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Design and Development of Automatic Train Staircase

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Abstract – Automatic Staircase Using Pneumatic Actuators & IR Sensors serves to automate the mechanism of Staircase operation using Pneumatic, controller and infrared sensor technology. The methodology applied in the project is divided into three parts, firstly designing and fabrication of the Staircase with the calculated dimensions, secondly, developing a controller for door operation and thirdly, interfacing the different components to work together in a cohesive manner to adjust the height of Staircase at each platform level. When a platform comes in or goes out of the range of the sensor, a signal is sent to the controller which controls the electro-pneumatic circuit to open or close the Staircase as per required height of steps. The significance of this system is automation of the Staircase which can be customized according to the use. Based on the results obtained an actual working prototype was designed and a suitable large scale will develop taking into account the platform height conditions

***Key Words*: :** Automatic staircase, platform height, Electro-Pneumatics Control, IR Proximity sensor, Train.

1. 1.INTRODUCTION

Presently, Indian Railways (IR) AC 3-Tier Sleeper Coaches of ICF design to CSC-1722 have a floor height of 1320 mm from rail level and have a customized design of complete entraining/ detraining arrangement including door with fixing arrangement, footsteps and door handle compatible with platform of height 760mm to 840mm from rail level in such a way that passenger during entraining from platform to coach floor uses a vertically straight parallel foot-steps and similarly during detraining from coach floor to platform. The Challenge is design a mechanism of operation of a convenient method of train access from low level platforms in a failsafe mode. The innovations may particularly look at opportunities of easy retro-fitment and seamless integration in the current design of coaches serving different age groups and physical capabilities. The Challenge aims to encourage creation of innovative, easy to use designs and solution that can enable convenient access to all kinds of passengers (of diverse ages and special requirements) without infringing the current constraints of fixed infrastructure at the station and along the trackside.

In places where there is a space restriction, a foldable stair can be used. In accordance with this, we have simulated a mechanism in which the unfolding and folding of the stair is due to the linear motion of the slider at one end. The effect of the change in length of connecting rod that converts linear motion to rotary motion is to be analyzed. The foldable stair mechanism consists of links arranged in vertical and horizontal manner that make up the stair like arrangement. These links are connected with each other using revolute joints. The crank in the crank and slider mechanism, which pulls the entire set of links up or down makes the stair like arrangement. This crank also acts like an input link for the four-bar mechanism. This folding and unfolding of the stair resemble the scissor like structure. The crank is connected to the connecting rod through a revolute joint, which moves due to the actuation of the slider. The slider moves linearly due to the translator motion exhibited by the linear actuator. The construction of the mechanism. Two sets of this planar mechanism are placed parallel to each other at an offset distance. The horizontal links in the two sets are connected together by using a bar over which the foot of the user is placed.

1.1 Problem Statement :

In many conventional rails boogies a mechanical fixed type staircases are used. But for this stair having fixed height & cover insufficient space to reach ground for passengers while walk out from train. For staircase height adjustment it is need to make a proper design of stairs and it is very unsafe for passengers there at local villages stations where staircase height is not match with ground. Due to such stairs chances of accidents or increases. To overcome problem this project deals with compact design of height adjustable stairs. Due to compact design space utilization is less and due to proper design, there are very less chances of accidents. The stairs operate on scissor mechanism by pneumatic which is safer than pneumatic operation.

1.2 Objectives :

To overcome this problem, mention above, we have to design the Automatic staircase System with electro-pneumatic control which has following objectives,

1) To increase the sureness of safety while walking down the train.

2) To reduce the chances of injuries & accidents in train travelling.

3) To performed the most rigid operation with high automatic height adjustable staircase.

4) To improve the safety while passengers walk out from train at local villages stations where staircase height is not match with ground.

5) To adjustment staircase height with proper design & development of stairs.

2. Literature Review :

1. Jing-Shan Zhao, Jian-Yi Wang, Fulei Chu, Zhi-Jing Feng & Jian S. Dai, suggested work on, Mechanism Synthesis of a Foldable Stair. This paper proposes a foldable stair that is easily deployed for use and folded for storage. It consists of a number of identical deployable scissor-like elements which form the staircases when expanded. In addition to use, the folded stair can be used for hanging clothes and acting as a decoration. [1]

2. Justin M. Thomas, Justin Joe Kappil, Kevin Peter N. Aravind Krishna, , done the work on , Design & Fabrication of Electro Mechanical Ladder. According to his work, project mainly intends to fabricate an electrically operated mechanical ladder actuated by electrical cum mechanical systems. The ultimate aim of our project is to commercialize the product in the market targeting, small scale industries, colleges, schools and other organizations.[2]

