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Control of Mechanisms and Robots using LabVIEW and SolidWorks and Arduino

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***Abstract*— The objective of this research is to design Cad-Models of various robotic arms and mechanisms and simulated them through LabVIEW using Arduino as Controller. Thus we have developed a virtual prototyping system which can demonstrate the movement in cad model by varying the voltage using Arduino instead of making actual prototype. The G-code was designed using LabVIEW software and Interface through Arduino. Thus we are able to achieve the interface of LabVIEW, SolidWorks and Arduino together for various robots and mechanisms.**

Keywords*— *Abview,Solidworks,Virtualprototyping,Interfacing

I. INTRODUCTION

The theme of our work is to create CAD models of various mechanisms and robots and then to control their motion using LabVIEW programming. This would help in performing the actual kinematic analysis, through their CAD models. In general, there are 2 types of motion studies related to mechanism analysis – kinematic and dynamic. Kinematics is study of motion without regard for the forces that cause the motion. A kinematic mechanism can be driven by a servo motor so that the position, velocity, and acceleration of each link of the mechanism can be analysed at any given time. Typically, a kinematic analysis is conducted before dynamic behaviour of the mechanism can be simulated properly. Dynamics is the study of motion in response to externally applied loads. The dynamic behaviour of a mechanism is governed by Newton's laws of motion. A kinematic chain is a series of links connected by kinematic pairs. The chain is said to be closed chain if every 'u' link is connected to at least two other links, otherwise it is called an open chain. Mechanisms that result from open kinematic chains are referred to as serial mechanisms. Serial mechanisms typically have larger reachable workspace, but are less rigid. Parallel Mechanisms are typically more rigid and exhibit larger load capacity and improved accuracy, but have smaller workspace.

In parallel mechanisms, many times the multiple closed loops carry single common link, referred to as the moving platform. Mechanisms that result from hybrid open-closed kinematic chains are referred to as hybrid serial-parallel mechanism. We have used Arduino as controller to control the position of Cad Model, algorithm is being designed in LabVIEW and Cad Models are mad using Solidworks. Overall this would give us an interface which would help us to virtually prototype the machines and robots.

II. CONTROLLING SOLIDWORKS CAD MODEL WITH LABVIEW

The connection between SOLIDWORKS and LabVIEW can be regarded as a Master – Slave communication model. LabVIEW works as the Master because it is LabVIEW, who has the general control of the system such as starting the communication between the two programs, abort the simulation, receive the inputs, etc. Outputs can be obtained both from SOLIDWORKS and LabVIEW.

The motors defined in the SOLIDWORKS Assembly are then actuated by LabVIEW NI SoftMotion axes that are also added to the project manager. If certain motion is to be performed by more than one motor simultaneously then a coordinate space formed by the axes of the respective motors has to be added to the LabVIEW project. To perform a perfect integration of SOLIDWORKS and LabVIEW, a set of requirements have to be satisfied by both programs.

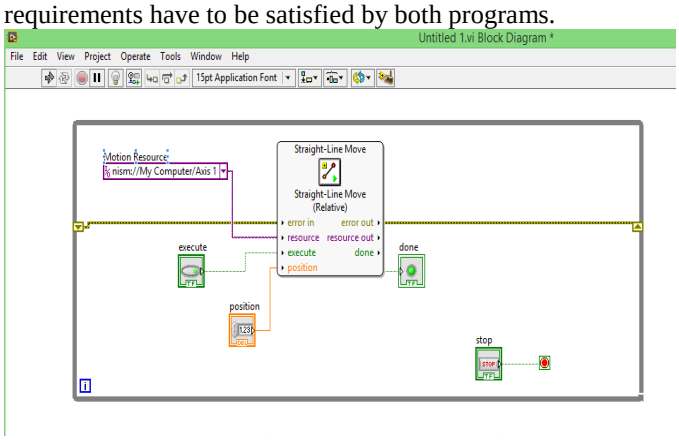

Fig.1 Basic programme for controlling single axis of Cad Model.

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The parts of the block diagram are mentioned as follows:
- While Loop – For continuous control of the model
- Line Move – Function found under the vision and motion palette used as the motion command in the CAD model.
- Resource – The axis of the SolidWorks motor acts as the resource input.
- Execute and Position – Controls for the Line Move Function input.
- Done – Indicator showing the completion of the motion.
- Stop – To exit the loop and stop motion control

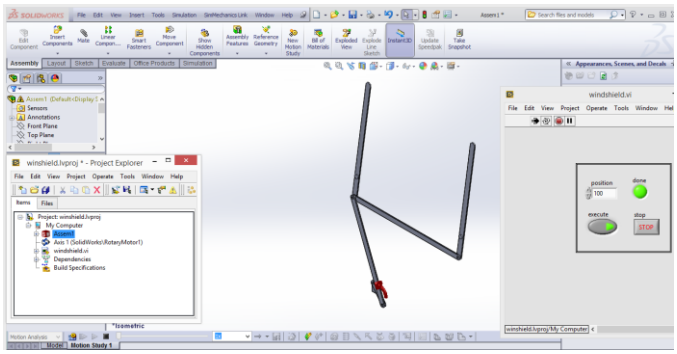

Fig.2 shows the cad model of windshield controlled via LabVIEW.

