# DIVYANSH GUPTA

ROBOTICS ENGINEER AND MECHANICAL DESIGNER

Email: gupta.divy@northeastern.edu | Contact: +1 (854) 544 1447 | LinkedIn: /divyansh2504

# About me

I am a Mechanical design engineer transitioning to control-systems, enabling robots to mimic bio-inspired efficient movements. Working at this crux of hardware and software engineering really excites me, and I aspire to build a deeper understanding on this topic through my master's at Northeastern University in MS Robotics (Fall'22 - Present).

Apart from work, I enjoy cooking, sketching, hiking and swimming.

Life Motto – “If you know you can, there is no way you would settle for less”

## TECHNICAL SKILLS

SOLIDWORKS · 3D · Geometric Dimensioning and Tolerancing · MATLAB · ARDUINO · python · ROS

## EDUCATION

भारतीय प्रौद्योगिकी संस्थान रूड़की
Indian Institute of Technology Roorkee

B Tech. Mechanical Engineering (2016-20)

Northeastern University

MS Robotics (2022-24)

# Projects

## Ottobot – Autonomous delivery robot

Robotics Design Engineer @ Ottonomy IO

## Predicting knee osteoarthritis using inertial sensors

Bachelor Thesis project, Indian Institute of Technology Roorkee (IIT R)

## Quadruped – Chitrak

Robotics Section, Indian Institute of Technology Roorkee (IIT R)

## Redesigning Crutches

Biomedical Innovation Challenge, Inter-IIT Tech Meet 2019

## Affordable Insulin Pump

Research Intern @ UTSAAH Lab, Indian Institute of Science (IISc) - 2019

## Gripper and Morphing wheel design

Summer Intern @ The Hitech Robotic Systemz - 2018

## Other projects

# Ottobots

Autonomous Delivery Robots

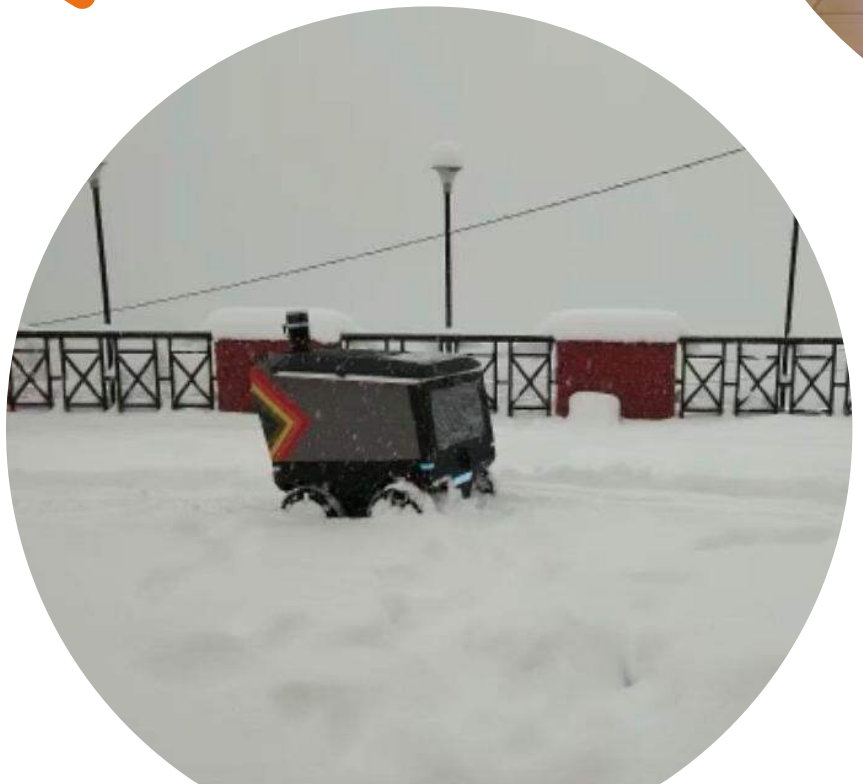
Robotics Design Engineer @ Ottonomy IO

https://ottonomy.io/

# Ottonomy IO


While at Ottonomy, I worked as a Robotics Design engineer where I was involved in designing and integration of the robot. Also, I worked on multiple R&D projects and few of my key works includes –

- Designing robots' thermal management system
- Enabling robots to navigate and move in snow
- Vibrational analysis for safety of electronics (Evaluating GRMS value from inertial data)
- Integrating modularity with sensors and electromechanical components



Ottobot 1.0:
https://youtu.be/ZNJettjtIj0

Ottobot 2.0:
https://youtu.be/knYMcZfIA6Q

Ottonomy Links:
https://www.youtube.com/c/OttonomyIO/videos
https://www.linkedin.com/company/ottonomyio/

# PredicKOA

Predicting knee osteoarthritis using low-cost wearable sensors

# Project Brief

- Monitoring human movements can help in understanding neurological and physiological changes in body affecting elderly mobility

- Knee osteoarthritis (KOA) is one of the most common degenerative change affecting elderly mobility – Tracking the movement changes corresponding to KOA can help in taking preventive measures for delaying the progress of knee osteoarthritis

# How it works?

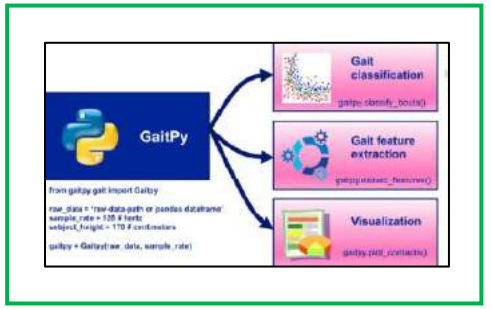
Collect acceleration (IMU) data from sensors placed on human body

Estimate gait features from this data – walking speed, step size, etc.

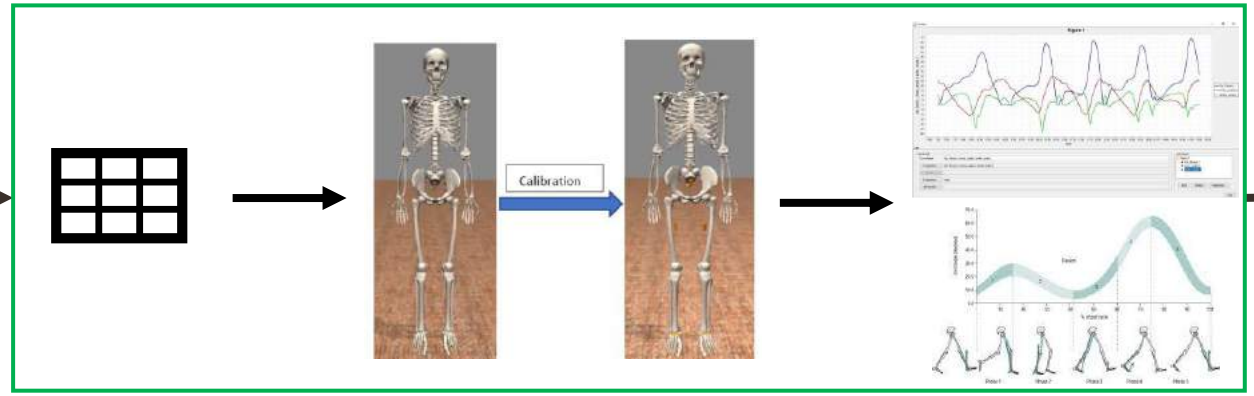
Estimate joint kinematics – joint angles

