Development of Two Degree Moving Platform with Integration of Virtual Reality Technology (Part II)

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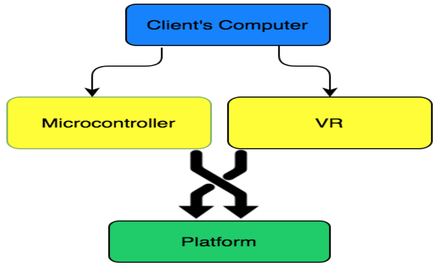
Abstract

Our mission is to design and build a force platform apparatus capable of linear movement. It shall be closely synchronized with a virtual environment viewed by the subject for the purposes of measuring physical response. The apparatus will be useful in the fields of physical therapy, training, and research within the biomechanical field. The moving platform would allow researchers to study natural human reactions to perturbations and potential effects of interventions.

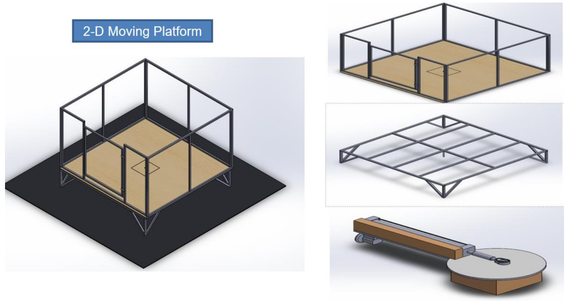
Introduction

Over time, humans learn balance innately as we learn to walk. This is a skill we continue to utilize and improve upon without even knowing it. Over the years, balance problems can arise from injury, disease, and aging. The variety of problems and the variety of causes make issues with balance very complex. To fully understand what is happening, it is important to consider different aspects of balance such as the effects of sight and sound. To put his years of experience in balance and postural control into practice, Dr. Hamid Bateni has begun to make use of a new system. The testing environment consists of a platform apparatus, an Oculus Rift, and a safety harness. Dr. Bateni is utilizing an Oculus Rift VR (Virtual Reality) headset and a computer that meets the specifications required with this operation to simulate an environment for the patient. This simulated environment allows for the ability to control what the patient sees and hears. The platform apparatus is set up in such a way to safely cause perturbation to the balance of the patient standing on top. By making use of the movement and the simulated environment, Dr. Bateni can see and study the effects of multiple senses on the balance of a patient.



Methods and Materials

This project was divided into three sections: Platform, Pneumatic Radial Actuation Driver (PRAD), and Virtual Reality Synchronization. Taking into consideration the team was composed of all Mechanical Engineering students, two team members were assigned to work on the electronics of the PRAD. The PRAD is responsible for rotating and moving the platform at a certain angle, in degrees, inputted by the operator. Once the actuator is moved into position, the actuator will fire and cause the platform to move in a linear direction. The system is controlled by an Arduino microcontroller. The Arduino commands the stepper motor driver to send a certain number of steps to move the motor to a location in degrees between 0-360. The Arduino also controls a relay that is wired into the directional control valves of the linear actuator. The actuator is programmed to have the arm retracted as its "resting position". It will only be extended after the stepper motor reaches its location. The material Tivar was used for the turntable due to its strong rigid properties to prevent flexing when the test was being conducted. The platform was reinforced at the corners by welding steel bars at each corner to prevent deformation when an individual would stand on the platform.



Results

The new modifications made on the past design set out to advance the following key areas of improvement: safety, reliability, presentation, accuracy and synchronization. Our client wants the project to be safe due to the amount of weight that is being shifted under the patient's feet. To mitigate those concerns, we implemented an emergency stop switch and guard rail that surrounds the perimeter of the platform. The project needs to be reliable because it costs a lot of time and money to bring our client's patients into his lab to conduct research. To solve this requirement, all the wiring was replaced with better wires to include wire ribbing and to get rid of lose wired being agitated during operation.

Discussion

Additionally, the wire diagram was redesigned to cut out unnecessary components and added two step-down transformers within the PRAD housing. Presentation is important to our client because he wants his patients to trust the device as they stand on it. The addition of vinyl tile to cover the plywood platform and replacement of the PRAD housing with metal. Accuracy in the project is directly correlated to the accuracy of Dr. Bateni's research. To ensure that the desired angle of actuation is met, dynamic breaking is utilized in the stepper motor. The plywood turntable was replaced with a hard, strong plastic called tivar. Doing so stopped the PRAD from lifting off the ground when actuating at large PSI's. Lastly, our client desired synchronization between the VR and the project code. The project does not currently implement any measures to satisfy this requirement, however, a third-generation team needs only to achieve that last task to make this prototype a working research tool.

Conclusions

The 3D moving platform created is a system with a variety of safety features, as well as the ability to easily be altered to suit the needs of the client. With options to change the movement direction and displays on the VR headset, balance studies can be conducted with many different variables. This setup also allows the data to easily be studied and referenced later due to the camera system. By using strong, but readily available components, this system can be built for a price much less than related systems for purchase. To better understand and treat underlying causes of balance problems, systems like this can help to improve lives.

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