Rajesh S Aouti

Projects

1) AI based Gym Trainer ASU

AD1040 Sports, Inc. ASU Active Perception Group (APG)

- AI-powered Gym Trainer provides real-time feedback on their exercise performance, Posture Correction and Gamification of the exercises.
- It uses Two Fisheye **cameras** to capture human data and run **deep learning models** to analyze the exercise.
- Developed a flask application to render the results using WebSocket.
- Created **3D reconstruction** of **Human Pose** using **Stereo Camera Calibration** and **Triangulation**.
- We have built our AI algorithm server based on the Six different GYM equipment which were, LAT PULLDOWN, CABLE ROW, HACK SQUAT, LEG PRESS, ROWING, TREADMILL and WEIGHTED SQUAT.

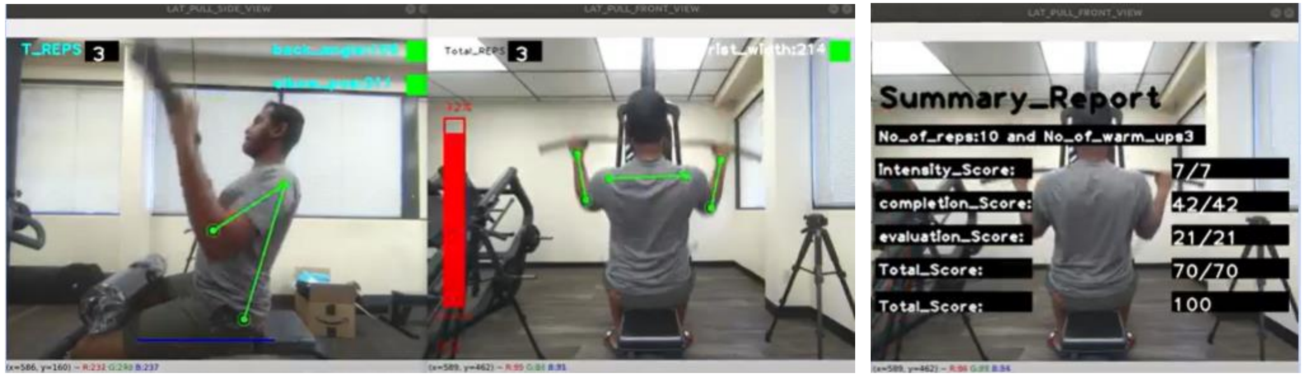


Fig 1 : Real time feedback and summary report of Lat Pull exercise

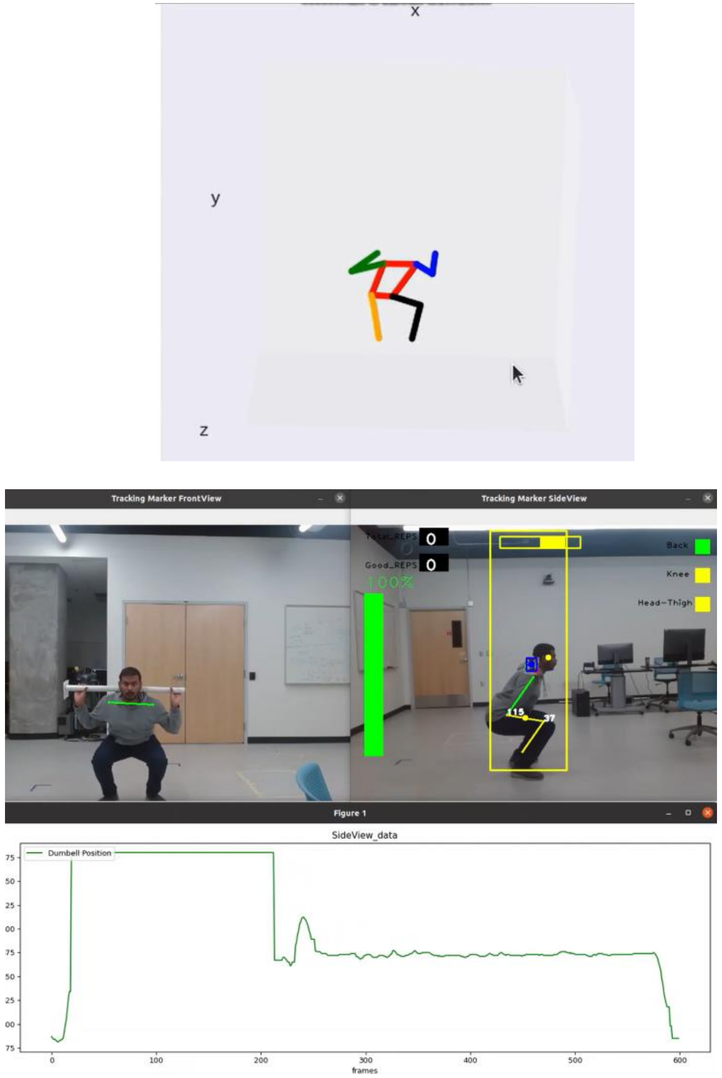


Fig 2 : Real time feedback of Weighted Squat exercise and 3D reconstructed Pose

Skills: OpenCV , Python, MediaPipe, Flask, Linux, Redis, 3D Reconstruction, Pose Estimation

1) AI based Gym Trainer ASU

AD1040 Sports, Inc. ASU Active Perception Group (APG)

- Utilized a 10-camera setup Opti tracker to collected 3D data for various exercises to get the baseline for building the Neural Network.
- The setup was calibrated using wanding process after applying masking for all the cameras.
- The data was cleaned for any discrepancy and rigid body joints was added to the pose to record the position and orientation data.

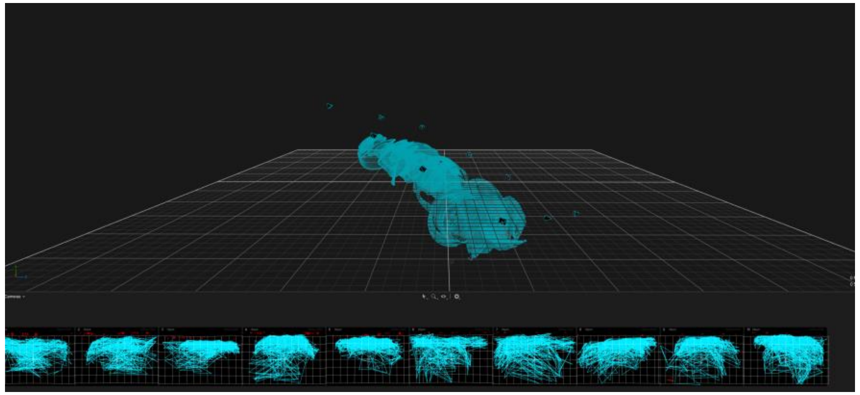


Fig 3 : Calibration data using wanding and masked the discrepanc
cameras.