Using gait features and joint kinematics predict knee osteoarthritis severity

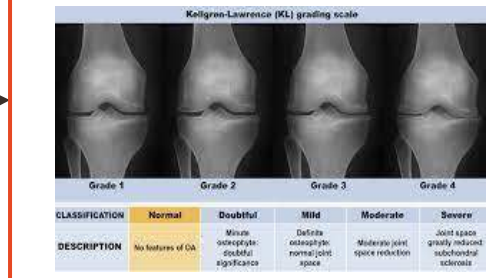

Collect inertial data wirelessly and do pre-processing




Estimating Gait features (using GaitPy)

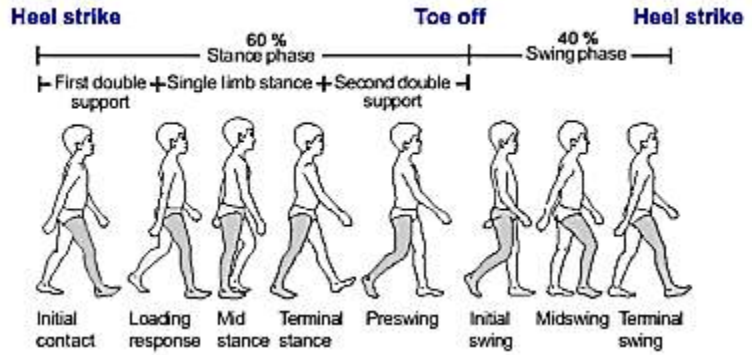


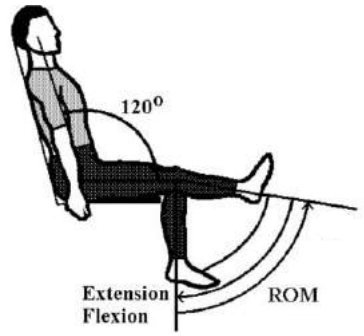

Estimating Joint orientations and Kinematics with mounted inertial sensors (using OpenSim - OpenSense)




Predict knee Osteoarthritis (using Joint Kinematics and Gait features)

# Parametric changes in Joint Kinematics and Gait features due to Knee Osteoarthritis



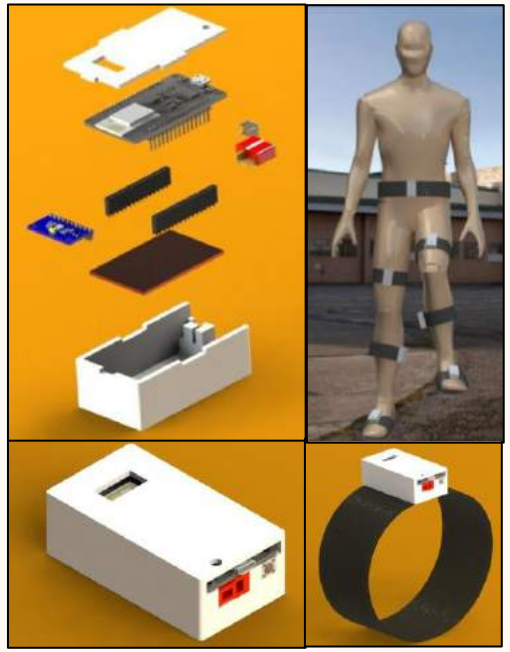




| PARAMETER | PARAMETER CATEGORY (GAIT FEATURE / KINEMATIC) | EFFECT OF OSTEOARTHRITIS ON PARAMETER |
|---|---|---|
| Walking speed | Gait feature | Decreased |
| Steps per minute | Gait feature | Decreased |
| Double support time | Gait feature | Increased |
| Peak Flexion Angle – at Heal Strike | Gait feature and Kinematic | Decreased |
| Peak Flexion Angle – at Midswing | Gait feature and Kinematic | Decreased |
| Range of Motion(ROM) - Knee Flexion | Kinematic | Decreased |
| Range of Motion(ROM) - Ankle Flexion | Kinematic | Decreased |
| Range of Motion(ROM) - Hip Flexion | Kinematic | Decreased |


Sources:

1. Astephen JL, Deluzio KJ, Caldwell GE, Dunbar MJ. Biomechanical changes at the hip, knee, and ankle joints during gait are associated with knee osteoarthritis severity. J Orthop Res. 2008;26(3):332-341. doi:10.1002/jor.20496
2. Heiden TL, Lloyd DG, Ackland TR. Knee joint kinematics, kinetics and muscle cocontraction in knee osteoarthritis patient gait. Clin Biomech (Bristol, Avon). 2009;24(10):833-841. doi:10.1016/j.clinbiomech.2009.08.005
3. Van der Straaten R, Wesseling M, Jonkers I, et al. Functional movement assessment by means of inertial sensor technology to discriminate between movement behaviour of healthy controls and persons with knee osteoarthritis. J Neuroeng Rehabil. 2020;17(1):65. Published 2020 May 19. doi:10.1186/s12984-020-00694-2

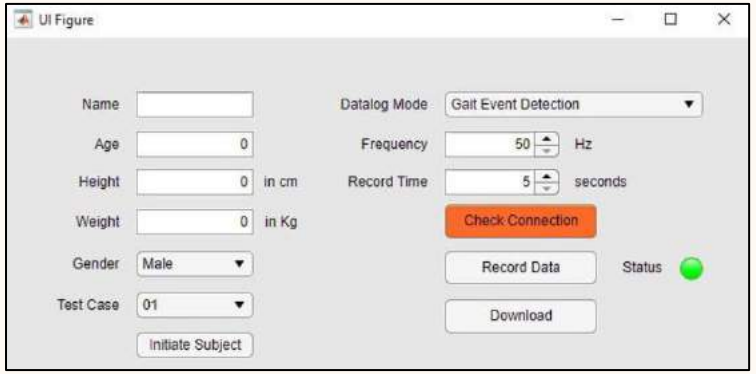
# Hardware Setup and Data collection UI

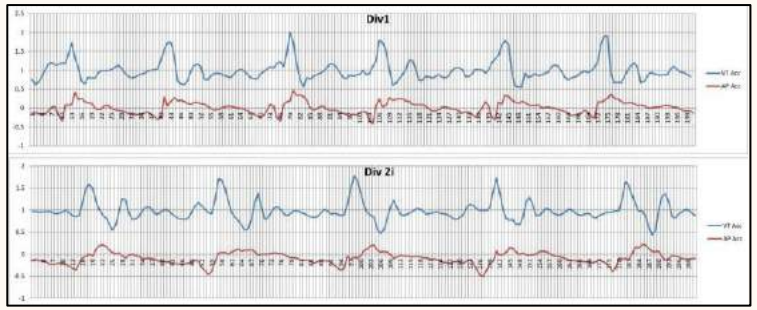


**Dimension (in mm):** 70x38x20
Hardware secured using Velcro

(i) Initial Test setup
(ii) Setup with SD Card
(iii) Setup without SD Card

Device powered using 5V Power bank and secured on pelvis using Leather belt




(i) Data Collection UI (using MATLAB)
(ii) Collected accelerometer data (Pelvis)

