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Automation of Vehicle Door

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Abstract: In this paper, we have implemented the concept of automatic sliding door in public transport focusing on the safety of the passengers. The objective is to design a simple, effective and economic automatic sliding door system. Pneumatic cylinders, direction control valves and optical proximity sensor has been used to design the circuit.

Keywords: Pneumatics, Direction control valves, Low cost Automation, Time delay valve.

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1. Introduction

In the existing sliding door system in public transports such as buses and trains, there is a high probability of passengers entering or leaving the vehicle. In contrast, the doors are being closed; this doesn't ensure the safety of the passengers and this may lead to accidents. To prevent such accidents, we have designed a system assuring passenger safety. Along with passenger safety, the system comes with other merits like low maintenance, easy installation, simple design, low cost automation, low noise, environmentally friendly, etc.

The pneumatic system uses compressed air to transmit and control energy. It is widely used for automation, which requires fast response and low load applications. The medium used is air, which is easy to compress and store. Air is abundantly available and in case of leakage, it doesn't harm the environment.

The existing technology can also be improvised by using a smart camera for human detection and path analysis to avoid false automatic door system actions [1]. While the system may provide advantages like safety, high precision and responsiveness, it is costlier than the solution using pneumatics.

To increase safety, we can also include smart digital door lock technology [2] but it proves to be efficient in long journeys as digital locking between every stops is impractical in a smaller distance range public transport vehicle. Instead, we can implement a keyless security system used widely in smart home applications. Bluetooth is used as a communication protocol to automate door locks [3].

Other technologies for the smart door lock system are the use of the Visible Light Identification (VLID) system, which adopts Visible Light Communication (VLC) technology to verify identification via fingerprint recognition or password entry [4].

2. Related Works

The concept of automatic door arose due to the difficulties faced in the supermarket. These difficulties are explained by Halper [5] – "shopper approaching the exit door had no choice but to bring the shopping cart to a halt, open the door one hand, and pull (or push) the shopping cart through with the other. The action forced every shopper behind him or her to come to a momentary but complete halt. When the store was busy, this sequence of movements resulted in a long line of customers waiting for a chance to use the exit door."

After analyzing the EMU lines in Korea, Jaisung et al. [6] pointed out the weak points in the 'Pocket Sliding Type' passenger-side door. When some obstacles are put between the sliding doors, only the driver can re-open the doors, which is very dangerous. They had implemented an electric motor control plug door system by using complex planetary gear and pneumatic cylinder.

Door automation is an important part of smart home implementation. Many have presented the design and the prototype implementation of a pneumatic door automation system intended to be used for access control in smart homes. One such structure of the developed system is built around a microprocessor operating along with a pneumatic actuator [7].

Adamu and Abraham [8] have stated that "The idea of using infrared signals to establish routes in communication networks between receivers and transmitters for convenience, safety and guarantee of service is not new, but the application, cost, design method and reliability of the system varies."

Zungeru et al. [9] have used infrared rays to sense the passengers entering and exiting the bus and counting them using a counter, we have used the rays to detect the presence of a passenger to signal the actuators to stay extended, i.e., doors opened.

Mohapatra and Anand [10] stated that "Pneumatic systems provide power in a cheaper, safer, more flexible, environment friendly and more reliable way than the orthodox electric motors and

actuators." Owing to the design, durability and compact size of pneumatic systems, they are widely used in the train door system. A review of pneumatic operated train door systems supports the statement [11].

A similar application was done using Arduino where when an object comes in or goes out of the range of the sensor, a signal is sent to the electro-pneumatic circuit to open or close the door [10].

3. Circuit

A simple pneumatic circuit has been designed using double acting pneumatic cylinders (#1), 3/2 DCVs (#2), 5/2 DCV (#3), two-way pressure valve (#4), ordinarily closed time delay-ON valve (#5), optical proximity switch (#6), FRL unit (#7) and compressor (#8) (**Figure 1** and **2**).

Initially, compressed air is not supplied to the entire system. It is provided only when the vehicle driver provides control utilizing a push button or a mechanical lever. When the signal from the driver is received, the supply is connected and the door opens.