3. Mangesh Wagh, Saurabh Pawar, Kiran Mane, Aditya Dhumal, Prof. D. P. Mali, , done the work on Design and Manufacturing of Pneumatically Operated Stairs by using Scissor Mechanism. To overcome space problem this project deals with compact design of stairs. Due to compact design space utilization is less and due to proper design, there are very less chances of accidents. The stairs operate on scissor mechanism by pneumatic which is safer than hydraulic operation. [3]

4. Wei ZHANG, Xuefei ZHANG, Chao YAN, Shujie XIANG and Liwen WANG. , done the work on , A characteristic triangle method on input vectors of scissor lift mechanism and its applications in modeling and analysis. This study can found that every linear driven scissor lift mechanism such as multiple group mechanism, parallel mechanism, or nonstandard connected single group mechanism. Thus, methodology and corresponding equations are also applicable to analyze and design other scissor mechanisms for design and further fabrication.[4]

5. Ashis Mohapatra, Aman Anand, , done the work on ,Modeling & Testing of Automatic Pneumatic Sliding Door Using Sensors & Controllers According to his work, Automatic Pneumatic Door Using IR Sensors, serves to automate the mechanism of door operation using Pneumatic, Aurdino microcontroller and infrared sensor technology. [5]

6. V.S.Rajashekhar, K.Thiruppathi, R.Senthil, , done the work on Modelling, Simulation and Control of a Foldable Stair Mechanism with a Linear Actuation Technique. According to his work, In places where there is a space restriction, a foldable stair can be used. In accordance with this, they have simulated a mechanism in which the unfolding and folding of the stair is due to the linear motion of the slider at one end. The effect of the change in length of connecting rod that converts linear motion to rotary motion is to be analyzed. [6]

3. EXPERIMENTAL SETUP :

3.1. Construction :

The frame is of MS material. The frame of our system is basically used to support the pneumatic components mounted on it. That is Piston cylinder, D.C.V, flow control valve, switches are mounted on frame.

1) Double Acting Cylinders:

Cylinders are linear actuators which convert fluid power into mechanical power. Gas is an expensive substance, it is dangerous to use pneumatic cylinders at high pressures so they are limited to about 10 bar pressure. Consequently they are constructed from lighter materials such as aluminum and brass. Because gas is a compressible substance, the motion of a pneumatic cylinder is hard to control precisely.

Parameters consider during the design of cylinder.

Piston diameter (mm): 32, 40,50,63,80,100

Std. Stroke(mm) :
25,50,80,100,125,160,200,250,300,320.

Medium : Compressed air-filtered-lubricated

Medium Temp. : 5°-60°1c

Working Pressure : 0.5-10 bar

 Considering Double Acting Cylinder of,

Piston Dia. (D) = 25mm

Stroke Length (L) = 100mm

Dia. Of Rod (d) = 10mm

Fig.Double acting cylinder.

2) Pneumatic pipe fittings:

Pneumatic tubing is also available in a number of other materials both with and without reinforcement for use in standard applications. SMC fittings incorporate a positive tube seal while the fitting is under pressure which allows polyurethane tubing to be used. Tubing is available in sizes of 1/8", 5/32", 3/16", 1/4", 5/16", 3/8", and 1/2". Metric tubing sizes of 3.2, 4, 6, 8, 10, 12, and 16mm are available.

Fig.2.Pneumatic hoses and fittings

3) Solenoid type 5/2 DCV valve:

A valve is a device that regulates the flow of fluid (gases, liquids, fluidized solids or slurries) by opening and closing or partially obstructing passage ways. A 5/2 way directional valve from the name itself has 5 ports equally spaced and 2 flow positions. It can be used to isolate and simultaneously bypass a passage way for the fluid which for example should retract or extend a double acting cylinder There is variety of ways to have this valve actuated.

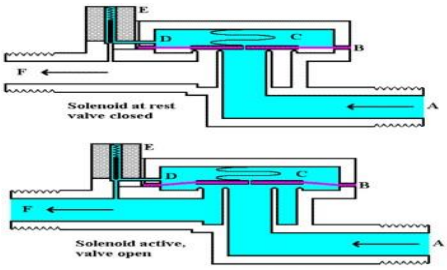

Fig.3. Solenoid valve operational principle.

4) **Relay board:**

Relays are simple switches which are operated both electrically and mechanically. Relays consist of a n electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. There are also other operating principles for its working. But they differ according to their applications. Most of the devices have the application of relays. The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits.

Fig.4.Relay Board

5) IR sensor:

The IR transmitting circuit is used in many projects. The IR transmitter sends 40 kHz (frequency can be adjusted) carrier control. IR carriers at around 40 kHz carrier frequencies are widely used in TV remote controlling and ICs for receiving these signals are quite easily available. The transmitted signal reflected by the obstacle and the IR receiver circuit receives the signal and giving control signal to the control unit. The control unit activates the weeding pneumatic actuation system.

