FES DEVICE REPORT

ABSTRACT

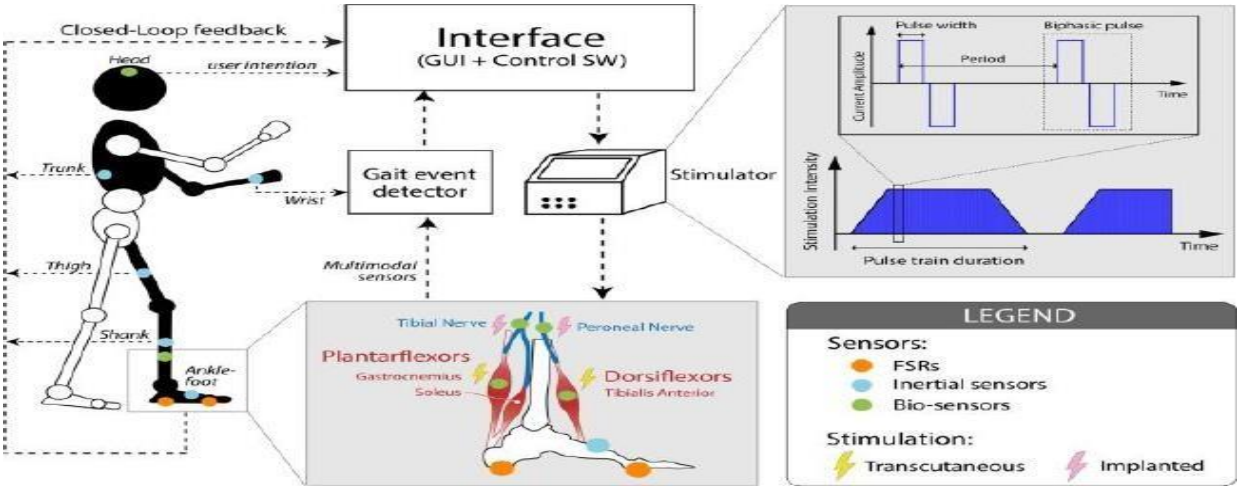
In this project, we attempt to use spark-fun IMU BNO080 sensor to understand the gait cycle on the shank of leg and understand its gyroscopic acceleration and angle deviation. Using this information, we classify various activities such as heel strike, toe off, swing, stance. Used an FSR (force resistive along with IMU) in the current device.

INTRODUCTION

what is FES?

FES short for functional electrical stimulation aims to improve the conditions such as cerebral palsy or stroke, where the electronic muscle stimulator reproduces the body's muscle contractions by applying electrical impulses to our motor nerves.

The functional part in this project is to assist and help in neurorehabilitation of lower-limb to the femoral nerve to help in aiding foot drop in the conditions mentioned above.



Types of FES device?

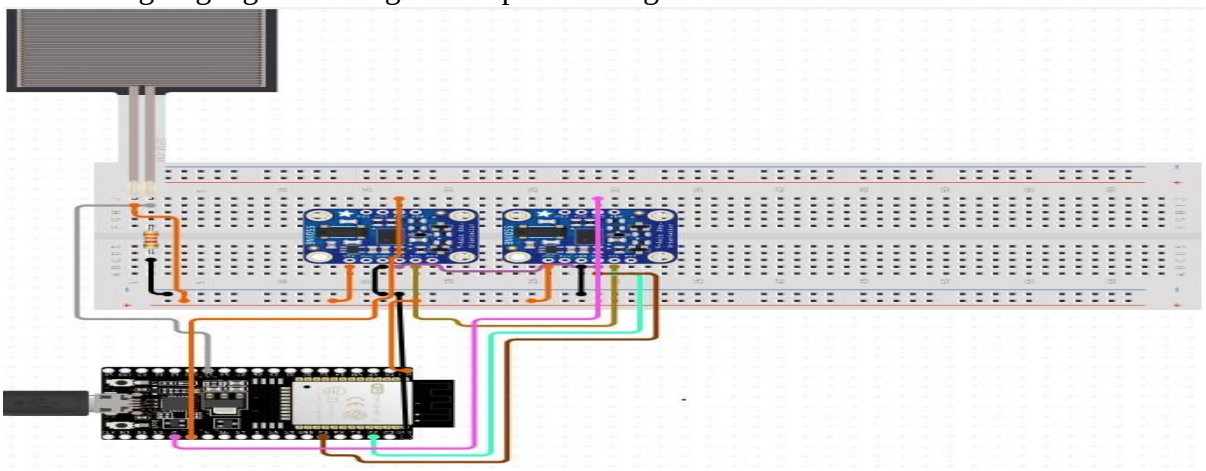
- Implant FES (where the stimulation circuit is implanted on the nerve)
- Transcutaneous FES (placed on the skin causes irritation but can reduced with use of alternating pulse width modulation using timer circuit)