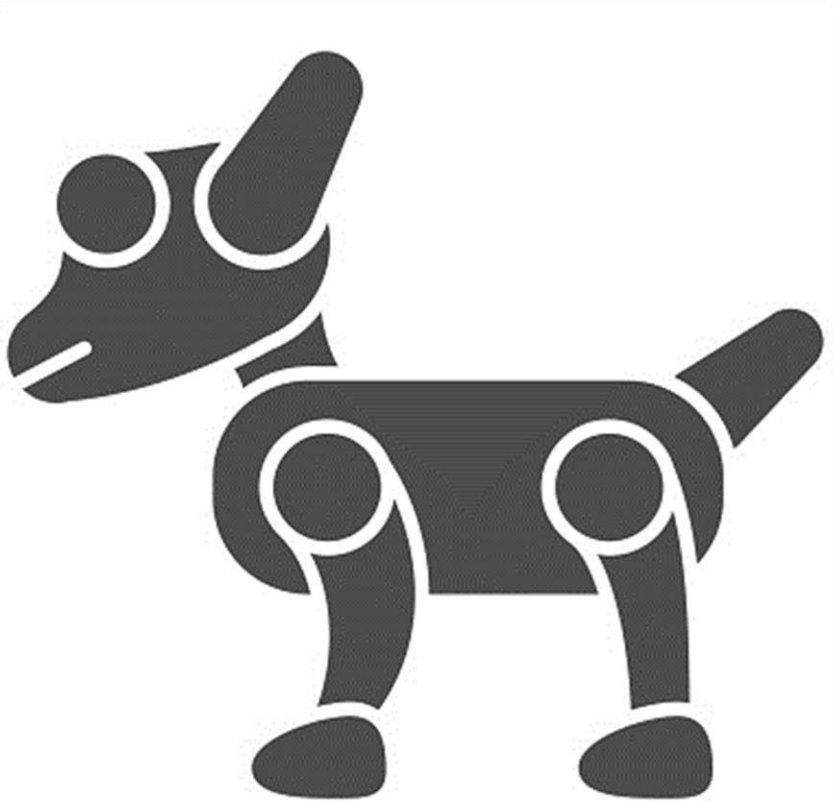
*Successfully completed my bachelor thesis and received A+ grade*



*Limitations in final prototyping due to COVID 19

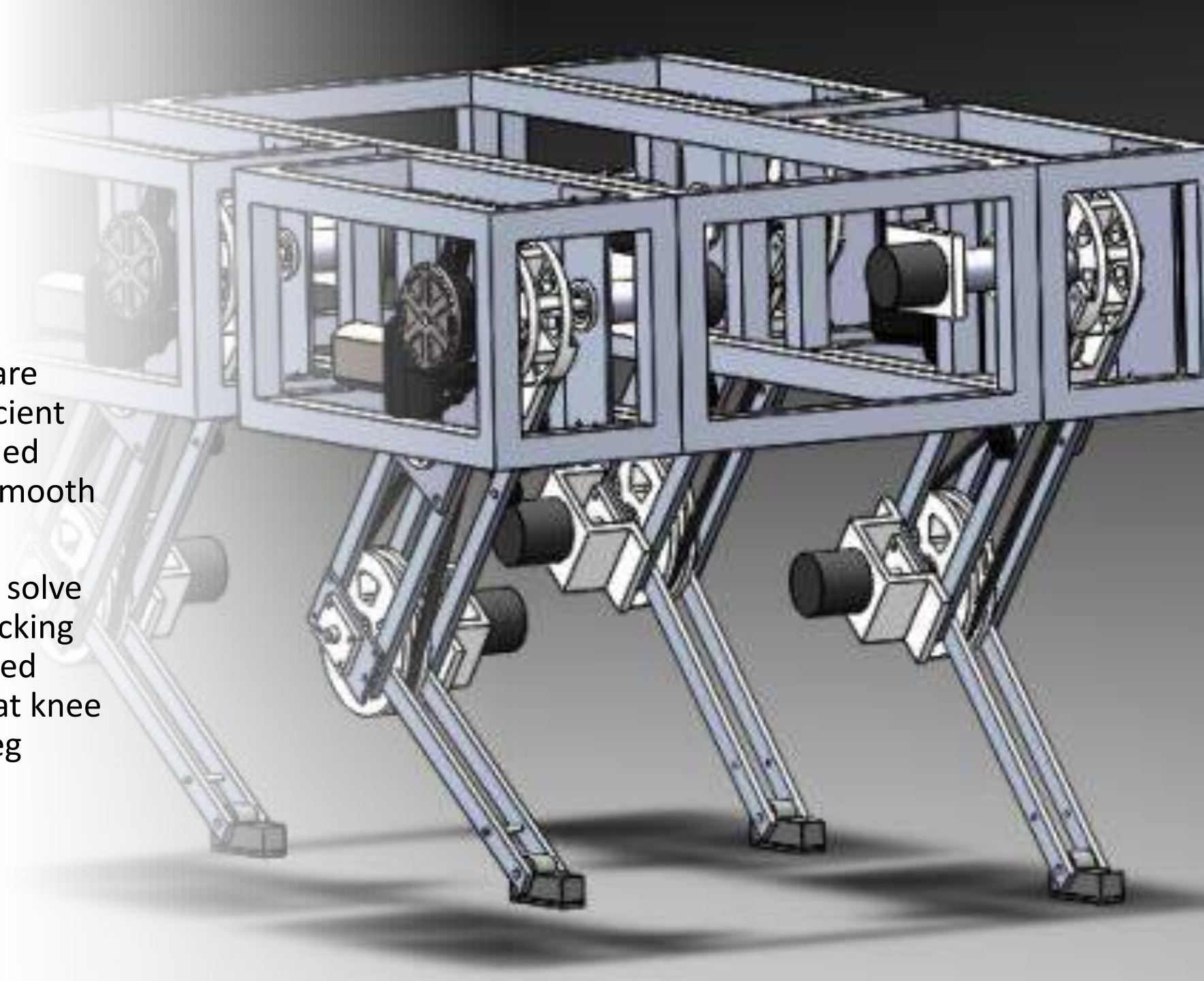
# Chitrak

Improving efficiency of Quadruped Robot



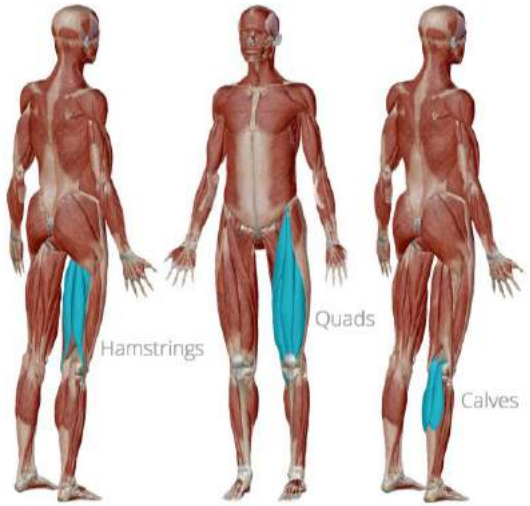
# Project Brief

- In general legged robots are considered to be less efficient when compared to wheeled robots when moving on smooth surfaces or standing still
- In this project we tried to solve this problem using self-locking actuators (lead screw based mechanism and motors) at knee and hip joint in a 2 DOF leg