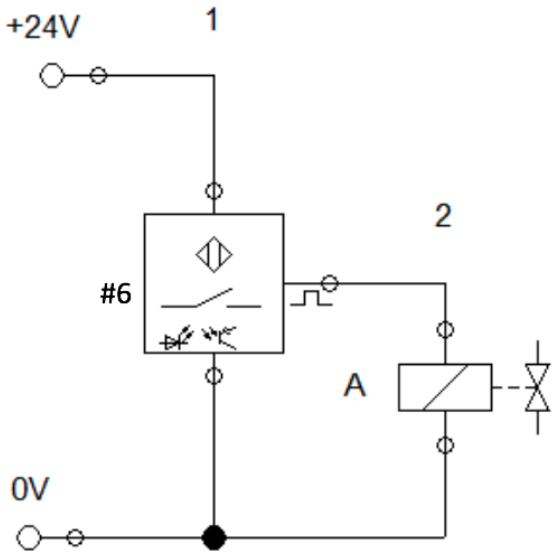

Figure 1 Electrical connection for optical proximity sensor

The optical proximity switch is used to detect the entering or exiting of the passengers. When the passenger enters or leaves from the vehicle, an electrical signal from the sensor is sent to the solenoid. This signal acts as a pilot for component #3, which keeps the door open.

When the compressed air is supplied to the entire system, the time delay valve starts. Once the time delay is achieved, the closing of the door is initiated. Whenever a signal from the optical proximity switch is received, the timer resets. So, as long as the passengers are entering or leaving the vehicle, the closing of the door is prevented and the safety of the passengers is ensured.

Once the time delay is achieved, a roller operated, spring return 3/2 DCV acts as a limit switch to check the complete closing of the door. This signal acts as a pilot to reset the driver control and the system is back to its initial state.

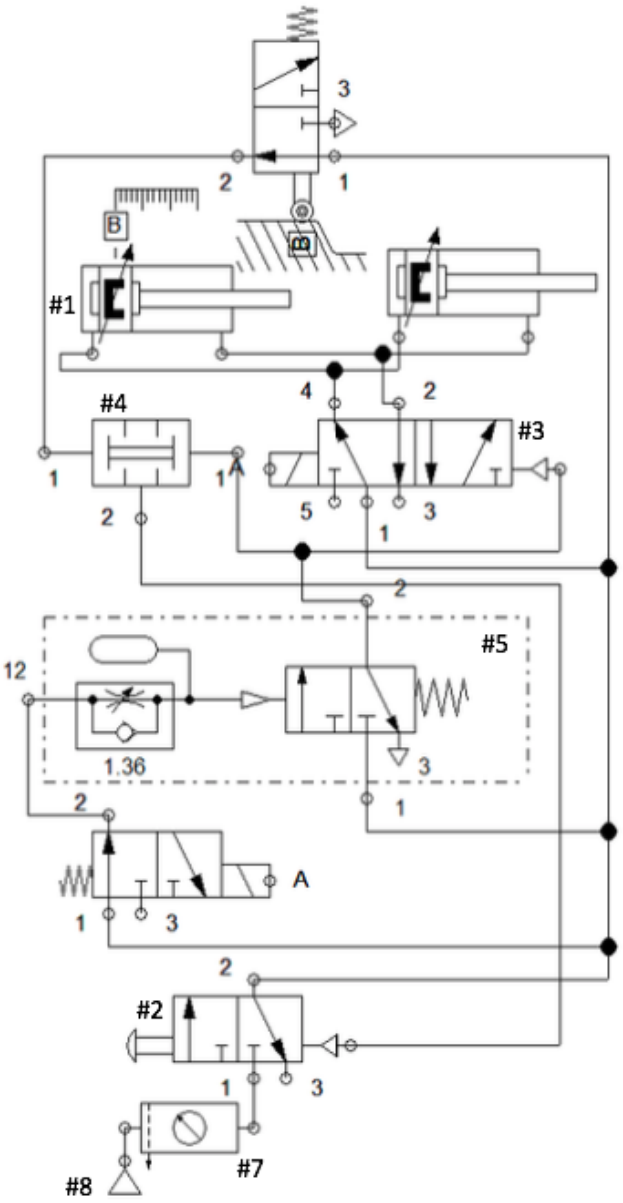

Figure 2. Pneumatic circuit for proposed model

4. Conclusions

The concept of automatic sliding door in public transport focusing on the safety of the passengers with low cost automation was achieved. This simple design provides low maintenance and easy debugging in case of breakdown. The sensing action of the sensor is dependent on the entering and exiting of the passenger within the range of the sensor. Hence, the sensing range of the sensor must be chosen appropriately.

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Conflict of interest

None of the authors have any conflicts of interest to declare.

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