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Design and Analysis of Automated Pneumatic Door System

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Abstract: ***This new feature deals with the actuating of the bus doors automatically using advanced timers, relays & specialized microprocessors to assist the driver to close these doors without closing in on the passengers effectively trapping them between powerful pneumatic doors as opposed with the existing manually operated technology where these accidents are prevailing as happenstance all-around and the country and the driver has to react to it manually, after realizing what is happening to their passenger because of a seemingly extenuated problem. Thus adding this piece of hardware to an existing component not only improves safety and assurance to property and personnel but takes off one more thing the driver has to worry about extensively while driving a multi axle vehicle carrying more than fifty passengers. This also allows passengers to have more feasible egress during an event of any emergencies including but not limited to smokes, collisions etc. After many avenues of analysis it is submitted for the future reference and use of next generation vehicles.***
Keywords: pneumatic cylinder, solenoid valve, microcontroller

I. INTRODUCTION

The Metropolitan Transport Corporation (formerly known as Pallavan Transport Corporation), sometimes known as the MTC, is the agency that operates the public bus service in Chennai, India. As of May 2017, the MTC had a scheduled fleet of 3688 buses and total fleet strength of 3968 buses, on a daily basis carries 4.8 million passengers to and fro, which is half the population of Chennai. On March 22, 2016, the Union Transport Ministry reported that Chennai had the most crowded buses in the country with 1300 passengers per bus in each direction per day.

During peak hours, in some routes, a bus with capacity to accommodate 80 persons carries twice the number of people due to the extensiveness of the system. It has an operating area of 3,929 square kilometers.

The above mentioned data indicates the amount of passengers travelling in the bus .Though these number of people travel in public transportation we still lack the necessary safety needs in those transportation. There are a lot of improvements to be done to ensure the safety of passengers. One such improvement would be using this pneumatic solenoid door controller to the existing component which helps in reducing accidents caused due to doors closing in on the boarding passengers

The original piece of technology employs the use of pilot valves to actuate the door open and close. Though these valves are essentially accurate and easy to operate and most of all cheaper they have their shortcomings. These pilot valves are fully mechanical overtime they degrade faster compared with an electronic valve.

The pilot valve moves in a single axis so pushing them a little more than it should be, causes mechanical strain and leakage due to prying the valve also it needs a memory location to hold its position once its actuated this could be a problem in most cases because MTC buses and state buses cannot be maintained thoroughly thus sedimentation of dust between these joints could cause imperfect lodging.

This improved solenoid function for opening/closing the door of the buses promises long life and smooth operation till it's invalid. It is featured with various sensors to help the driver to prevent closing the doors with passengers between them. Since it uses a PCB (Printed Circuit Board) circuit with a specialized microprocessor to power the pneumatic controls, manufacturers can easily employ their own design when mass producing. A solenoid pneumatic circuit is formed by various pneumatic components, such as cylinders, directional control valves, flow control valves, etc.

Despite their appearance the bus doors are not the same doors that we see in lifts and it won't open once you interrupt it with your hands and it's not easy to simply add this "feature" onto a moving bus. The safety features we employ to this PCB uses magnetic reach and timers to carefully calculate the door closing; it also uses smoke sensors and vibration sensors to sense smoke and collisions. After sensing these variables the microprocessor gives a signal appropriately to depressurize the air cylinder or to open the door once interrupted.

II. LITERATURE SURVEY

Lin Shuai et al (1): Train passenger doors are the key system for operation and maintenance on urban rail trains. In this paper, we analyze the passenger door system of the urban rail train working process and establish the mathematical model. Firstly, we use the method of parameter estimation to get physical parameters of doors on different working conditions. Then a fault diagnosis experiment is done to train the passenger door with principal component analysis and rough set theory. In the end, we verify fault diagnose accuracies under different time settings of opening and closing profile with the test rig.

S.M.Bashi et all(2): The pneumatic actuator represents the main force control operator in many industrial applications, where its static and dynamic characteristics play an important role in the overall behavior of the control system. Therefore improving the dynamic behavior of the pneumatic actuator is of prime interest to control system designers. This paper is a review of literature that is related to is abundant in nature and hence the running and maintenance cost of these systems are exceptionally low. All fluids have the ability to translate and transfigure and hence pneumatic systems permit a variety of power conversion with minimal mechanical hardware. Conversion of various combinations of motions like rotary-rotary, linear-rotary and linear-linear is possible. The simplicity in design, durability and compact size of pneumatic systems make them well suited for mobile innovations in different control strategies applied to pneumatic actuators along with the modeling, controlling and simulation techniques developed for different applications of pneumatic actuators are reviewed. The review
concentrates also on the analysis, investigation, performance, practical constraints, nonlinearities, uncertainties and the new applications of the pneumatic actuators.

