Controller Design for a Linearly Actuated Active Suspension

Functional Description & System Block Diagram

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Introduction

The purpose of a linearly actuated active suspension system is to decrease the vertical acceleration of a load supported by an electric linear actuator. This project will build upon the previous active suspension system project completed by Blake Boe and Tyson Richards in 2005[1].

An active suspension system could be implemented under the cab of heavy equipment machinery to decrease the injury rate of operators, as well as wear and tear on onboard equipment, exposed to daily amounts of substantial vibration and other jarring movements.

The following equipment will be included in the active suspension design: a ballscrew linear actuator; LabVIEW hardware and software; potentiometers and an accelerometer; and a camshaft and motor.

Boe and Richards Project Achievements [1]

- Replaced the pneumatic actuator with an electric linear actuator
- Integrated the linear actuator and H-bridge hardware into the suspension system
- Modeled the H-bridge in PSPICE
- Modeled the linear actuator and motor using Simulink
- Implemented open and closed loop controllers to minimize the error displacement to ¼ [in] with a 1 [in] disturbance

Current Project Goals

- Model the system characteristics of the linear actuator
- Implement LabVIEW hardware and software
- Implement an accelerometer to the system.
- Create a tutorial for the use of Labview
- Implement a better controller to minimize the error displacement

The previous project revealed potential flaws in the derived system model so preliminary effort will be made to improve the system model especially where the linear actuator is concerned. This model will be implemented in Labview rather than Simulink as used by the previous group. With a successful test of our model, a controller will be designed to further minimize the error displacement. A potentiometer is included in the system pictured in Figure ## and was used as the position sensor in the original project. We will use the same sensor for position with the goal of adding an accelerometer in order to handle the disturbances more smoothly than with position feedback only. As stated in the goals, a tutorial will be created in order to assist future students with Labview implementation. Included in this tutorial will be detailed instructions with figures to assist in the procedures described.

Block Diagram

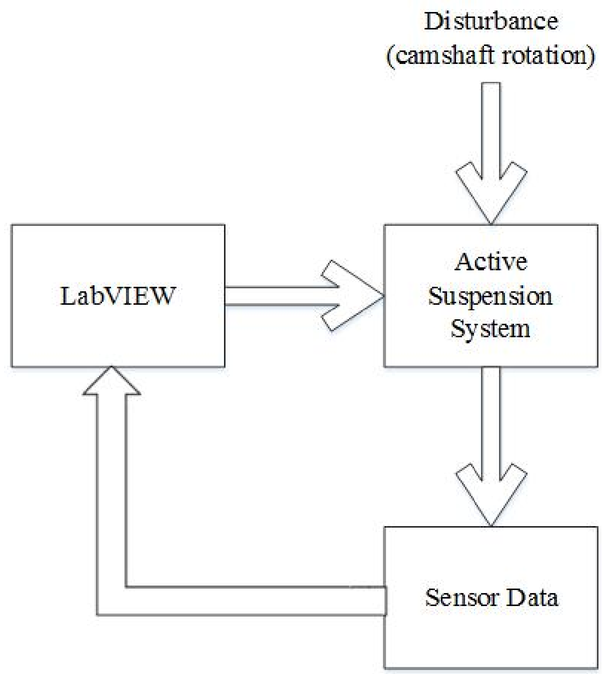

FIGURE 1

LabVIEW drives the system and it reacts to disturbances then the sensors send data back to the LabVIEW module to repeat the process

Functional Description

This project will involve focused efforts in several areas. The first component will be system modeling. The modeling will use much of the data presented in the previous project while correcting or improving key areas such as damping. Once a sufficient model is ascertained, we will be able to move on to the primary goals of this project.

Following the system modeling, we will develop the model in LabVIEW. As mentioned above, the model will rely heavily on the previous work performed while adding improvements. The challenge will come from using LabVIEW software where Simulink was used in the past. With a successful model functioning in LabVIEW, a controller can be designed to interface with the physical system, pictured in Figures 2 and 3, via LabVIEW hardware.

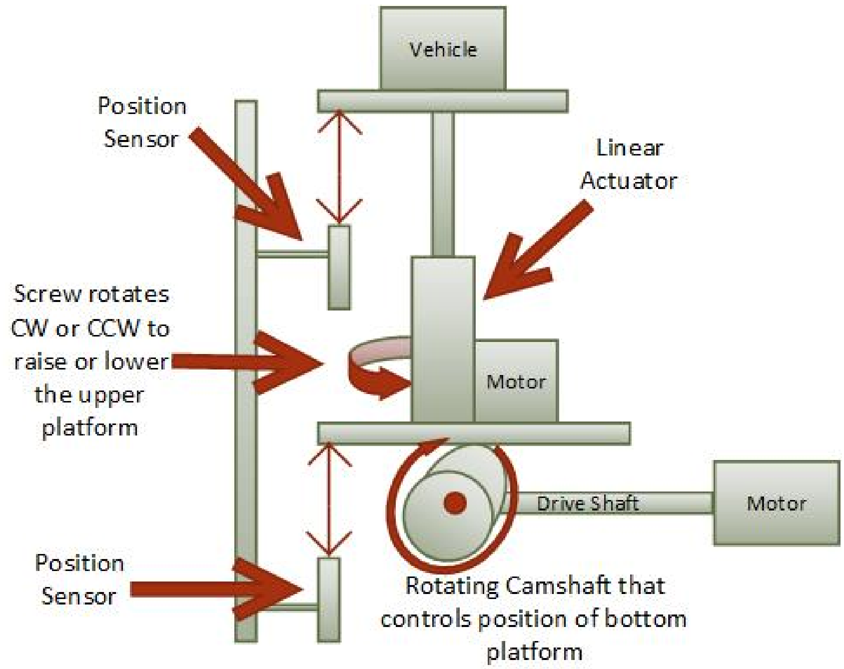

FIGURE 2

A diagram of the physical system is pictured in Figure 2

FIGURE 3

Photograph of the physical system

While work on the modeling is being performed, the tutorial will be developed to ensure its accuracy. The guide will provide step-by-step instructions accompanied by pictures and diagrams to assist future Bradley students with their senior projects with LabVIEW software and hardware.

A third aspect to the project will be the power electronics. The system has not been used in over six years and will need to be rewired in order to function properly. To do so, information from the previous team will have to be integrated into our current understanding of the equipment. A significant amount of time will have to be devoted to this step so that the test unit can operate safely and as intended.

Conclusion

The active suspension system built by previous senior projects will be used as the building block for our senior project. The first goal of the project will be to improve the system model, especially where the linear actuator is concerned. LabVIEW will be used to control the system and to analyze the data. An accelerometer will be introduced to the system to help us implement a better controller to minimize the error displacement. And finally, we will be creating a tutorial on how to use LabVIEW with this project for future senior project groups.

References

[1] Blake Boe and Tyson Richards. “Active Suspension System”, Senior Project, Electrical and Computer Engineering Department, Bradley University, May 2006, http://cegt201.bradley.edu/projects/proj2006/actss/