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## Design and Control of All Pneumatic Virtual Motion Simulator

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### Abstract

Virtual Motion Simulators are electro-mechanical systems that are used to create immersive environment for virtual reality applications, like, gaming platforms for entertainment industry, Flight Training Simulators, Vehicle testing systems, etc. A Gough-Stewart parallel manipulator is one of the most widely used platform to support the human handling cockpits of these applications, along with its integrated controls. Most of these motion platforms were originally proposed with hydraulic jacks [1, 2], which later on with advancement in electrical controls it was reported with electrical actuators, as in [3, 4]. Hydraulic actuators find its application in robust and huge load capacity moving platforms like [1], whereas, electrical actuators are applied mostly for applications with high stiffness and precision, like telescope mounts [3]. Both, hydraulic and electrical actuators pose a trade-off of being expensive for non-critical applications like gaming platforms or a training simulators where a high degree of precision is not much of a concern. On the contrary, pneumatic actuators are in-expensive, fast and offer a long linear actuation. Reckoning to this we propose to use a pneumatic piston linear actuators for all six-legs of a Gough-Stewart platform for a Virtual Motion Simulator. However, due to the compressibility of air present in the linear cylinder, the actuators are prone to acquire external disturbances in its position due to the dynamically varying load while the platform is moving.

The paper proposes to use Continuous Integral Sliding Mode Control for precise positioning of six pneumatic actuators of Virtual Motion Simulator. The first part of the paper would discuss the mechanical design, the kinematics and physical assembly of the motion platform [5], as shown in Figure 1. Secondly, the paper would discuss the hardware integration of electro-pneumatic system which is used to implement the controller for all the six linear actuators of Gough-Stewart platform, as shown in Figure 2. Next, the paper would discuss the control approaches for precise positioning of pneumatic actuator [6], namely continuous integral sliding model control technique. Finally, the integration of hardware to the PC based gaming engine is discussed, where the methods for extracting the data, pose, velocity and acceleration, from the gaming engine is discussed. The paper would conclude with results and discussion on the performance of the motion simulator as a whole.



**Figure 1:** Virtual Motion Simulator



**Figure 2:** Electro-Pneumatic Control System

### References

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- [5] Racing Car Simulator using Servo-Pneumatic Actuated Gough-Stewart Platform Youtube Channel of Arun Dayal Udai <https://www.youtube.com/watch?v=keE5ChhCodA>
- [6] Position Control of Pneumatic Cylinders with Stroke Reading Sensor, Youtube channel of Arun Dayal Udai <https://www.youtube.com/watch?v=LR3GyU4Z1II>