# How it works?

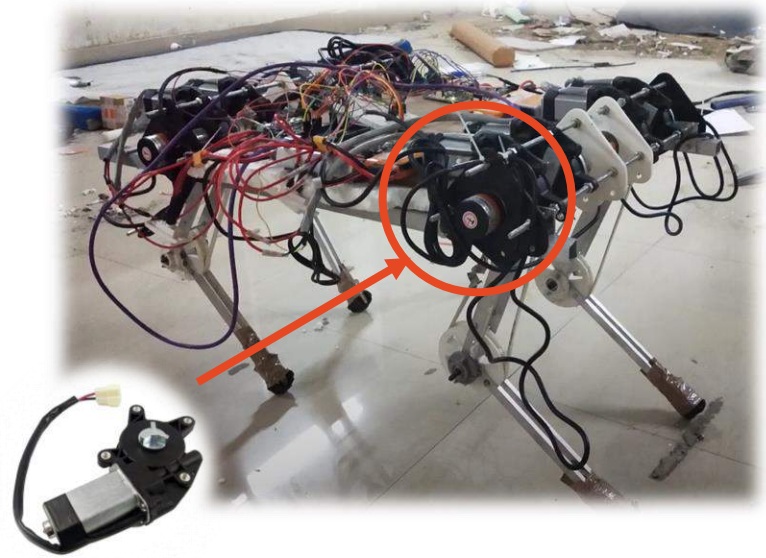
**Problem**




In humans, while standing theoretically no work is done (as no movement) but still **muscles are continuously activated** to maintain the stance

Similarly in legged robots, **continuous holding torque** is required for robot to maintain its stance

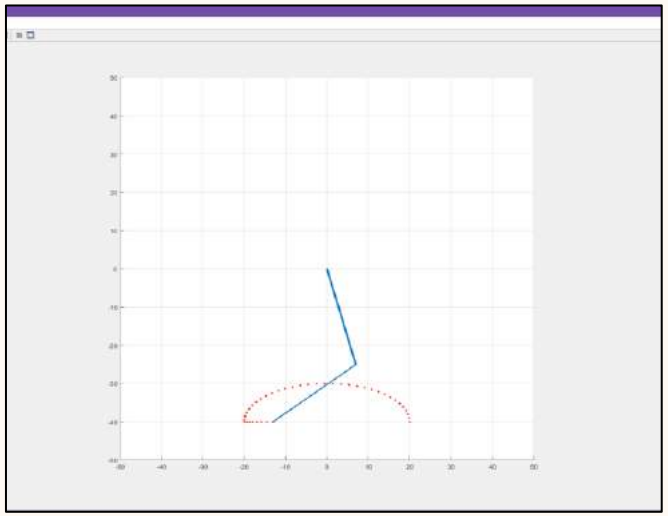
**Solution**



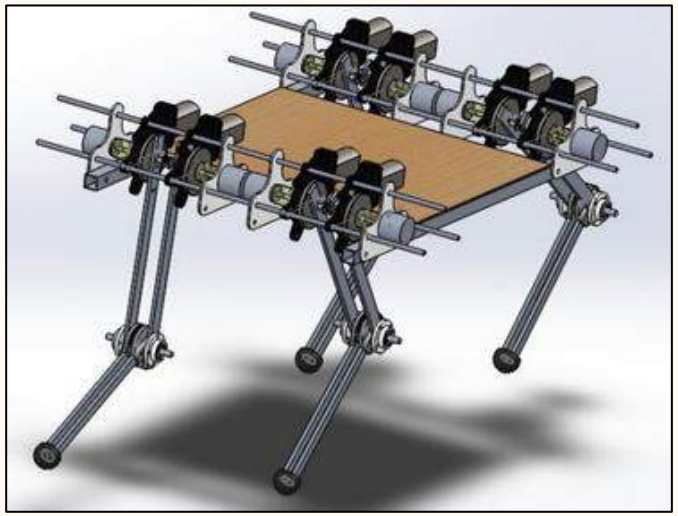
Using self-locking mechanism at the knee and hip joint can prevent the need for continuous motor activation to maintain robot stance

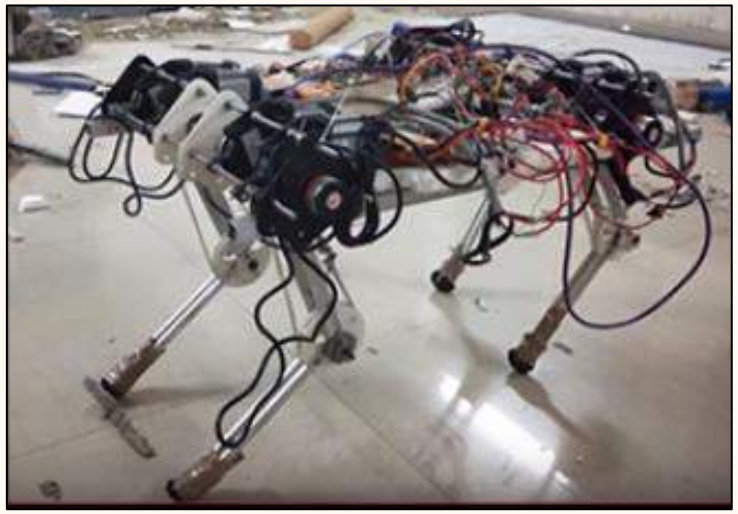
For self-locking, worm gear motors or lead Screw based linkage can be used

# Simulations and prototypes



Generated Bezier curve based foot trajectory and simulated the inverse kinematics for knee and hip joint on MATLAB (Simulink)





Designed multiple iterations for the robot using Solidworks to minimize weight and simplify fabrication. Further, built the prototype from parts manufactured using CNC and 3D Printing

Iteration 1: https://youtu.be/hBBhkbbs5qY

Iteration 2: https://youtu.be/Yxk5NU94QKA

*Chitrak was selected among top 5 student-led projects to represent IIT Roorkee in Inter IIT-Technical Meet 2019*