Wonkyong Kim et al (3): There are many EMU lines in Korea. But only one type has been applied to passenger side door. This type is so called "Pocket sliding type". This type has some weak points. To begin with, it is not good for decreasing the noise from the outside of the car body. And the second time, if some obstacles are put between the sliding doors, only the driver can operate the re-open door switch manually in the driver's cab. This type is so dangerous for passengers. So many people want to the new door type that have no defect. KRRI joined forces with ANT corporation for pneumatic plug door system. This type will be good for decreasing the noisy, passenger's safe. The project was started at the last year on November and finished on June, this year. In this paper, we will deal with the role of the cylinder, complex planetary gear, door control unit, dynamic mechanism, and the report of FEM, type test. This paper will contribute to the electric motor control plug door system.

Saurabh Shakya et al(4): Indian Railways is India's national railway system. Operated by the Ministry of Railways, IR carried 8.107 billion passengers (more than 22 million passengers per day), transported 1.101 billion tons of freight, and had 8,500 stations in the 2015-16 fiscal year.[2] It is the fourth-largest railway network in the world by size, with 119,630 kilometres (74,330 mi) of total track[4] and 92,081 km (57,216 mi) of running track over a 66,687kilometre (41,437 mi) route at the end of 2015-16.[2] Forty per cent of its routes are electrified [5] with 25 kV AC electric traction.[2] Its track is mostly broad gauge, with short stretches of metre- and narrow- gauge track. Thirtyseven percent of its routes are double- or multi-tracked. [5] IR operates long-distance and suburban rail systems, and ran an average of 13,313 passenger trains daily in 2015-16.

The trains have a five-digit numbering system. Mail or express trains, the most common types, run at an average speed of 50.9 kilometres per hour (31.6 mph). [6] At the end of 2015-16, IR's rolling stock consisted of 254,006 freight wagons, 70,241 passenger coaches and 11,122 locomotives (39 powered by steam, 5,869 by diesel fuel and 5,214 by electricity).[2] IR owns locomotive- and coach-production facilities at several locations in India. The world's eighth largest employer, it had 1.33143 million employees at the end of 2015-16.[3] IR had earnings of ₹ 1.683 trillion (US$26 billion) in 2015–2016, consisting of ₹ 1.069 trillion (US$17 billion) in freight revenue and ₹ 442.83 billion (US$6.9 billion) in passenger revenue, and an operating ratio of 90.5 per cent in 2015-16. IR's Research Design and Standards Organisation (RDSO) undertakes research, design and standardisation. The railway has undertaken several initiatives to upgrade its ageing infrastructure and improve its quality of service. The Indian government plans to invest ₹ 9.05 trillion (US$140 billion) to upgrade IR by 2020. Hence we decided to take on a challenge to make a project in this Train field to support energy conservation.

III. METHODOLOGY

The electro-pneumatic system works based on the control from the electrical switches. A two way switch is used to control the door. The door will be a jack-knife type door. It is coupled with the double acting cylinder. Cylinders will be directed by using the solenoid valve. That will be electrically operated. We introduce the Embedded System technology to actuate the solenoid valve with help of battery power which is present in the vehicle itself.

The PIC microcontroller to perform the control system for door actuation is being used.When the switch for open is activated, then the microcontroller will activate the solenoid valve suitably for opening the door. At the same time the switch for close is activated,then the microcontroller will actuate the solenoid valve suitably for door closing .

The case study is when the door closing operation is started, a software timer will be automatically started. The time delay will be varied by user with help of an electrical Potentiometer. A reed switch is placed at the end of the cylinder which denotes the closed condition of the door. If the switch is before the time delay , it will be normal. If in case the reed switch does not sensed before the time delay , the microcontroller will automatically actuate the solenoid valve for the door opening process; it will help to prevent collision based accident entraining and Detraining into the vehicle .
The emergency switches are placed for the emergency like power failures and driver unconscious or any accidental condition.

IV. RESULTS AND DISCUSSION

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.

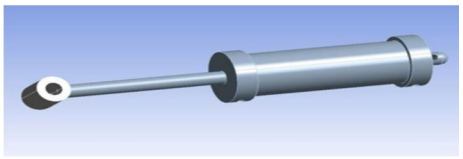

Fig:4.1 Pneumatic cylinder Model

The door motion was managed to finish within 4 seconds with a properly selected speed profile. Retesting the integrated system with a fast controller is highly recommended

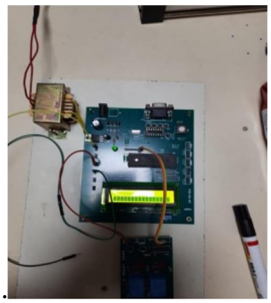

Fig:4.2 Mechatronic Unit

This prototyping project delivered a mature approach for automatic door system design with a functional prototype. The strength of the full scale door mechanism' structure is validated with simulations. Current FEA results show maximum von Mises stress of 111.3 MPa. The deformation is within the dimension tolerance. It is expected that the full scale can maintain its mechanism effectiveness under designed loading conditions. The convergence of the stress reading can be validated with physical tests about strength on the prototype product.