Fig 4 : Using Retro Reflective markers for tracking.

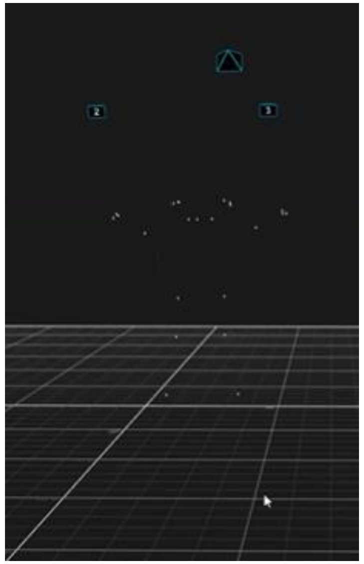


Fig 5 : Captured 3D data point of human skeleton.

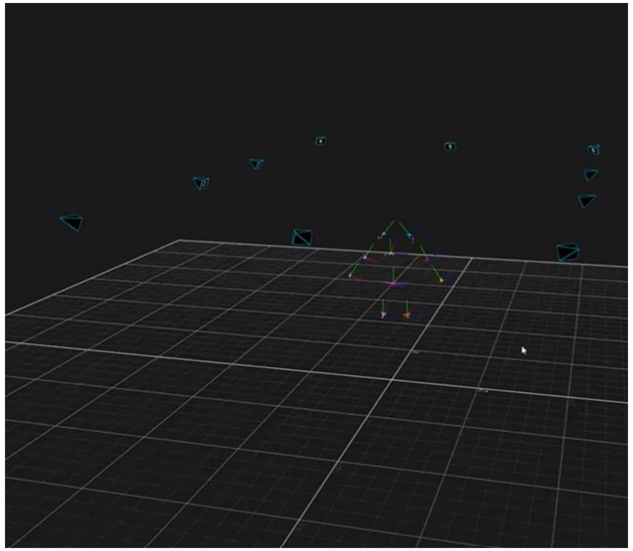


Fig 6 : Rigid body creation of human segments.

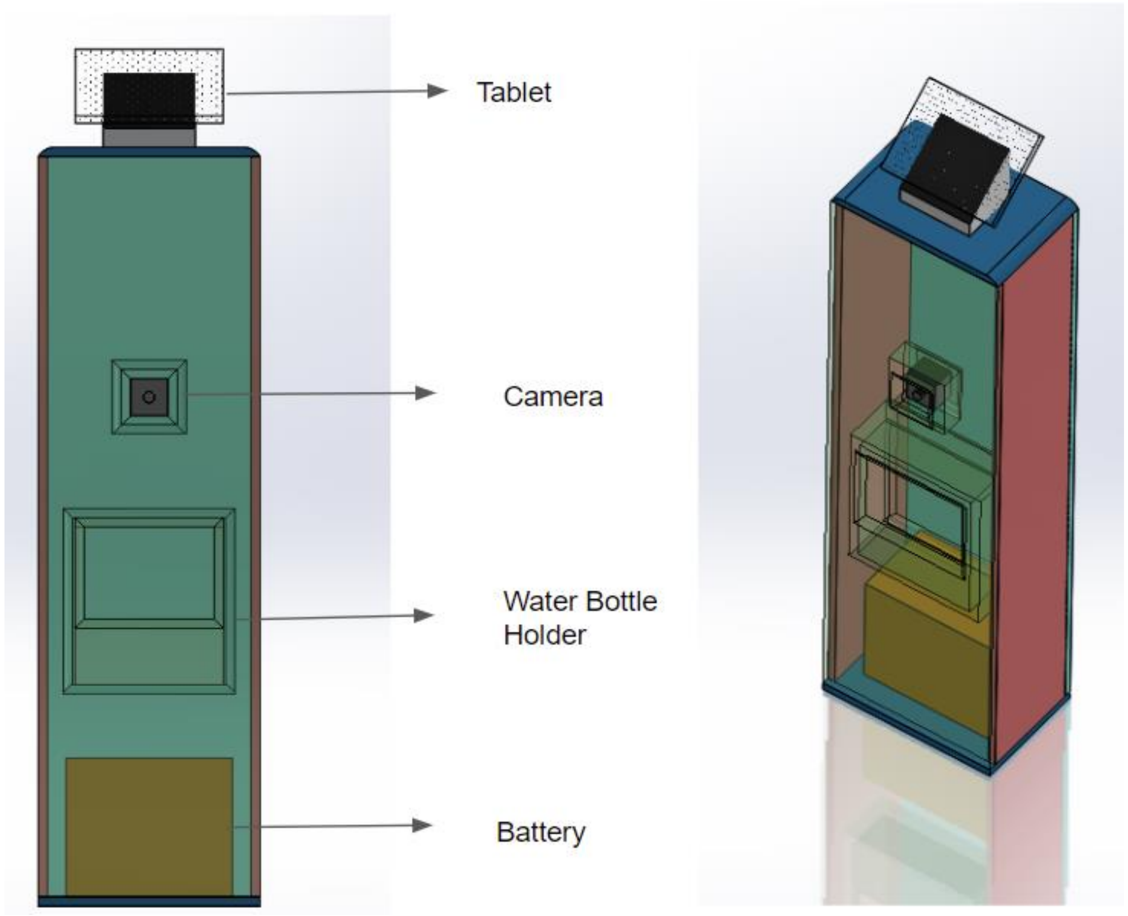
1) AI based Gym Trainer ASU

AD1040 Sports, Inc. /ASU Active Perception Group (APG)

- Demonstrated proficiency in using SolidWorks to design an ergonomic fixture for mounting camera components in the development of a Smart AI Gym Assistant.

- Utilized a thorough understanding of ergonomic design principles to create a 3D model of the fixture that is both functional and user-friendly.

- This project showcased the ability to effectively use SolidWorks to create innovative designs that meet the specific needs of the user.



Skills: Solidworks, Design, Ergonomics.

2) Gesture Control and Collision Avoidance for Drone using Computer Vision

- Implemented Gesture Control on DJI Tello EDU with OpenCV for image processing and MediaPipe for human pose detection.
- Built a heuristic model using the key points obtained from MediaPipe for pose estimation and maneuvering the drone accordingly.
- Implemented deep learning library YOLO object detection for collision avoidance which is estimated by monitoring the area of Region of interest is within the threshold limit.