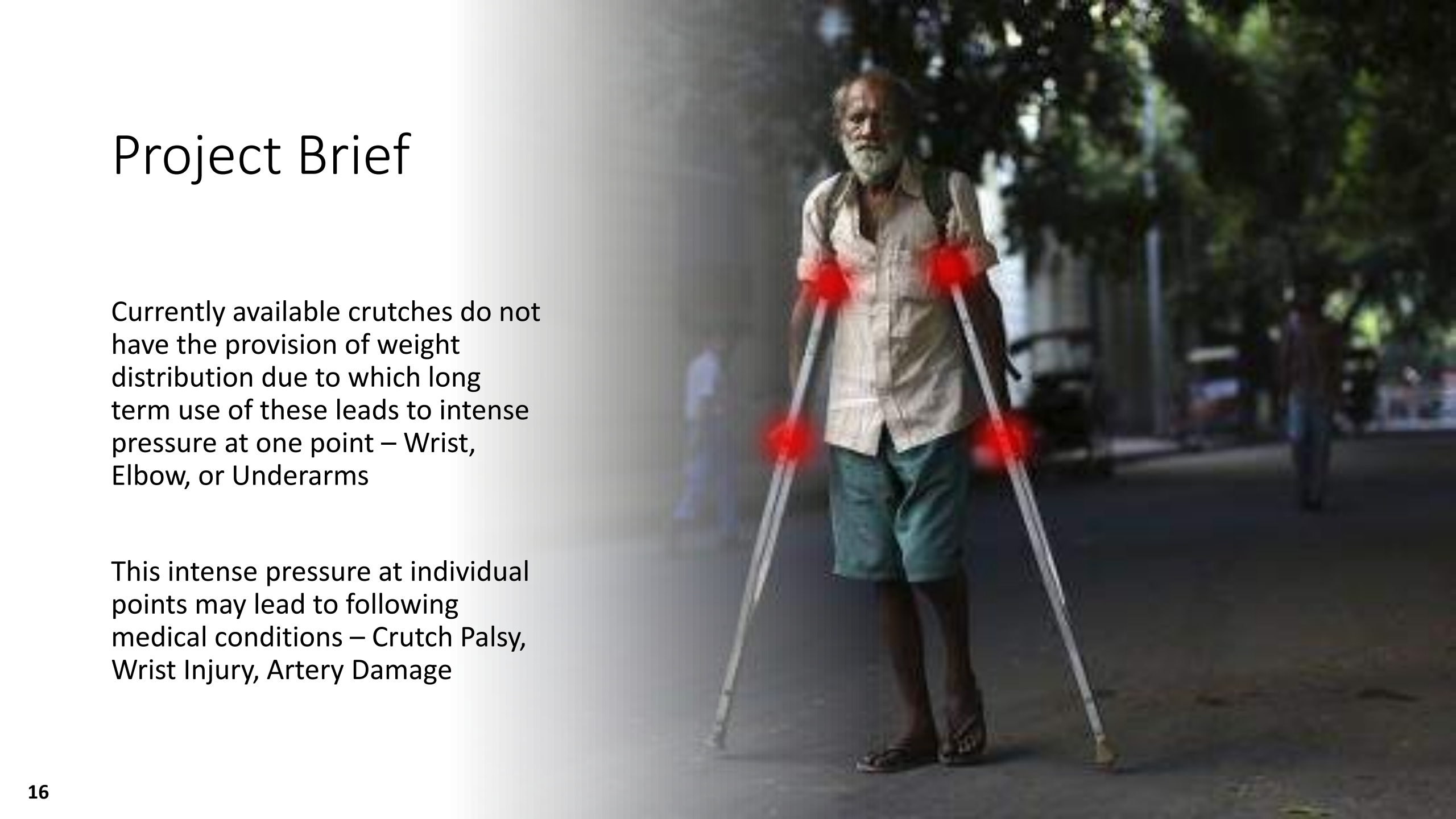
# Crutches

Redesigning crutches to reduce the risk of Crutch Palsy

# Project Brief

Currently available crutches do not have the provision of weight distribution due to which long term use of these leads to intense pressure at one point – Wrist, Elbow, or Underarms

This intense pressure at individual points may lead to following medical conditions – Crutch Palsy, Wrist Injury, Artery Damage



# Prevalence of problem

Lack of training among crutch users increases risk for medical conditions due to improper posture while walking with crutch

In India, approximately **13.5 million** people are more prone to risk of crutch palsy and similar conditions due to improper crutch handling

- 4.1% of India's population has locomotor disability
- 30% of locomotor disabled uses crutches
- 80% of these don't have proper medical training

**What are the common problems you face while using crutches? – Auxiliary crutch user**

- Pain at wrists, neck and shoulder
- Difficulty in standing; blood circulation stops in hands
- Painful to use for more than 20min and long walks

