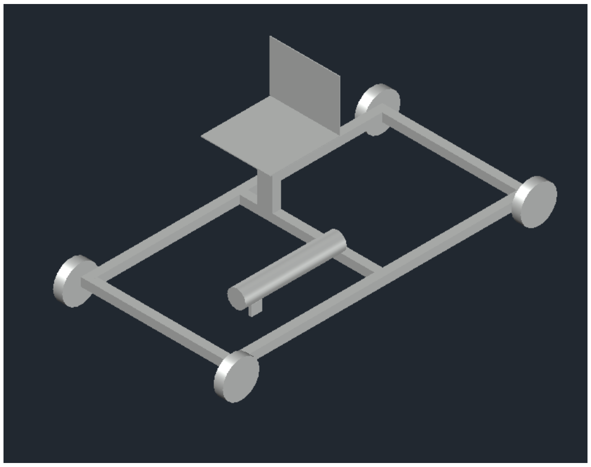


Diagram using AutoCAD

IV. WORKING

The self-handbrake system integrates various components to automate the engagement and disengagement of the handbrake based on specific conditions. At its core, the system comprises a 5/2 solenoid valve, double-actingcylinder, and a limit switch placed under the driver's seat. When the vehicle's ignition is turned on and the driver is seated, the controller receives signals indicating these conditions. Upon confirmation of the driver's presence and the ignition being on, the controller initiates the process to disengage the handbrake. This is achieved by activating the solenoid valve to allow compressed air or hydraulic fluid to flow to the appropriate side of the double-acting cylinder, thereby releasing the handbrake mechanism.

Conversely, when the ignition is turned off or the driver leaves the seat, the controller receives signals indicating these events. In response, the controller triggers the system to engage the handbrake. The solenoid valve is actuated to block the flow of air or hydraulic fluid to the cylinder, causing the handbrake mechanism to engage and secure the vehicle in place.

The limit switch positioned under the driver's seat serves as a safety measure to ensure that the handbrake is only engaged when the driver is not present. If the seat is empty, indicating that the driver has left the vehicle, the limit switch signals the controller to activate the handbrake.

Overall, the system operates seamlessly by leveraging electronic control signals to automate the handbrake process, enhancing both safety and convenience for the driver. By intelligently monitoring the vehicle's status and driver's presence, it ensures that the handbrake is engaged or disengaged at the appropriate times, contributing to a smoother and more efficient driving experience.

V. BRAKING CONDITIONS

Table.1 Conditions for Braking System

Sl .no	LIMIT SWITCH	IGNITION	PNUEMATIC CYLINDER	HAND BRAKE
1.	On	On	Retracts	Disengage
2.	On	Off	Extends	Engage
3.	Off	On	Extends	Engage

V. RESULTS AND DISCUSSION

The automatic handbrake system demonstrated promising results during testing and evaluation. Upon ignition activation and driver seating, the system consistently disengaged the handbrake,providing a seamless transition to vehicle operation. This functionality was observed to enhance driver convenience and streamline the startup process. Moreover, the system reliably engaged the handbrake in the absence of either condition, ensuring safety by preventing unintended vehicle movement. The integration of the 5/2 solenoid valve, double-acting cylinder, and limit switch proved effective in achieving the desired automation. Additionally, the system exhibited consistent and predictable behaviour across various test scenarios, highlighting its reliability and robustness.

However, further optimization may be explored to fine-tune response times and enhance overall performance. Overall, the results indicate that the automatic handbrake system offers significant advantages interms of safety, convenience, andreliability, representing a valuable addition tomodern automotive technology.

VI.ADVANTAGES

- **Safety Enhancement:** The self -handbrake system enhances safety by ensuring that the handbrake is engaged whenever the vehicle is not in operation or when the driver is not seated in the driver's seat. This helps prevent unintended vehicle movement and reduces the risk of accidents caused by a forgotten handbrake.
- **Convenience:** The system provides convenience to the driver by automatically disengaging the handbrake when the ignitionis turned on and the driver is seated. This eliminates the need for manual operationof the handbrake, making the vehicle easierto use, especially in situations where the driver may have their hands full.
- **Reduced Wear and Tear:** By automating the handbrake engagement and disengagement process, the system may helpreduce wear and tear on the handbrake mechanism itself, potentially extending its lifespan and reducing maintenance costs over time.
- **Reduces the manual interaction:**The self-handbrake system streamlines vehicle operation by automating handbrake engagement and disengagement. Its hands-free functionality minimizes driver distraction, promoting safer driving conditions. By eliminating the need for manual interaction, the system enhances driver comfort and overall driving experience.

VII. LIMITATIONS

- **Maintenance Complexity:** When air is compressed, moisture from the ambient air can condense and collect in the storage tank along with the compressed air. This moisture can pose issues for pneumatic systems, as it can lead to corrosion, rust, and damage to pneumatic components if not properly managed.
- **Response Time:** Depending on the responsiveness of the electronic control system, there may be a slight delay in the engagement or disengagement of the handbrake compared to manual operation, which could impact the driver's perception of vehicle control.
- **Power Dependency:** The automated handbrake system relies on the vehicle's electrical power supply, making it vulnerable to power outages or electrical failures, which could render the system inoperable in certain situations.
- **Reliability Concerns**: The reliance on electronic sensors and actuators introduces the possibility of system malfunctions, which could result in unintended engagement or disengagement of the handbrake.

VIII. CONCLUSION

Overall, the automatic handbrake system offers a combination of safety, convenience, and reliability benefits. By automatically engaging and disengaging the handbrake based on specific conditions, it helps enhance vehicle safety, reduce driver workload, and potentially extend the lifespan of the handbrake mechanism. Additionally, the system ensures consistent and predictable operation, contributing to a smoother and more controlled driving experience. As automotive technology continues to evolve, integrated systems like these play a crucial role in improving both the safety and usability of vehicles.

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