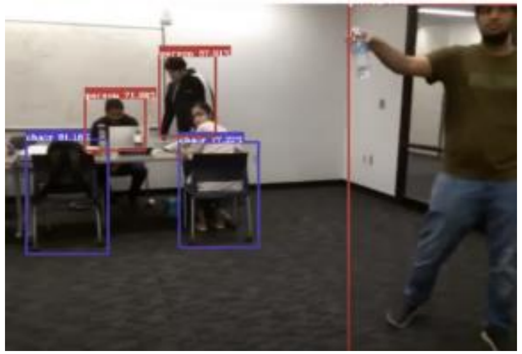


Fig 1 : Real time feedback and summary report of Lat Pull exercise

A Move Right

B. Move Left

C Move Up

D Move Forward

Fig 1 : Real time feedback and summary report of Lat Pull exercise

Skills: OpenCV , Python, MediaPipe, Pose Estimation, Object Detection, YOLO.

Team Member : Rajesh S Aouti, Anirudh Vardharajan

3) Data Solution Architecture using Azure Databricks

- Created end to end solution architecture using **Azure Data Lake Gen2, Azure Data Factory** and **Delta Lake** for analyzing Formula1 motor racing dataset.
- Performed Feature to identify the most important parameters, standardize the values and cleaned the dataset.
- Trained **machine learning** model with **algorithms** such as **Logistic Regression, Decision Tree Classifier, Support Vector Machine and Gaussian Naïve Bayes** to predict the winners of future championships.
- Scheduled pipelines for executing Databricks notebook, utilized data factory triggers for monitoring and created dashboards using Databricks Visualization Tools.

Sl No	Model	Accuracy
1	Logistic Regression	64.67 %
2	Decision Tree Classifier	79.67 %
3	Support Vector Machine	64.35 %
4	Gaussian Naive Bayes	63.46 %

Fig 1: Test results for the multiple models

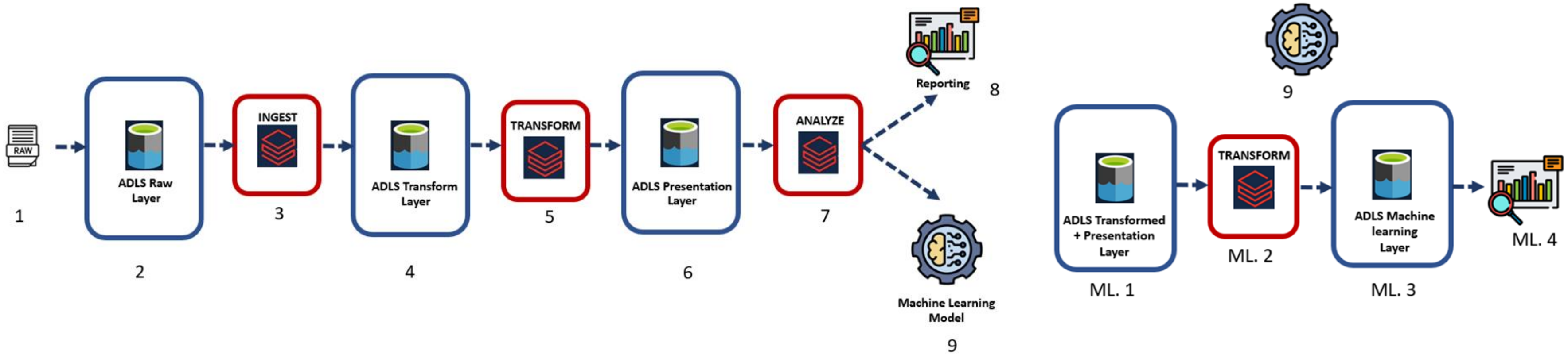


Fig 2: Solution Architecture

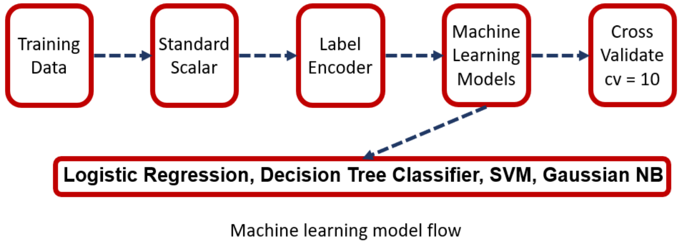


Fig 3: Machine Learning Flow

Skills : Python, Spark using Databricks, Spark ML libraries, spark, Pandas, sklearn, Azure Data Lake, CSV, JSON

4) Robotic Arm

- Built a 6 Axis Mobile manipulator for pick and place application.
- Performed and verified the **forward** and **inverse kinematics** of the robot with the model using **MATLAB**.
- Controlled the robot through a mobile application using **ESP32 Module**, **Position** and **Velocity controlled motors**.
- Implemented **shape tracing** and **applied smoothing functions** for the robot motions.

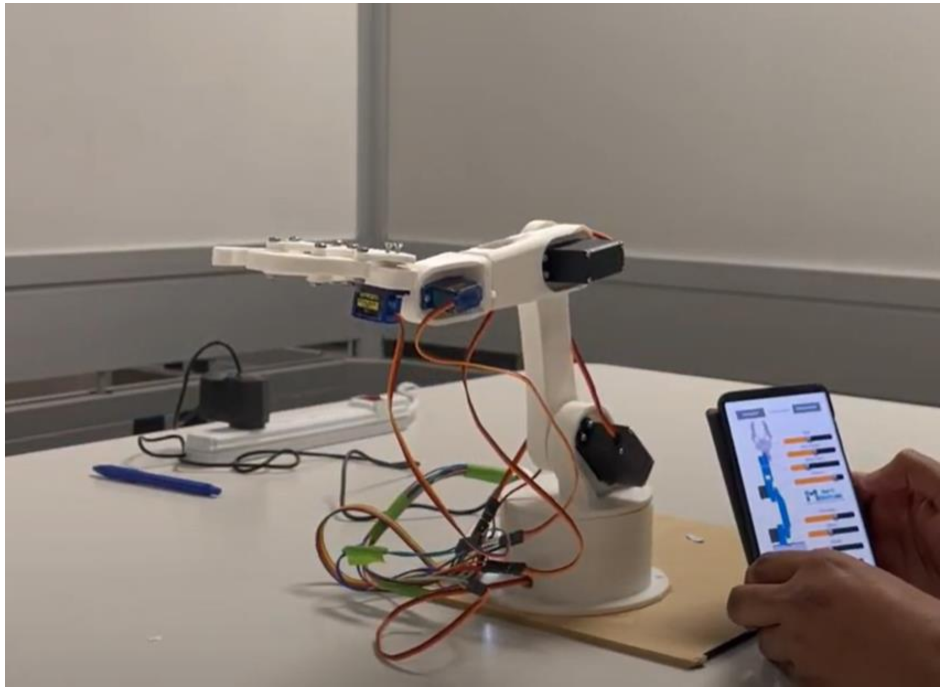


Fig 1 : Control of robot using a mobile interface

Skills: Solidworks, 3D Printing, C Programming, Arduino nano and ESP32 Programming, UART Communication, Design, Kinematics

5) Motor Control using Potentiometer

The Velocity of the motor was controlled using a potentiometer. The system has 3 components,

Epos Block:

The input for the Epos block in the form of the pules from the encoder which is converted to the motor position with a conversion factor of 1/2048.The motor velocity is then obtained by differentiating the motor position. We add a low pass filter of 30 Hz to remove noise.