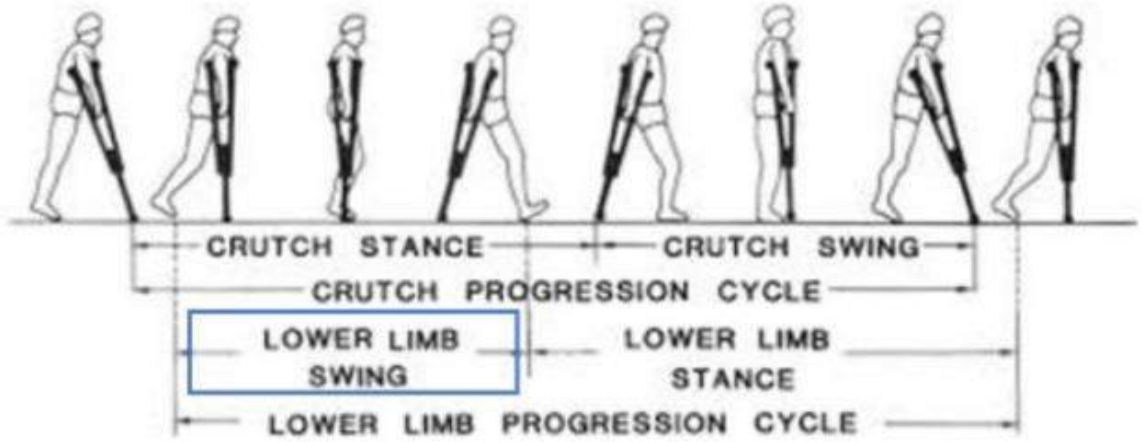
**User comments**

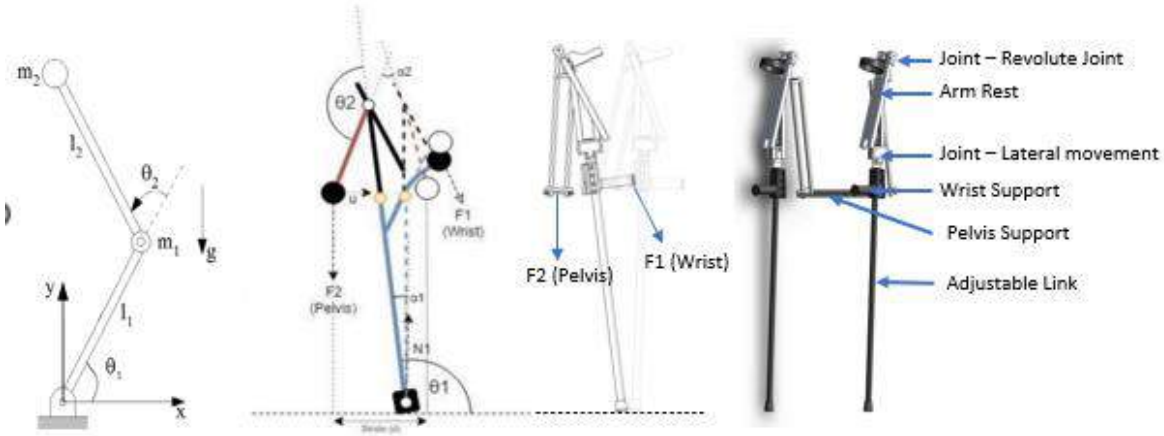
# Proposed Solution

Crutch that supports pelvis – Distributing body weight on wrists, forearms and pelvis

Video Link

# How it works?




Crutch movement can be considered similar to that of a double inverted pendulum where crutch acts as Link1 and our upper-body length acts as Link2 about which body swings forward

Adding a rigid link to support swinging body help take off the load from wrists and shoulders

# Iterations and Prototypes

*Won 2nd prize for our design in Inter IIT Tech Meet organized by Biomedical Engineering and Technology Innovation Centre (BETIC), IIT Bombay, India (https://www.betic.org/ )*

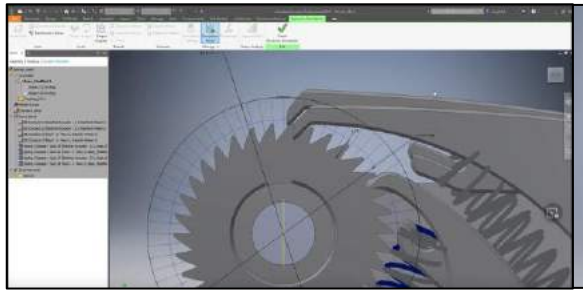
# Affordable Insulin Pump

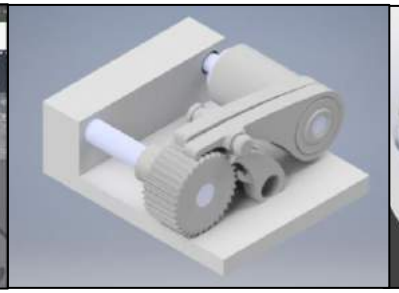
Low-cost insulin pump for T1DM patients

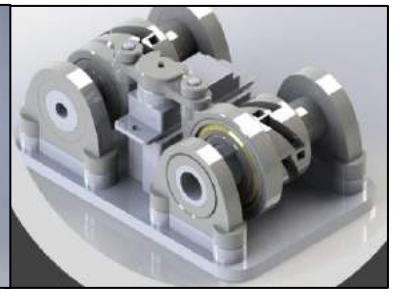
Research intern@ UTSAAH Lab, IISc Bangalore

https://cpdm.iisc.ac.in/utsaah/

# Affordable Insulin pump for T1DM patients

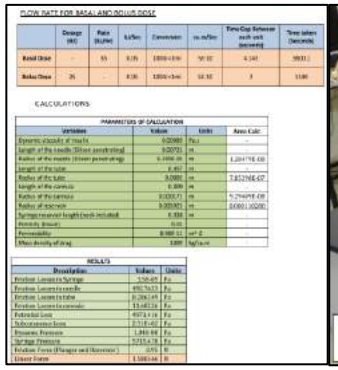


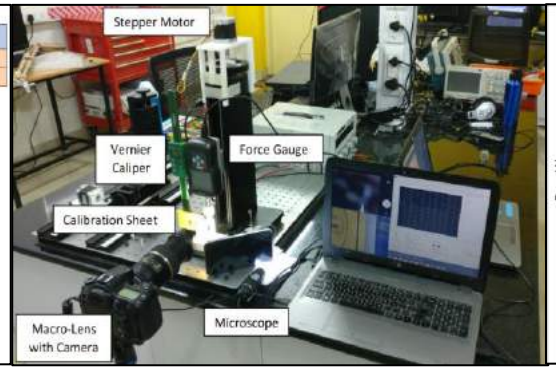


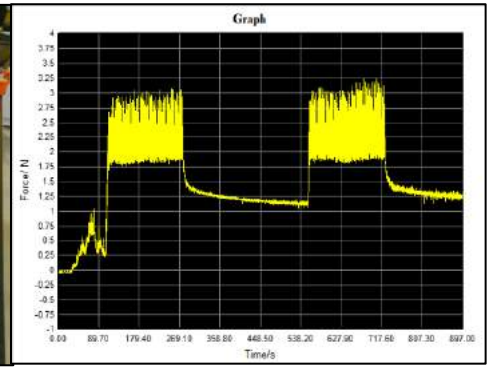


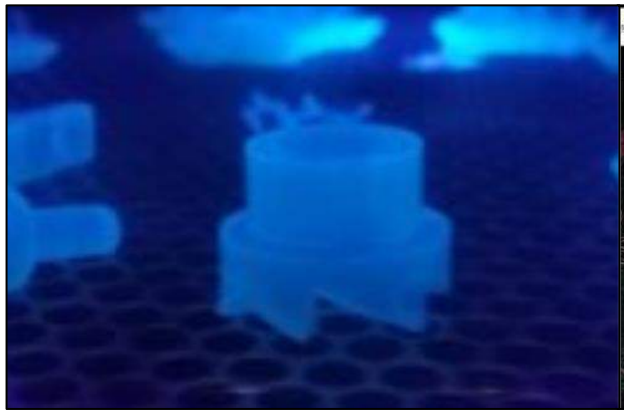
During my internship I worked on the development of the insulin pump – which included design, simulation and prototyping. Few of my key works at UTSAAH Lab includes –

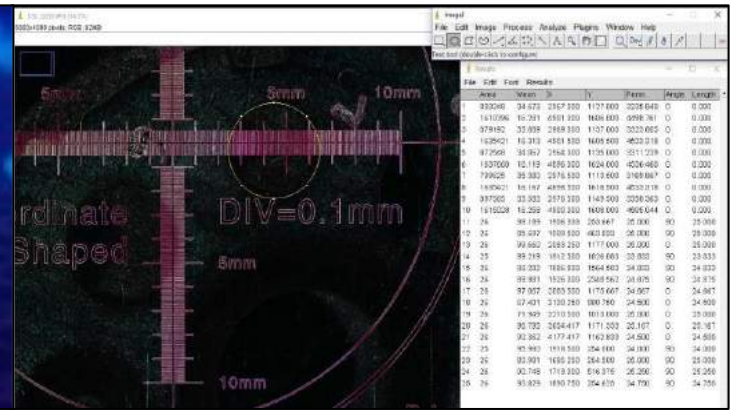
- Design and simulation of novel double ratchet-pawl mechanism to facilitate 1:64 gear reduction
- Theoretical estimation of Plunger force for subcutaneous injection followed by experimental validation
- Estimating dimensional accuracy of 3D printed parts (SLA) and comparative analysis with FDM and Polyjet printing across different materials