1. Gait detection device

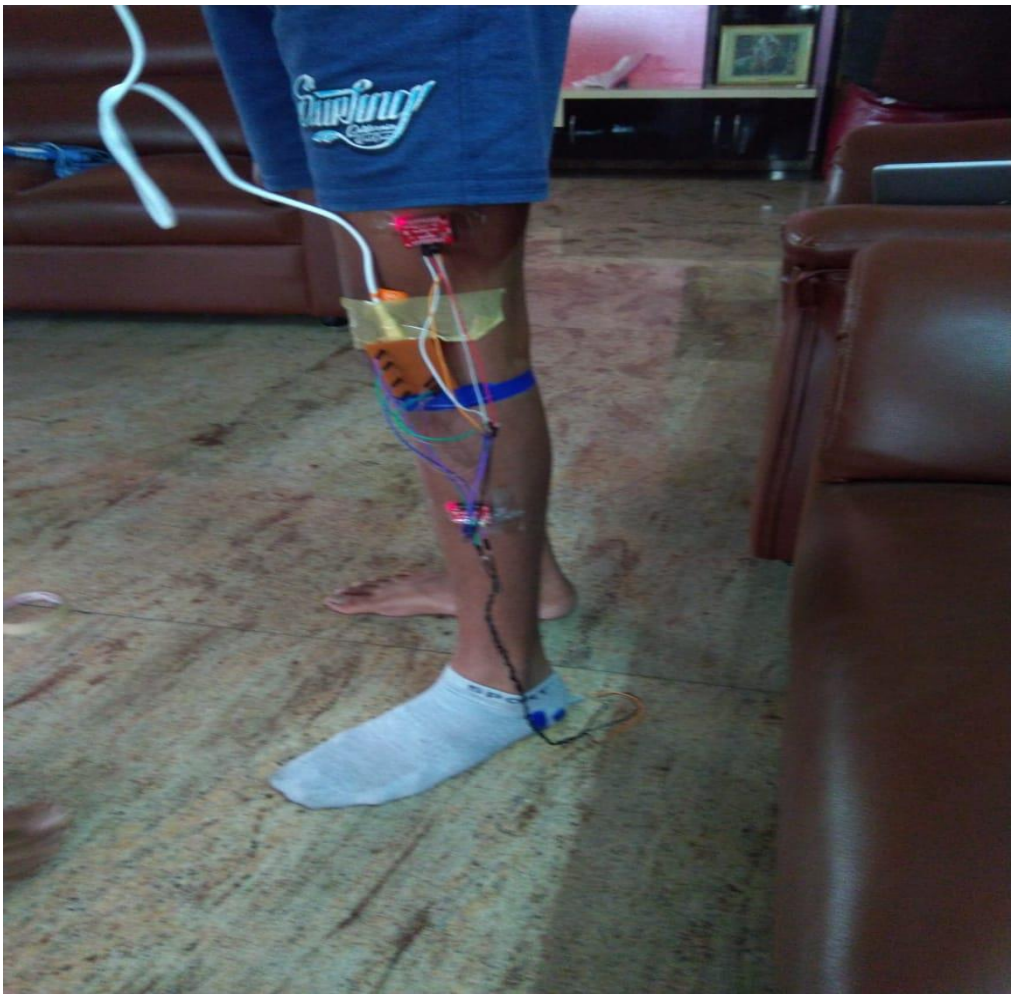
With the help of your company's resourcefulness, I was able to procure IMU devices and ESP32 microprocessor for the measurement of gait with the help velocity, acceleration and angle deviation. Combined with an addition of FSR (force sensing resistor). I was able to determine the point of heel strike and toe off to understand the deterministic point of application of stimulation.

