Design and Manufacture of the components of an Electro-Mechanical Integrator

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Aim of the Project

⊡The primary aims of the project are:

- To research and analyse the creation and functionality of the mechanical integrator.
- The design manufacture and testing of prototypes of the components that the integrator will consist of.
- The completion of a full project report document detailing the process and steps taken to complete the project.

Background

For reference, 'A Mechanical Integrator is a mechanical device which can be used to obtain the continual integration of the input variable value.' (B. Popkonstantinović, 2019) They are practically known as the mechanical systems before computers. They were also used to integrate a curve and determine the area below the curve. An example of this would have been in World War 2 when they were used to calculate the trajectory of projectiles. Most design concepts originate from Lord Kelvins design used in his harmonic analyser.

Figure 1: Lord Kelvins harmonic analyser.

Due to the phasing out of analogue computers, all the current designs of these mechanical integrators are used for teaching. They can help learners of calculus visualise the process behind the equation.

Digital Input

The aim of the digital input is to convert a sin wave into X-axial movement to be integrated. The digital input will be tested on a rig design and manufactured by a lecturer in our department. A breadboard is used to connect the circuit together.

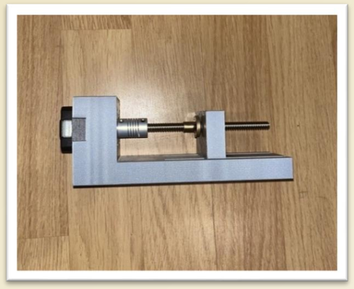

Figure 2: Digital Input test rig.

Track Ball

The next component for the mechanical integrator is the track ball. It consists of a holder connected to the top rail and a smooth spherical ball housed in a socket which allows it to rotate in any axis. The drive mechanism moves the holder of the track ball depending on the output of the Arduino code.

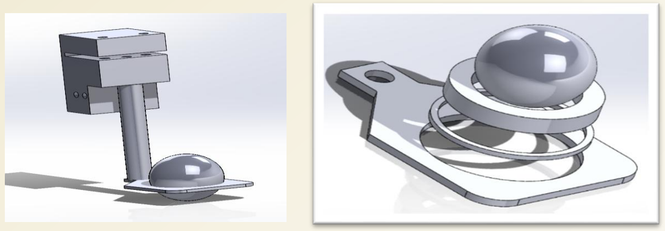

Figure 3: Track ball CAD design.

Conveyer System

Its primary use is to accurately move the ball and carriage left and right smoothly without any disruption or sudden movement. It must also take inputs from the Arduino via a stepper motor and convert them into mechanical outputs such as the program accurately turning the motor X number of steps as needed.

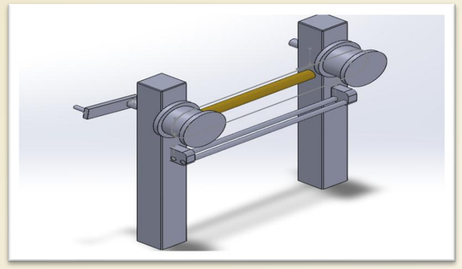

Figure 4: Conveyer system CAD design

Mechanical Output

The aim of the mechanical output section is to design and create the best method of transferring data from the trackball to the rotary encoder. Design consists of the roller being held by two supports. The disk is held at a 45° angle to the base. This allows a ball to sit between the roller and the disk. The disk can be fitted to a bearing in a stand. Within the centre there can be a keyway. This allows for a key to enter and rotate the disk by hand.

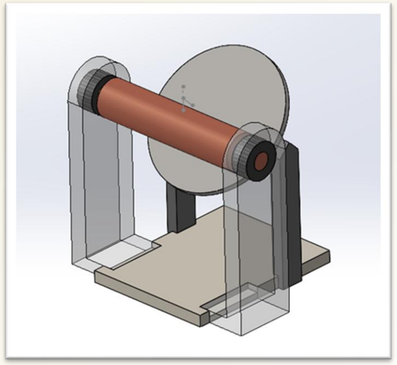

Figure 5: Mechanical output CAD design

Digital Output

The aim of the digital output component is to accurately measure and display the physical output data of the roller in digital numerical display. A rotary encoder is a sensor that converts the angular position of a shaft into an electrical signal. It measures rotation, speed, and direction of rotation.

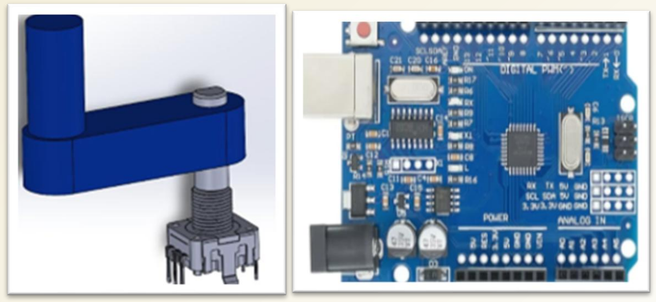

Figure 6: Rotary encoder and handle & Arduino board

The handle is attached to the shaft of the encoder . It was decided to 3d print the handle. An Arduino Uno was used. The Arduino IDE was downloaded to write the code for the component. It is uploaded to the Arduino via USB connection. The Arduino must be accurately wired to the other parts according to the fritzing diagram.

Conclusion

In conclusion a mechanical integrator may be built using the concept designs shown. Due to time restraints, this was not feasible for this team. However, the figure shown below is a CAD model demonstrating a possible completed mechanical integrator.

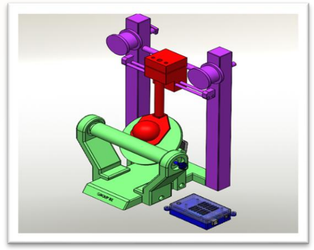

Figure 7: Possible complete design of a mechanical integrator

Acknowledgements

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