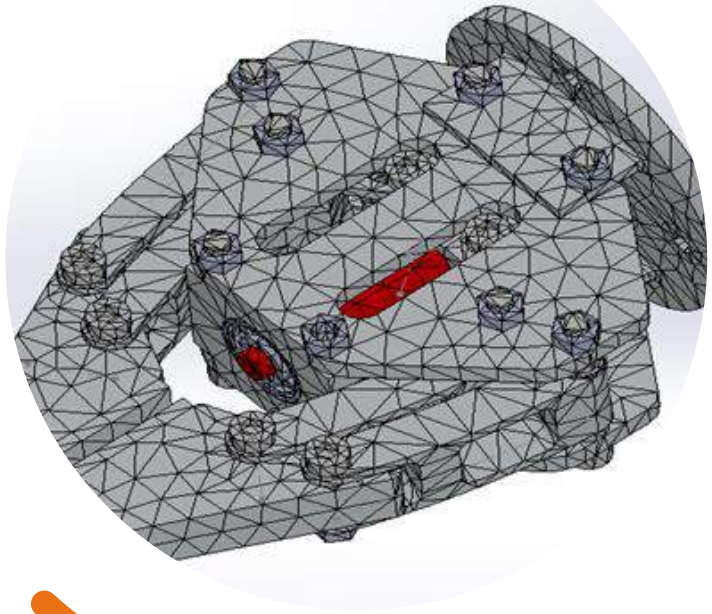
# Stair climbing robot

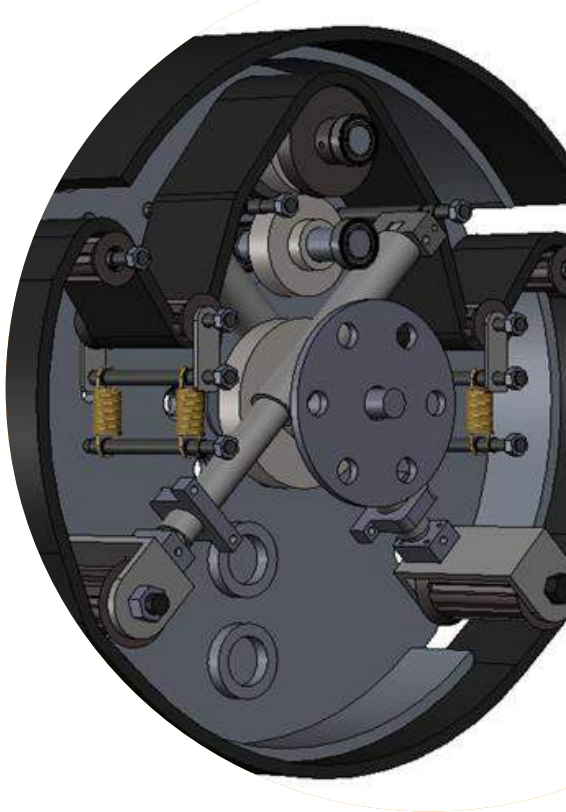
Parallel Jaw-Gripper and concept design for a morphing wheel

Summer Intern @ The Hitech Robotic Systemz

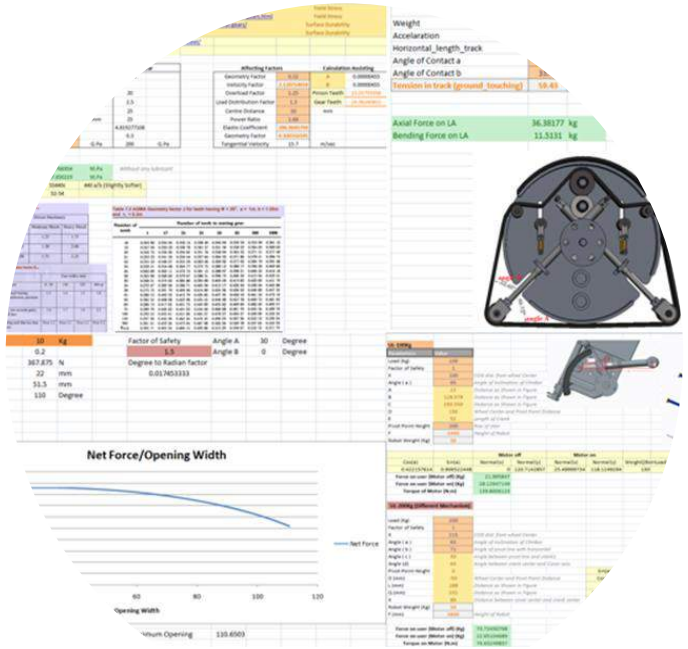
https://thrsl.xyz/index.html

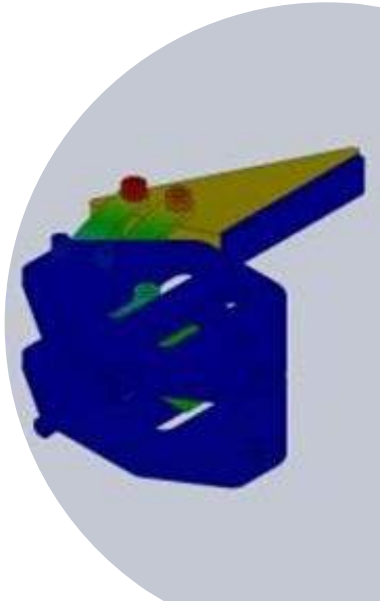
# The Hitech Robotic Systemz





While at The Hitech Robotic Systemz, I worked as an intern where I designed a parallel jaw gripper capable of lifting payload of up to 10 Kg and 100mm. Additionally I worked on the conceptual design for morphing wheel capable of switching between track and wheel configuration