ADC Block:

The ADC converts the analog signal from the potentiometer to the voltage output of 0 – 3.3V by multiplying a gain of 4095/3.3. The speed of the motor is limited to a range of 0 - 60 RPS by multiplying a gain of 60/3.3. The actual motor velocity $\dot{\theta}_{act}$ is the output form the EPOS block and the desired motor velocity $\dot{\theta}_{d}$ is the output from the Potentiometer (ADC Block).

PID Block:

The input to the PID block is the error which is got from the difference between the output of the EPOS and the ADC block. The value of Kp, Ki, and Kd were determined experimentally with Kd is set to Zero as there was not a high amount of overshoot as the motor has Inertia.

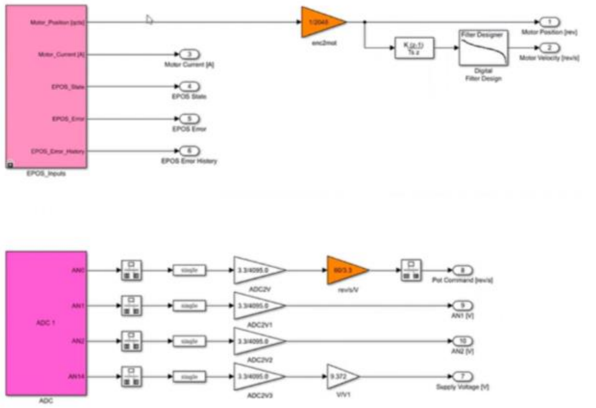


Fig 1: The Input block of Actual Velocity and the desired Velocity of the Motor Velocity from the EPOS block and the ADC block, respectively.

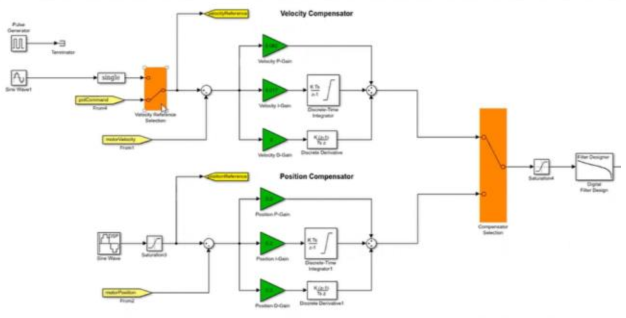


Fig 2: The Control block - PID

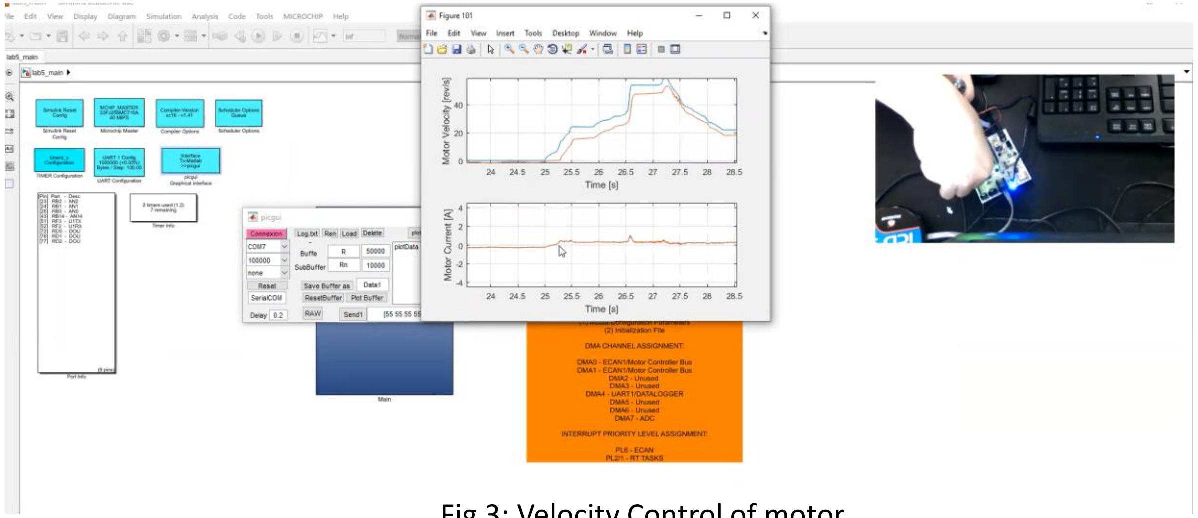


Fig 3: Velocity Control of motor

Skills: Simulink, MATLAB, Control System Design, PID, Motor Control.

6) Banking Application

- Developed a secure and user-friendly banking application using Node.js and Express.js framework.
- Implemented features such as account management, loan services and loan amount calculator.
- Utilized MongoDB for database storage and implemented security measures such as encryption and secure session management using forms, JWT, bcrypt and sessions-cookies.
- Rendered dynamic web pages using EJS and PUG.