Mitsubishi Move master

The Mitsubishi Move master with a full four degrees of freedom is completely user friendly with simple, trouble free programming and handling, maximum reliability due to the drive unit diagnostics functions. It has a lifting capacity of 1kg and has excellent speed and repeatability. Move master can perform virtually any task, from picking and moving components to complex manipulation sequences which can be programmed and controlled with the teach pendant as well as with a PC, a PLC or other process control system.

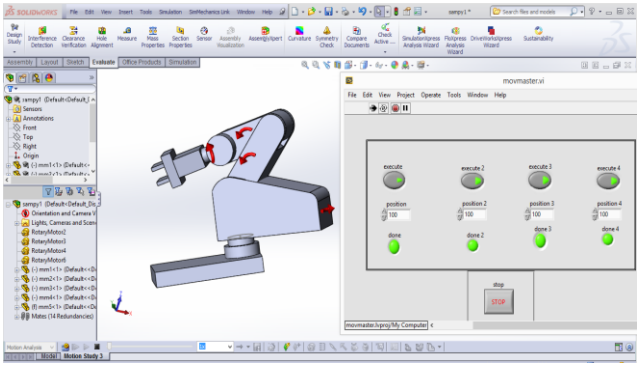

Fig.3 Mitsubishi Move master Controlled via LabVIEW.

Kawasaki PUMA 560

The PUMA (Programmable Universal Machine for Assembly), is an industrial robot arm developed by Victor Scheinman at pioneering robot company Unimation. Its specifications are as follows –
- 6 Axis arm with 3 axes making up a spherical wrist.
- Maximum reach 878mm from centre axis to centre of wrist
- Software selectable payloads from 4 kg to 2.5 kg
- Arm wright: 83 kg (approximate)
- Repeatability ±0.1mm
- 2.5 kg max velocity: 500mm/sec straight line moves
- 4.0 kg max velocity: 470mm/sec straight line moves

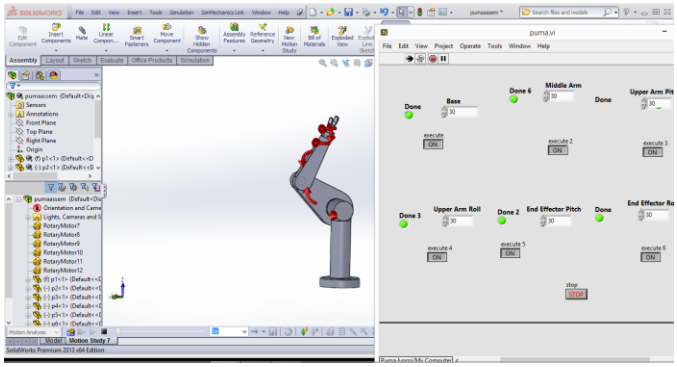

Fig.4 Puma Robot Controlled by LabVIEW.

III. CONTROLLING SOLIDWORKS CAD MODEL WITH LABVIEW AND ARDUINO

Till now we have seen cad models controlled using LabVIEW only, now we will incorporate Arduino to send analog signals to generate motions in the Cad models. These analog signals are sent using the potentiometer which varies the voltage between the 0V to 5V.
Fig. below shows the algorithm to control Cad models using Arduino and LabVIEW:

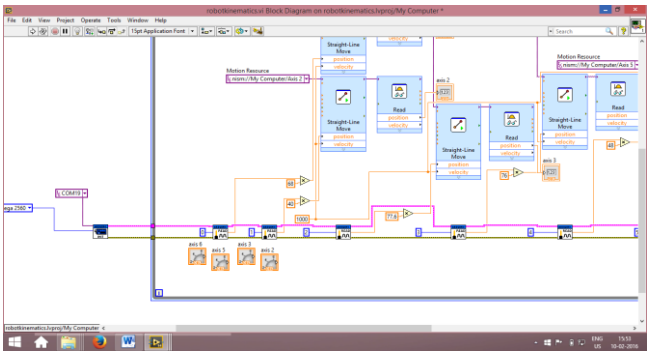

Fig.5 Algorithm to control Models using Arduino.

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IV. CIRCUIT CONTROLLING CAD MODEL

In this section we will discuss the circuit used to control the Cad model:

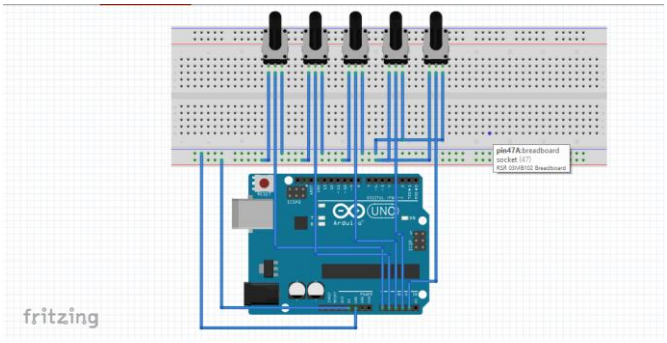

Fig.6 Frtizing Sketch for Arduino Control.