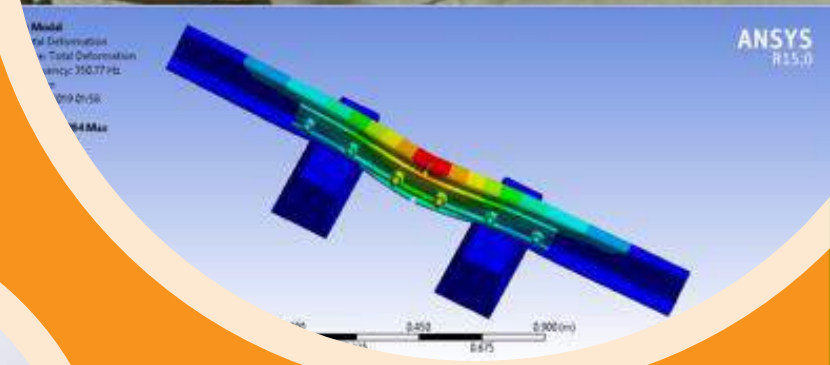



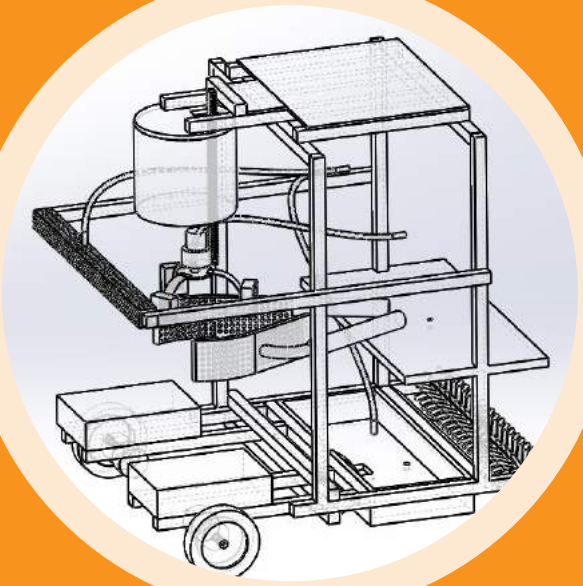
Skills:

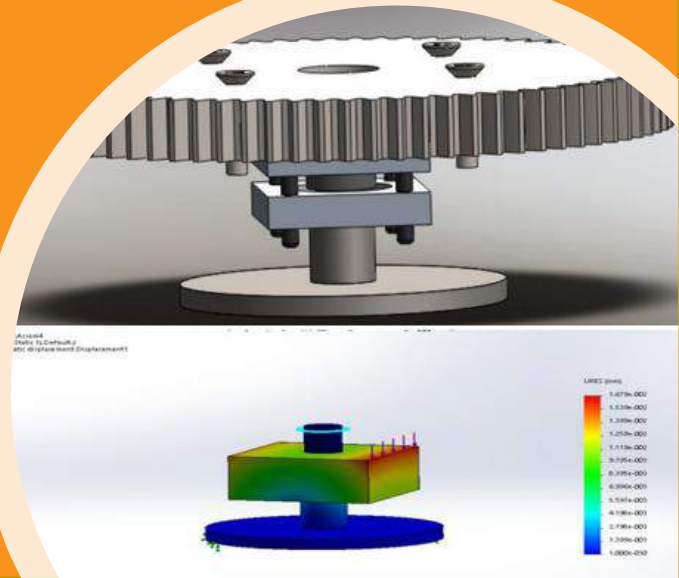
- CAD Modeling (Solidworks and CREO)
- Stress Analysis (ANSYS)
- Dynamic simulation (Simwise 4D)
- GD&T
- Theoretical analysis of mechanisms (Static analysis)

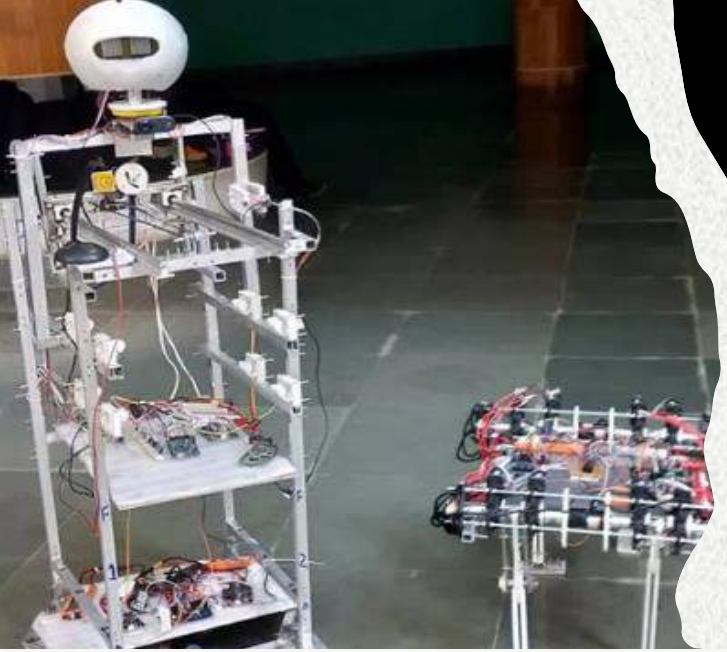
# Other Projects

- Automated Toilet Cleaning robot
  - Enable automated cleaning of public toilets in India
- Butler Robot – Restaurant the future
  - Enable automated servicing in a futuristic restaurant model
- Insulated Rail Joint (IRJ)– Frequency response under different pretension
  - Reduce loosening of bolts in an IRJ due to rail crossings
- Mobile manipulator – Bearing support for high moment capacity (withstand manipulator arm movement)
  - Design an alternative to lazy-susan for high radial loads
- Design of external sole for footwear to minimize risk of falling among geriatrics on uneven surfaces
  - Solution for geriatrics mobility in rural infrastructure







Butler Robot and Quadruped

# Thank you for your time

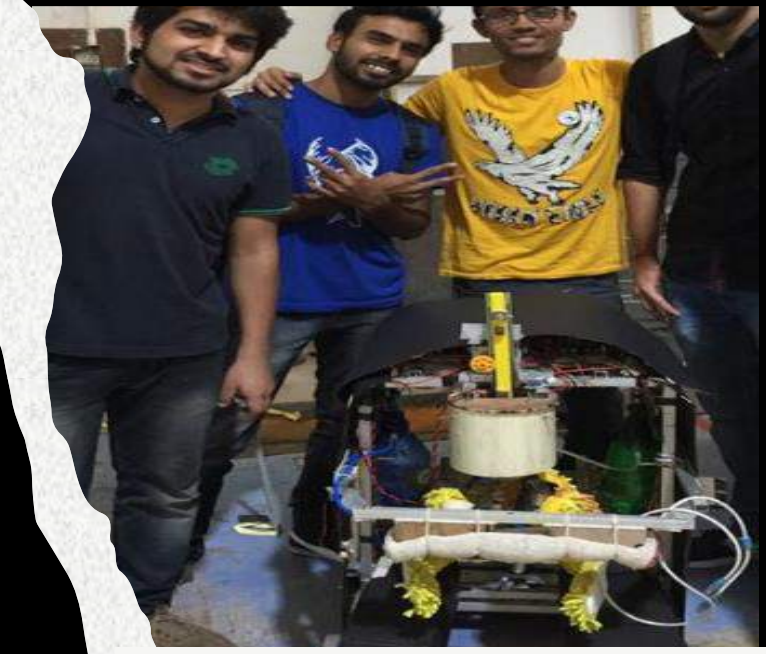
Feel free to reach out to me to discuss any ideas or projects


/divyansh2504

divg2504@gmail.com


Ottobot – Ottonomy IO

Quadruped - Chitrak



Automated Toilet cleaning robot