Web Page Renderings

Fig 1 : Rendering of loan amount calculator

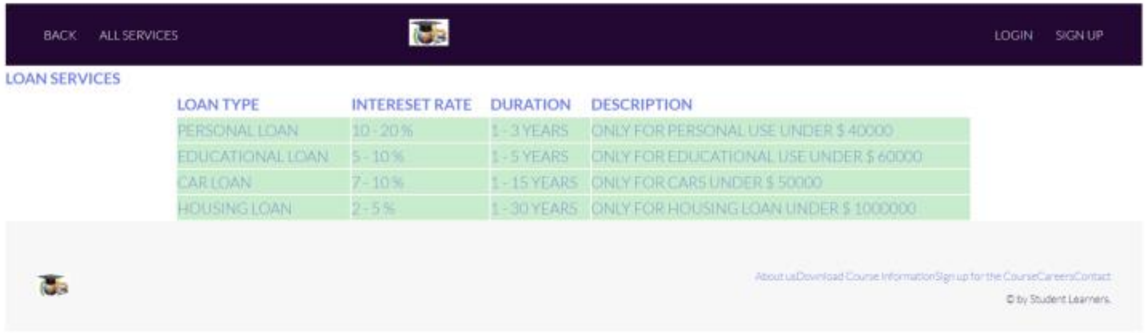


Fig 2 : Rendering of the loan services page

Flow Diagrams

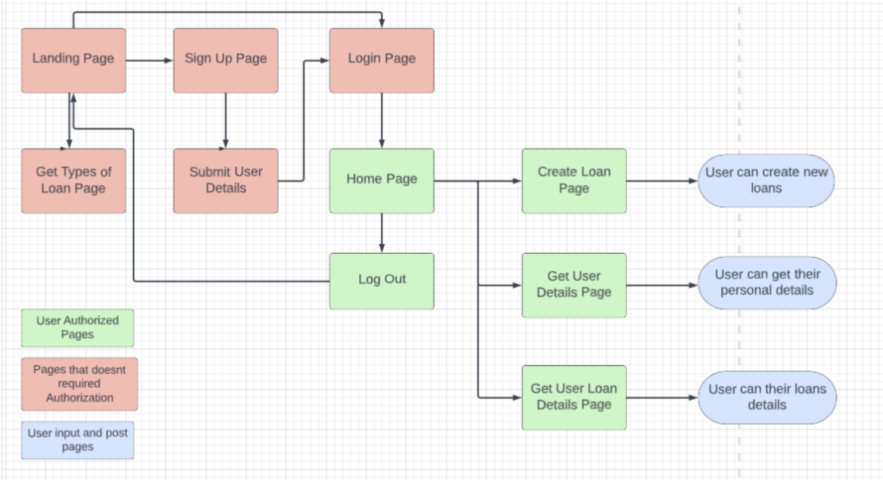


Fig 3 : The process flow of the Application

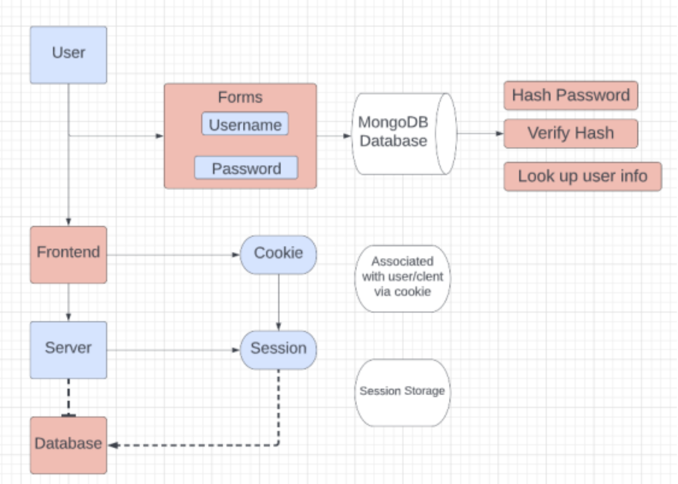


Fig 4 : Implementation of security of the application

Skills: Node.js, Express.js, MongoDB, EJS, PUG, Validation, Authorization, Security

7) Soil Moisture Sensor

Fig 1 : Soil Moisture Sensor

Measurand	Volumetric Water Content (VWC)
Error (% VWC)	±3 % VWC
Range (% VWC)	0 – 40% VWC
Least count (% VWC)	1% VWC
Dimension of enclosure(mm)	48 × 44 × 25
Power consumption (mW)	600 mW
Measurement Time (s)	125 s
Cost (INR)	3200

- Designed, Modelled and Fabricated a low-cost soil moisture sensor for precision agriculture using Dual Probe Heat Pluse Technique.

- Modelled the Dual-Probe Heat-Pulse soil moisture sensor through **Finite Element Analysis** using **COMSOL Multiphysics**, **Lumped Model Analysis** using **LT Spice** and programmed electronic modules using **C programming**.

- **Performed ETL jobs** and **data analysis** to created models for auto calibration of sensor using **regression analysis** and **hypothesis testing.**

- Conducted performance benchmarks and improved reliability of the sensor from **60% to 90%** success rate using Design Failure Mode Effect & Analysis **(DFMEA)** and **SIX SIGMA** tools.

- Designing a prototype for **automation** of manufacturing process of the sensor, which would result in a reduction in cost, time, and man-power for mass-manufacturing.

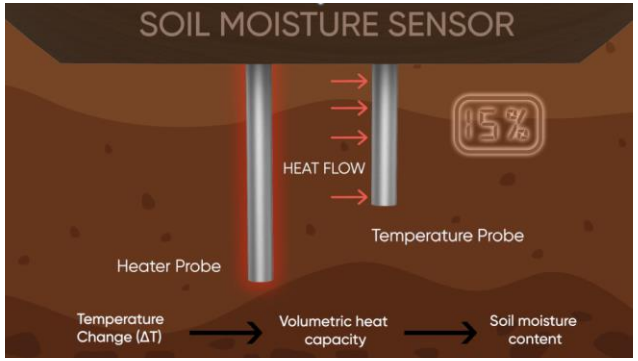


Fig 2 : Working Principle

Fig 3 : Field Testing at IISC campus, Bangalore

Skills: Solidworks, COMSOL Multiphysics , Six Sigma Tools, C Programming, LT Spice, 3D-Printing, Design, Fabrication, Documentation

7) Soil Moisture Sensor

Ministry of Electronics and Information Technology
Government of India

Components of the sensor

- Mechanical Design and Analysis

Electronic Design and Analysis

- Assisted in the development of the electronics module and testing.