Here Arduino is interfaced with the 5 potentiometers to send analog signals to LabVIEW then they are converted to motion of Cad models through LabVIEW algorithm. Arduino has 6 analog pins. We have also made the real circuit which can be seen in Fig. below.

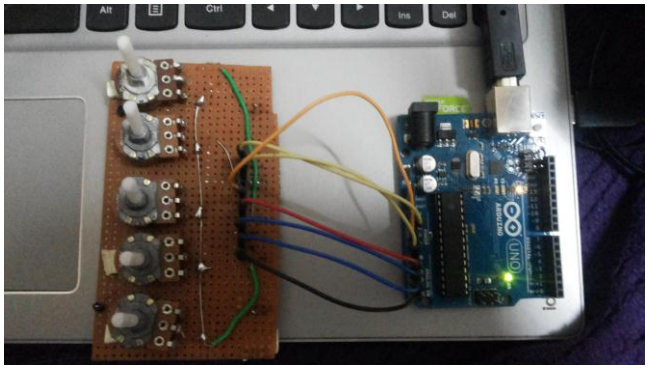

Fig.7 Circuit used to control Cad Models.

V. ALGORITHM FLOW FOR CAD MODEL MOTION

Here are controlling the motion of robot using potentiometer which gives output in form of voltage varying between 0 to 5V (volts). So we need to convert the voltage in form of degrees to make the rotation of cad model.

Velocity = 1000(we have given constant value)

Position = (Voltage from potentiometer) x (constant value)

We acquire this position from the maximum degree of movement that particular joint can move.

Let say, For base joint which can go maximum 180 degrees we need to calculate constant value using:

Constant Value = 180/voltage

In ideal potentiometer maximum output will be near to 4.5 volts, so we obtain constant value for 180degrees near to 40.We can see in the Fig. below that output from Arduino is multiplied by constant value 40 to get desired result. Another joint is being multiplied by constant value 68 to get desired motion of some other joint.

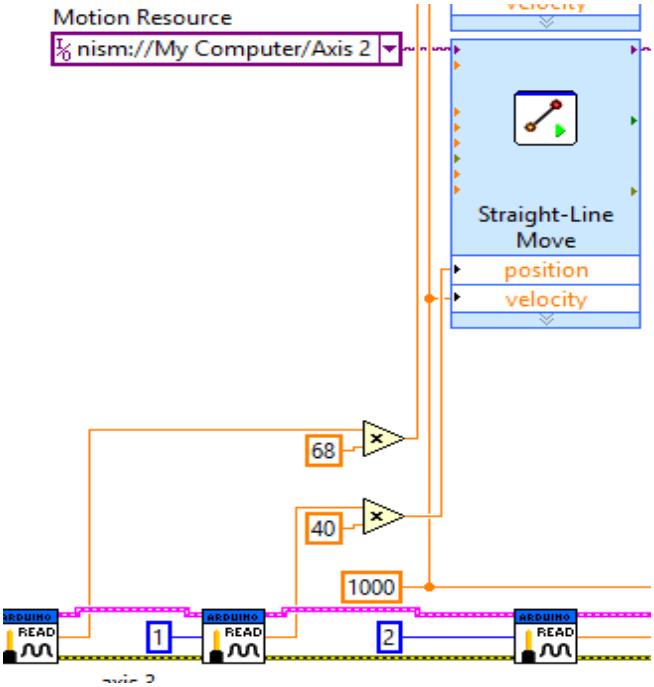

Fig.8 Algorithm for Control using Arduino

In above fig.8 we have used Arduino analog read function to get data from the potentiometer which are then sent to LabVIEW function which causes the rotation in the Cad Model.

VI. ACKNOWLEDGEMENT

Our work was supported in part by our institution to bring up the ideas and develop our project. The authors would like to thank their Parents and the Mechanical and Mechatronics Department for their constructive comments which greatly improved the quality of this work.

VII. CONCLUSION

"Solidworks Motion" which is 3D CAD software was used to successfully design Mechanisms and articulated robot arms. They were simulated using LabVIEW softmotion and finally we were able to design the control system using Arduino and potentiometer to generate motion in Cad Models. Overall we got a Virtual Simulator to Study the motion of various machines. Finally, we have developed virtual prototyping interface using the SolidWorks as Cad software, LabVIEW to programme the controller, and Arduino as a controller to generate motions in Cad Models. Using this system we can study motions in complex mechanisms using this interface without actually making the real mechanism.

VIII. RECOMMENDATION FOR FUTURE DEVELOPMENT

We can overall improve the certain sections like controller portion in which we can incorporate flex sensors in place of potentiometers, flex sensors can be installed on our fingers, by which we can control the Cad Models by motion of our fingers.

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proper nouns and element symbols.