I was able to gather the data through wireless means using the Bluetooth feature to enable a free movement for the patient. The data gathered in text file format has been sorted and processed

with an ongoing algorithm to give an optimized signal to the stimulation circuit.



I have used two IMU sensors one for the knee and the other for the shank of the leg.



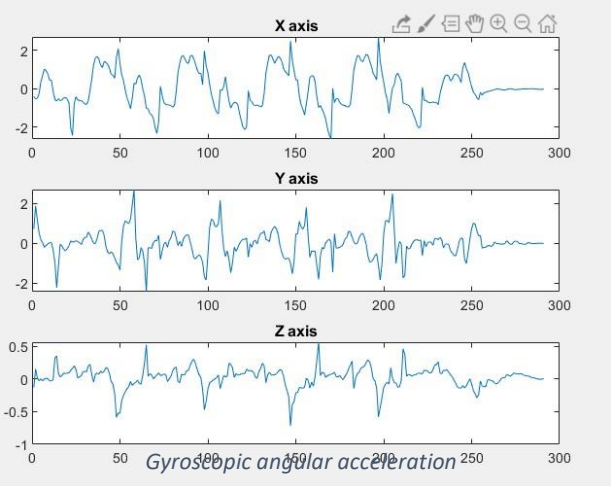
2) Working

I. For the initial understanding of gait, I got pre-recorded signals from the project done to understand gait detection having variable mentioning the pitch, roll, yaw and gyroscopic acceleration gx, gy and gz.

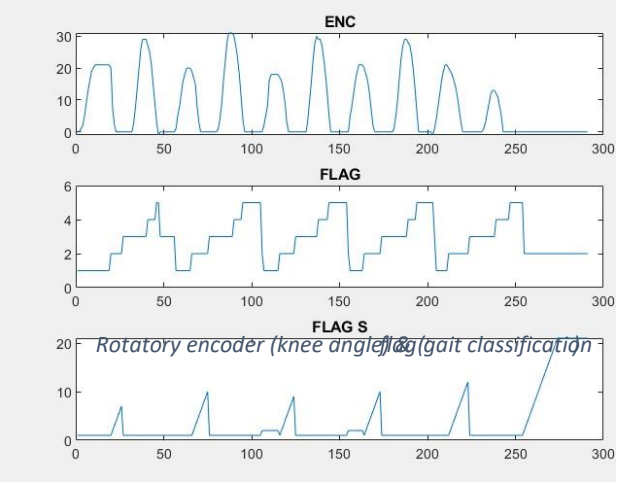
II. I had to do research to understand the point of interest to be exploited for different actions (heel strike, toe off points).

III. I understood the classification of the signals and proceeded to get those points on MATLAB software.

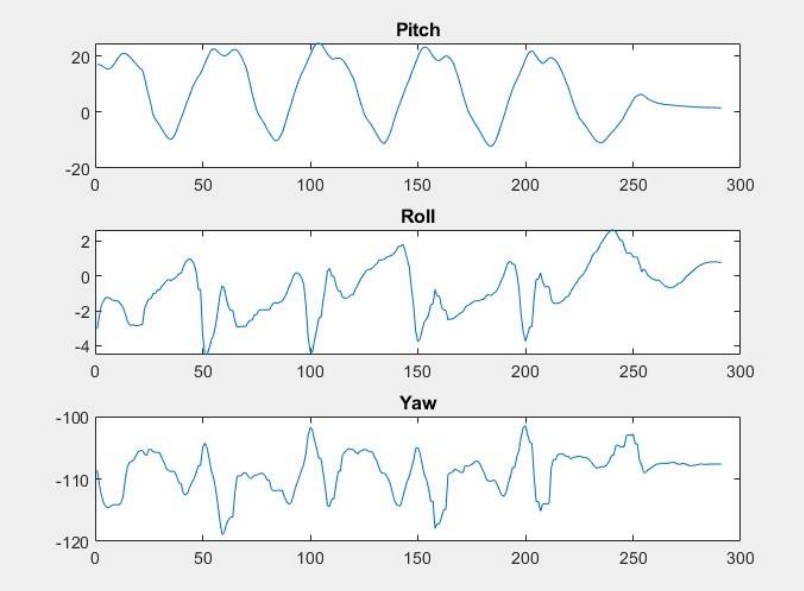
IV. Below are the achieved plots for the same.