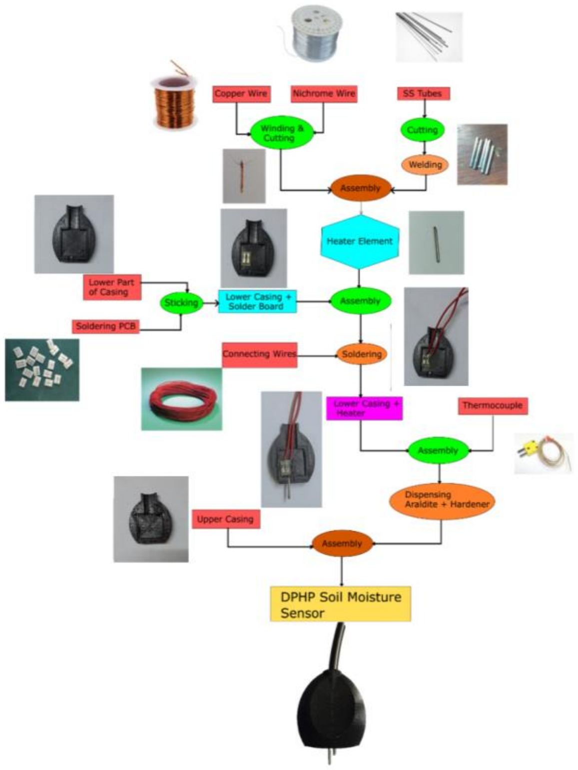


Fig 4 : Fabrication Process

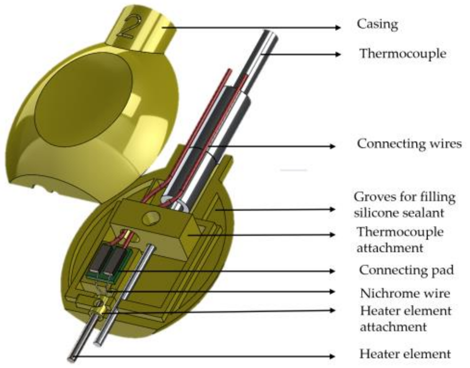


Fig 5 : Solidworks Model of sensor casing

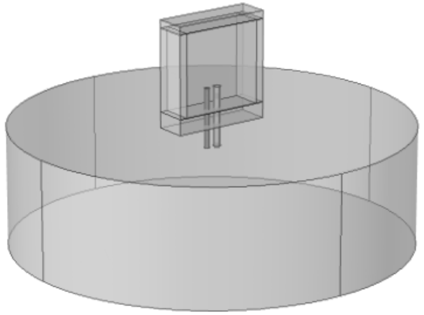


Fig 6 : Finite Element Analysis using COMSOL Multiphysics

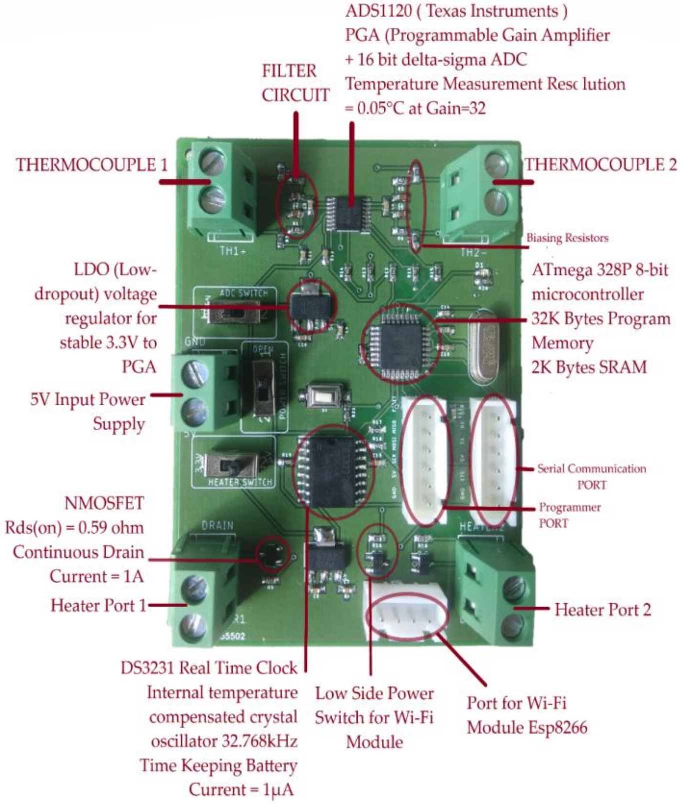


Fig 7 : PCB Design using Eagle

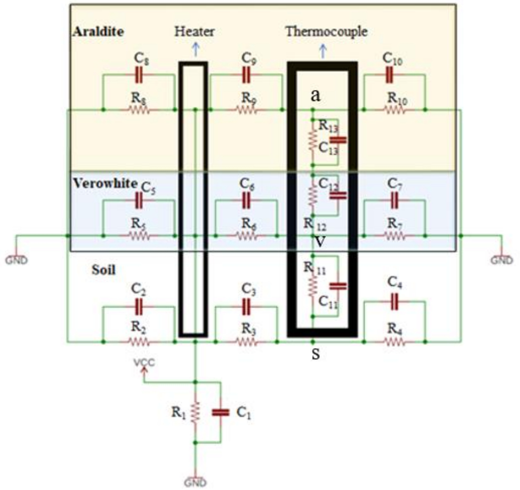


Fig 8 : Lumped Model Analysis using LT Spi

7) Soil Moisture Sensor

Ministry of Electronics and Information Technology
Government of India

mahindra

Precision Farmers

Automation of Fabrication Process

- The preparation of heater element through winding process is automated using the mechanism.
- The automation setup will bring down the cost of making a sensor by cutting down the labor costs involved for making the critical parts.
- The setup improves the reliability of the system by bringing uniformity in manufacturing.

Fig 9 : Image of sensor winding

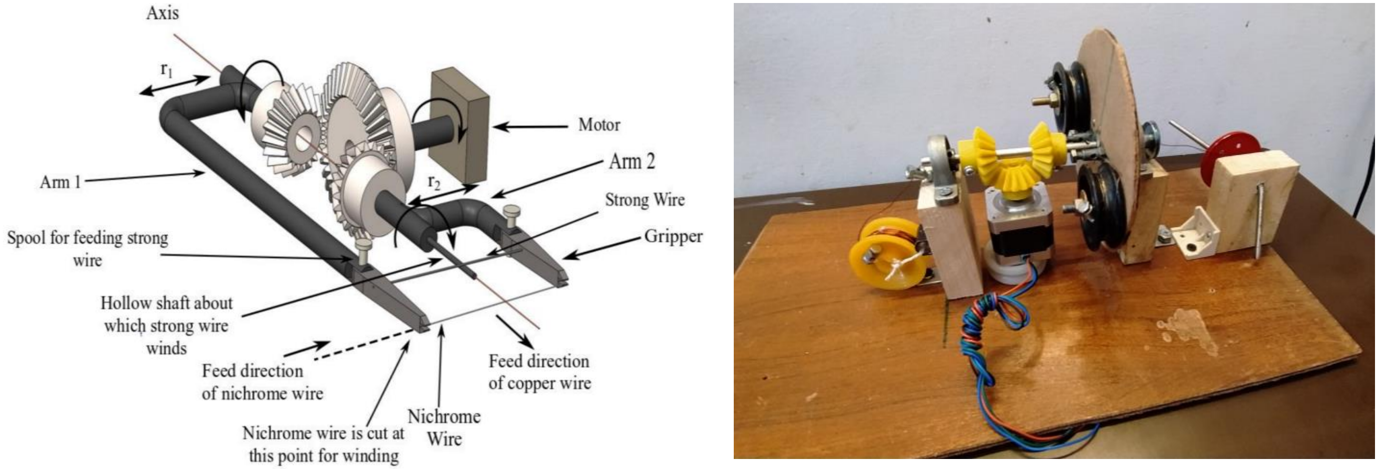


Fig 10 : Design and Fabricated prototype of the winding system

Fabrication of an Auger Device

- Auger facilities the insertion of multiple sensor and varying depth into the soil.
- This device is used for the soil penetration, water retention studies.

Fig 11 : Design and Fabricated prototype of the Auger Device

8) Hybrid Rocket Propulsion System

- Built a **hybrid rocket motor** and its **open-loop control system** through **NI-LabView** interface for **valve actuation** and **data acquisition**.

- **Development** of oxidizer-tank and combustion chamber to withstand high fluid pressure(70 bar). SolidWorks was used to generate **3D CAD models** and **structural Analysis** was carried out using **ANSYS Workbench**.