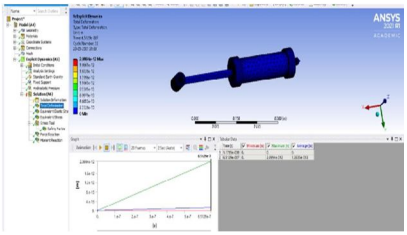

Fig:4.3 Analysis Results

V. CONCLUSION

The FEA simulation shows the commercial model similar to IFE design may be more superior in carrying heavy loads. But the CAD modeling shows the dimension design has more constraints as the equilibrium point of the panel support should be placed at a much backward location. This will make the panel support harder to be balanced and complicates the transmission mechanism. Building a small scale model with a mechanism of such kind can help to understand the operation before further investment is put into this design direction.

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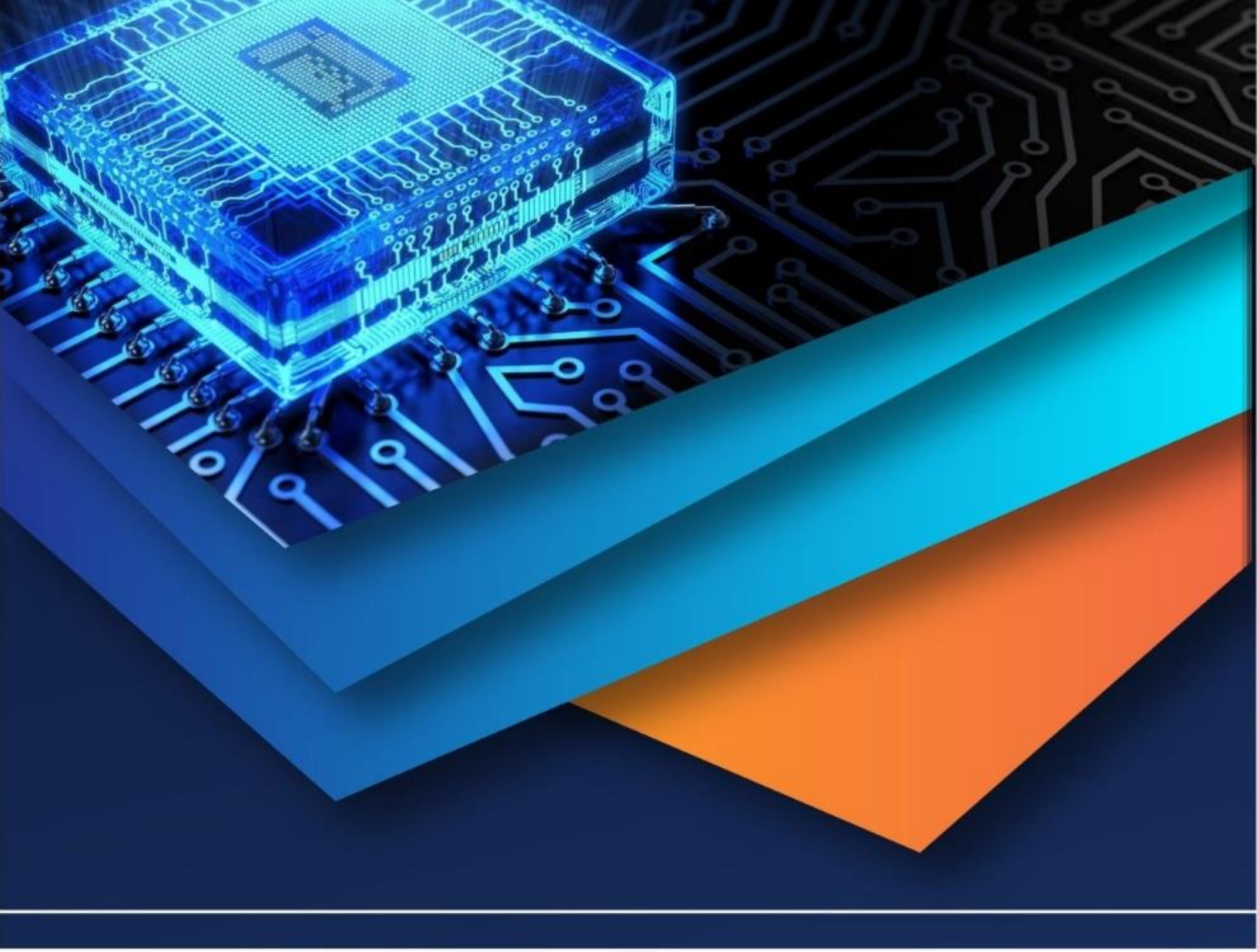

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