Gyroscopic angular acceleration

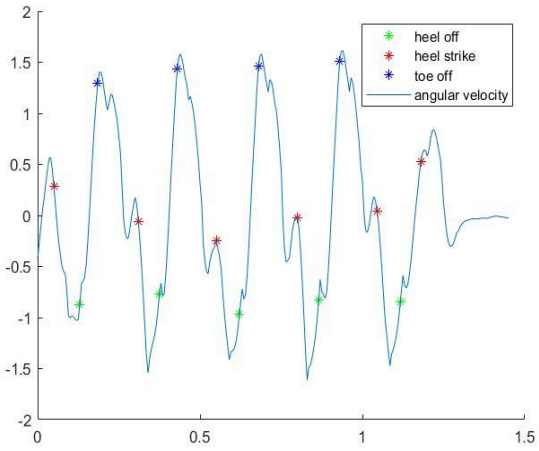


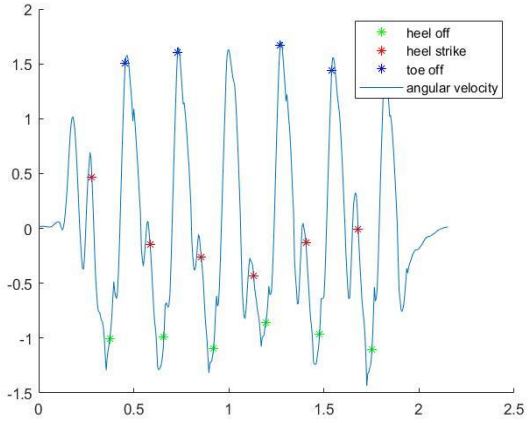
Rotatory encoder (knee angle) & flag (gait classification)



Various parameters from the gait classification from IMU

Using these parameters, I was able to achieve the following graph to mentioning the heel strike, heel off and toe off region.