- Performed Cold flow testing / HYDRO STATIC using water to test the individual subsystems/elements, check for leakages, determine the mass flow rate and the Coefficient of discharge.

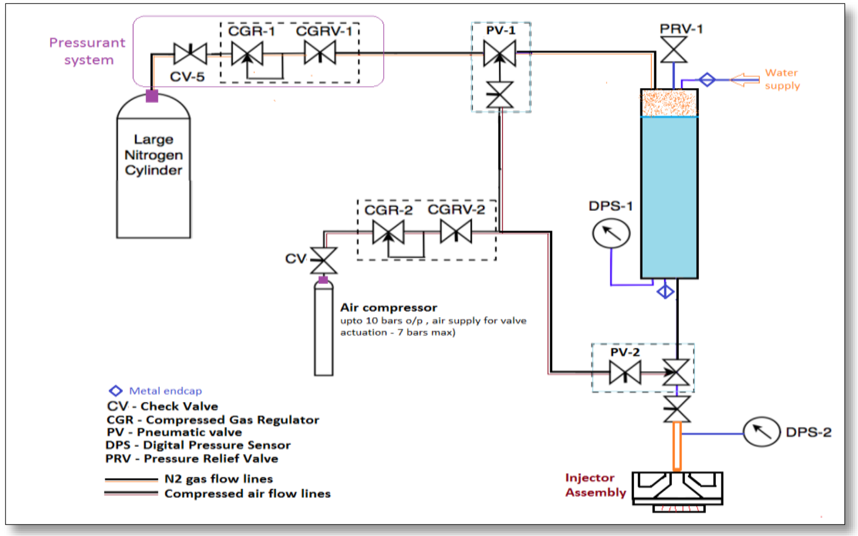


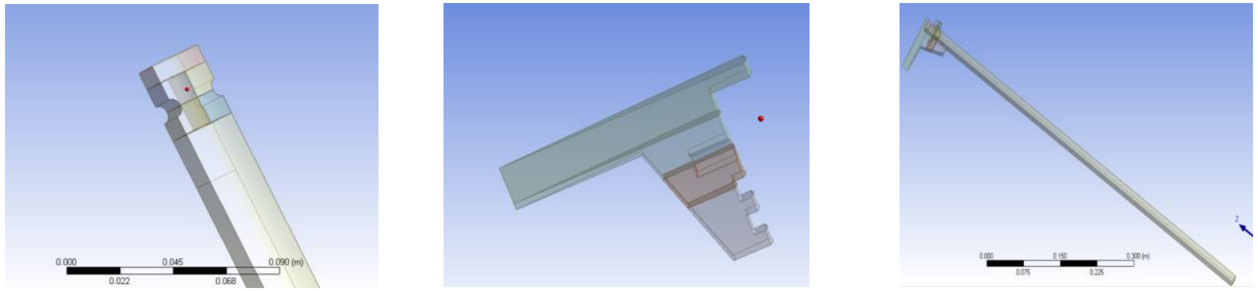
Fig 1 : Process Flow Diagram

Fig 2 : System Setup and Hydro Static Testing

Skills: Solidworks, Ansys Workbench, C Programming, Design, Fabrication, Documentation, LabView, Data acquisition, Control System Design

8) Hybrid Rocket Propulsion System

Mechanical Design and Structural Analysis of Oxidizer Tank



The model was divided into 1/40th part for analysis

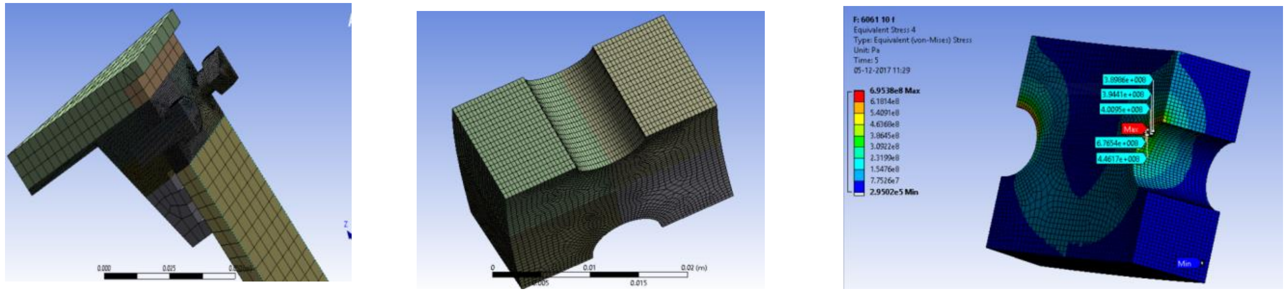


Fig 3 : Mechanical Design and Structural Analysis

The oxidizer tank was analysed for 30 MPa pressure and the max von mises stress values obtained is 70 MPa which is within limits. The actual operating pressure will only be 6 MPa based on the Pressure of Nitrous oxide in the temperature range of 25-35^{o}C. Hence the model is deemed Safe for Operation.

Control System Design and Data Acquisition

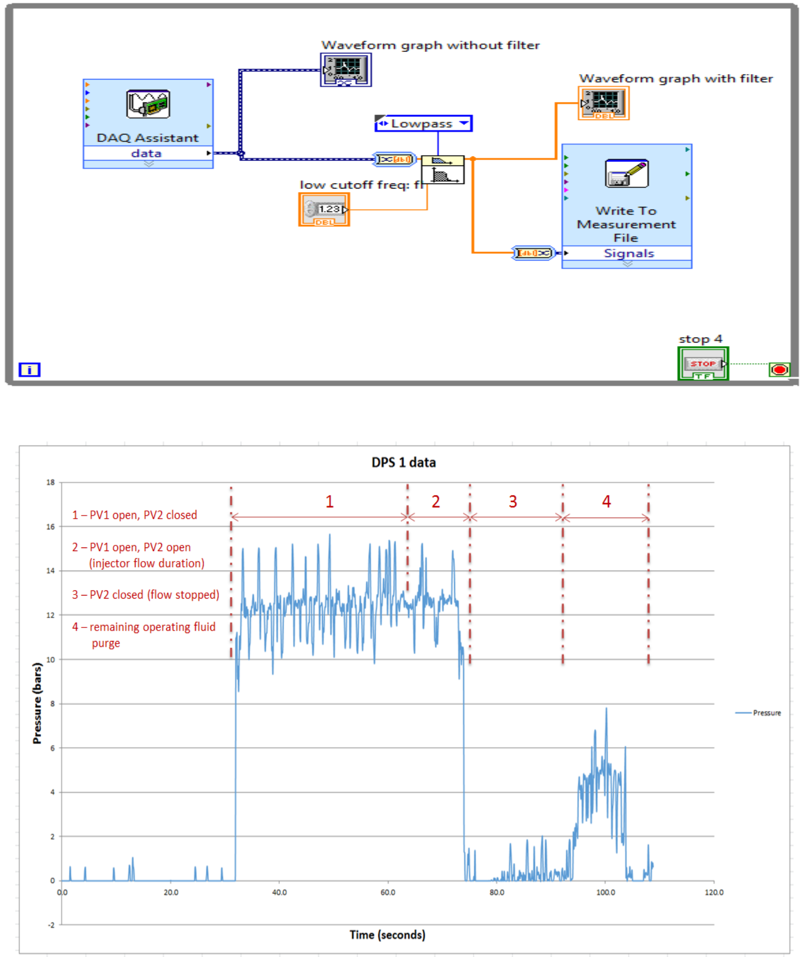
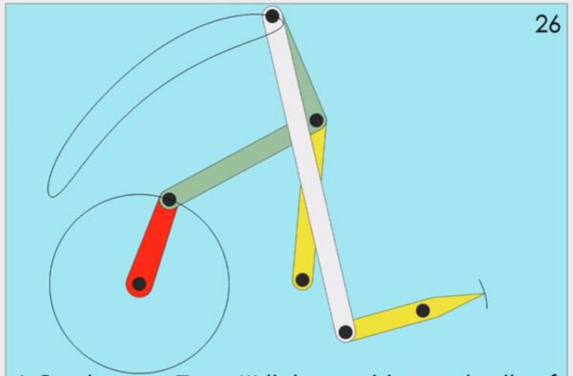