Fig.5. IR sensor

3.2. Working:

This project consists of pneumatic control staircase system which is mounted on base end side of movable boogie platform on M.S. frame stand. A compressed air is supply through compressor using solenoid direction control valve DCV from remote air tank to double acting cylinder and automatic staircase adjust the particular required height with the application of IR sensor operation when it senses the particular height steps will stretch or contract as per required platform height. When we required operating the staircase system, then to operate the solenoid direction control valve DCV automatically with the application of sensor by 12 Volt batteries. So that the air from DCV is passes through DCV to actuate the stair case height. The boogie operated manually for giving motion for showing actual working as per different platform height. Here we use pneumatic double acting cylinder which having two ports for inlet and outlet of compressed air. Double acting cylinders are available in variety of sizes with low cost application in pneumatics.

Advantages:

1) An Automatic staircase Control is implemented with very simple hardware and easy control.
2) Human intervention at level crossings can be removed with the help of this project and many railway accidents can be prevented.
3) It will give better output as compared to another type of staircase systems. This system has higher efficiency as compared to others staircase in safety point of view.
4) There are very rare chances of an accident during down the staircase.

Limitations:

1) The system develop by us is only scale model demonstration of automatic train staircase system.

2) The system develop by us is having train demonstration model in which, scale model design components are used ,but in actual practice this system will locate in replacement of stairs of train & synchronize with train brake part.

3) The performance of this system can be affected by frication in links & pneumatic pressure during working.

4. CONCLUSIONS

The train stairs developed by us is electro-pneumatically operated. Old train staircase system is having fixed height; hence it is needed to give attention of passenger during walking in or out from train during starting & stopping the train. This train stairs can be modified to fully automate pneumatic controlling train stairs by using programming with synchronizing with train brakes. This automated train stairs with braking system can perform specified work in minimum time, speed, reliably, safely and with high accuracy

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REFERENCES

[1] Jing-Shan Zhao, Jian-Yi Wang, Fulei Chu, Zhi-Jing Feng & Jian S. Dai, Mechanism Synthesis of a Foldable Stair, Journal of Mechanisms and Robotics Copyright VC 2012 by ASME FEBRUARY 2012, Vol. 4 / 014502-1, pp.1-7.

[2] Justin M. Thomas, Justin Joe Kappil, Kevin Peter N. Aravind Krishna, Design & Fabrication of Electro Mechanical Ladder, IJIRST –International Journal for Innovative Research in Science & Technology| Volume 2 | Issue 11 | April 2016,pp.145-150.

[3] Mangesh Wagh, Saurabh Pawar, Kiran Mane, Aditya Dhumal, Prof. D. P. Mali,Design and Manufacturing of Pneumatically Operated Stairs by using Scissor Mechanism,IJSRD - International Journal for Scientific Research & Development| Vol. 7, Issue 02, 2019 | ISSN (online): 2321-0613,pp.548-549.

[4] Wei ZHANG, Xuefei ZHANG, Chao YAN, Shujie XIANG and Liwen WANG. A characteristic triangle method on input vectors of scissor lift mechanism and its applications in modeling and analysis, Journal of Advanced Mechanical Design, Systems, and Manufacturing, Vol.9, No.3, 2015,pp.1-20.

[5] Ashis Mohapatra, Aman Anand, Modeling & Testing of Automatic Pneumatic Sliding Door Using Sensors & Controllers, International Journal of Scientific and Research Publications, Volume 4, Issue 10, October 2014,pp.1-7.

[6] V.S.Rajashekhar, K.Thiruppathi, R.Senthil, Modelling, Simulation and Control of a Foldable Stair

Mechanism with a Linear Actuation Technique, 12th Global Congress On Manufacturing And Management, GCMM 2014, Procedia Engineering 97 (2014) pp.1312 – 1321.

[7] Prof. Tushar. A. Bora, Krushna. S. Rajput, Swapnil. J. Vikhe, Inamulhaq. M. Shaikh, Sahil. B. Shinde, A Review on Pneumatic Operated Train Door System, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056, Volume: 06 Issue: 01 | Jan 2019 www.irjet.net,pp. 472-477.

[8] Sumedh Ingle, Anshul Gupta, Rohit Chauhan & Kamlesh Naik, Design and Fabrication of Mechanized Stair, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 06 Issue: 06 | June 2019 www.irjet.net,pp. 2664- 2666.

[9] Jimmi Kumar Bharti, Akash Bhardwaj, Akhil Das & Mishal Raj, Pneumatic Based Automatic Railway Gate Control System, International Journal of Advance Research, Ideas and Innovations in Technology. (Volume3, Issue3) Available online at www.ijariit.com,pp. 1575- 1580.

[10] Adarsh K S, Riya Robert, Kavia E., Railway Track Pedestrian Crossing without using Staircase, International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 12, December 2015),pp. 259-261.

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