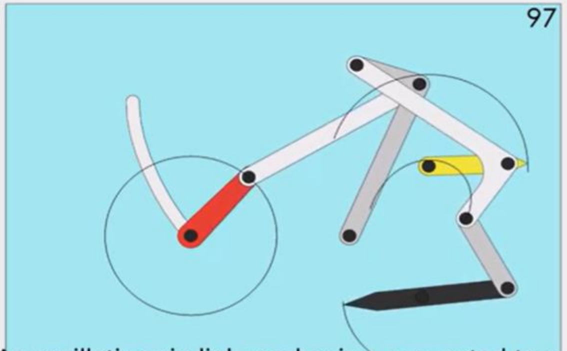
Fig 4 : Control system and data aquation using NI lab View

9) Digitalization of Prof. KLN’s Mechanism Collections

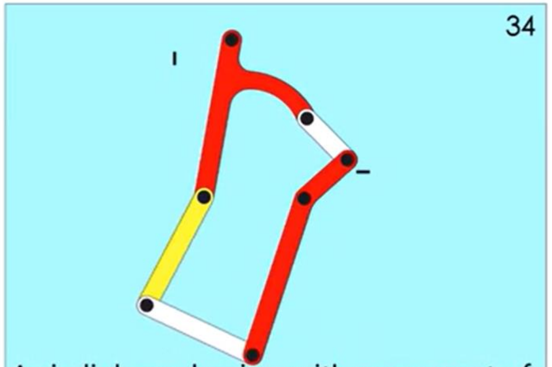
- Create 3D models and simulations of mechanical components and assemblies of Prof. KLN's mechanism using Solidworks.



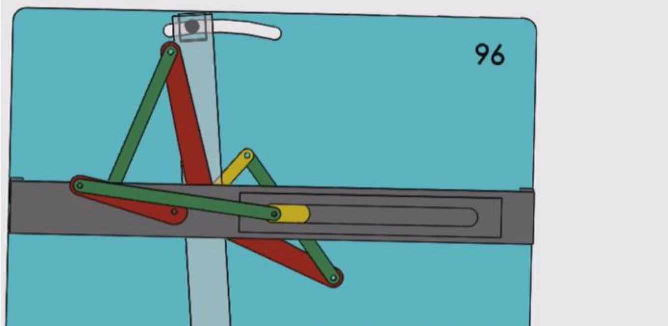
A Stephenson Type-III linkage with two dwells of the output rocker.



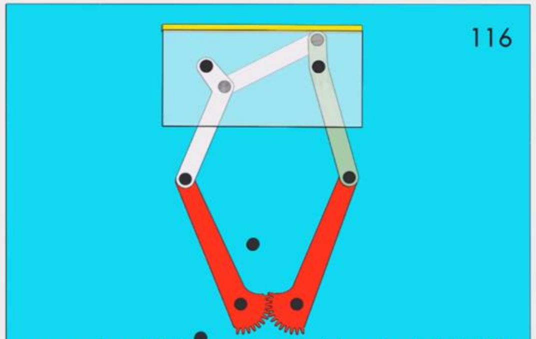
An oscillating six-link mechanism connected to a crank and rocker mechanism to adjust the dwell without varying the output link.



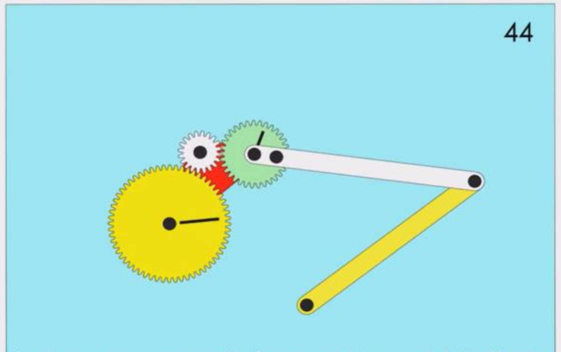
A six-link mechanism with movement of output and input link in the same position and most favorable transmission.



An adjustable slider-crank linkage with changing quick-return ratio and a dwell.



A seven-bar linkage useful in straight lifting without linear guides.



A planetary-gear linkage with multi-indexing stations of the output gear.

Intermittent rotary motion using Geneva wheel mechanism

Skills: Solidworks, Design, Mechanisms.

10) Nanoclay Reinforced Wood-Polymer Composites

- This study was aimed at studying the **Mechanical and Physical properties** of **Wood polymer composites** reinforced with Nano clay.

- The compositions include wood flour (WF), Polypropylene (PP) and Nano Clay. Three different types of Nano Clay were used in different proportions. Maleic anhydride grafted polypropylene (MAPP) was added as a coupling agent to increase the interaction between the components of wood plastic composites.

- The Nano Clay was introduced as direct addition into the PP/Wood Flour composites during convectional dry compounding direct blending process).

- Nano Clay based wood plastic composites were made by **extrusion process** and then injection moulding. The mechanical properties of injection moulded WPCs were characterized using **flexural, tensile and Izod impact test**.

- The results of strength measurement showed that the flexural yield decreased with addition of Nano clay of about 15%.Unmodified Nano clay had a relative **higher flexural yield strength** compared to the modified Nano clay.

Skills: Solidworks, Ansys Workbench, Design, Fabrication, Injection moulding, Mechanical Testing.