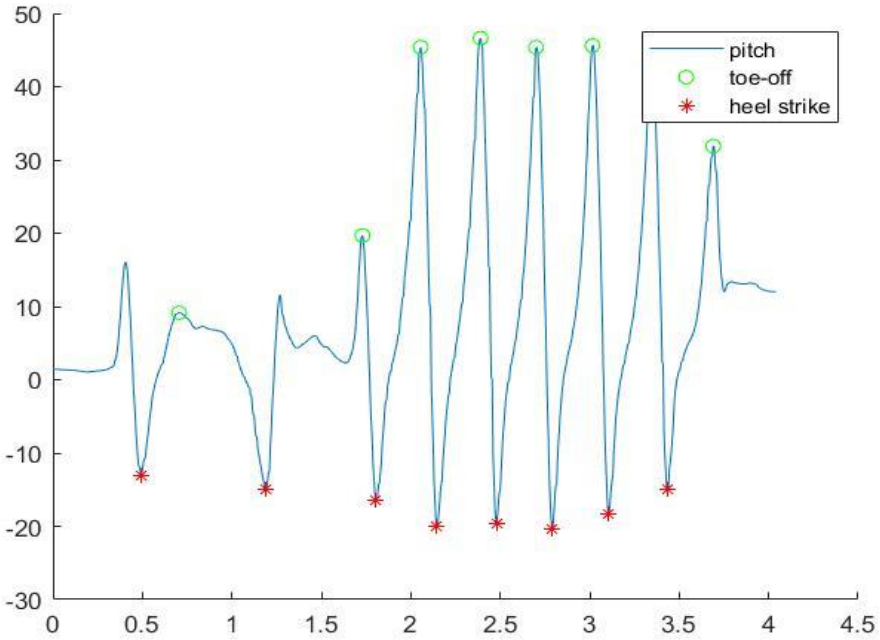




1) MATLAB GAIT DETECTION CODE

2)DATASET TESTED DATA

V. Later I took the data from the IMU and plotted it to check the resemblance to the pre-recorded signals.



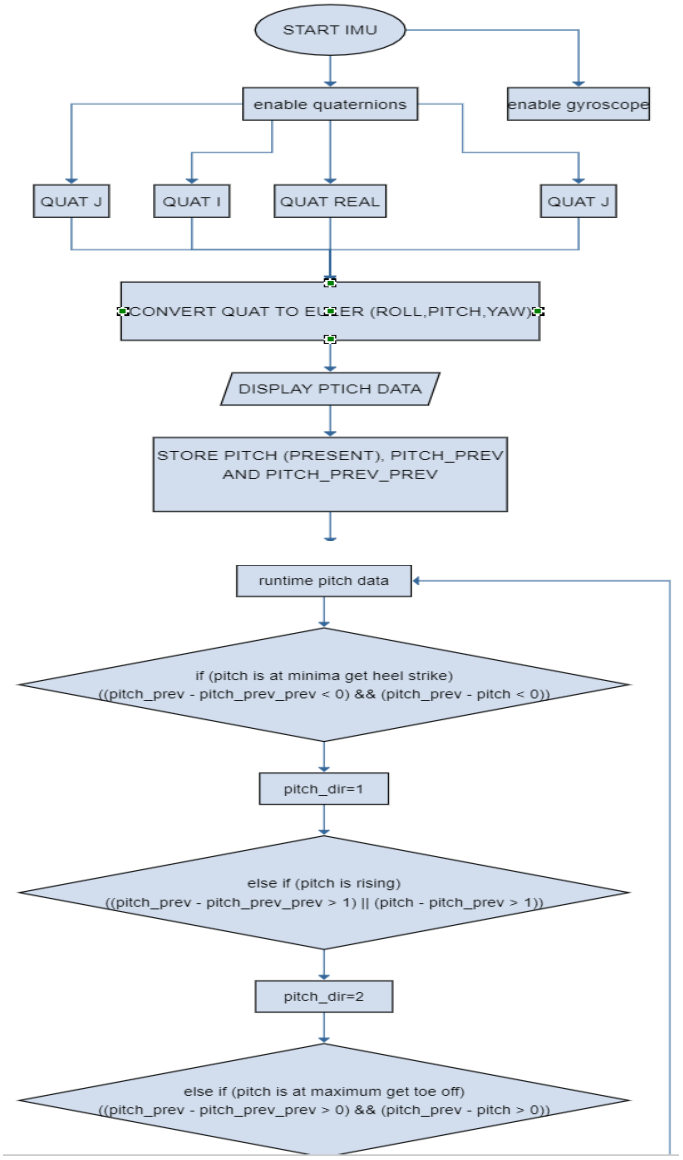
vid_data_3.mat NEW GAIT LOAD CODE

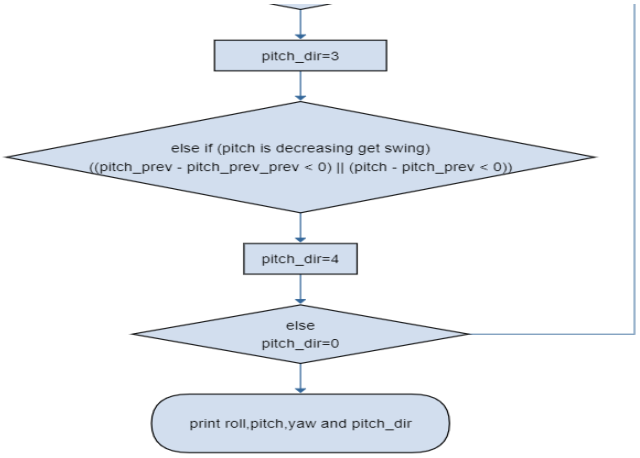
data I acquired and obtained heel strike and toe-off using the pitch graph from the above dataset.

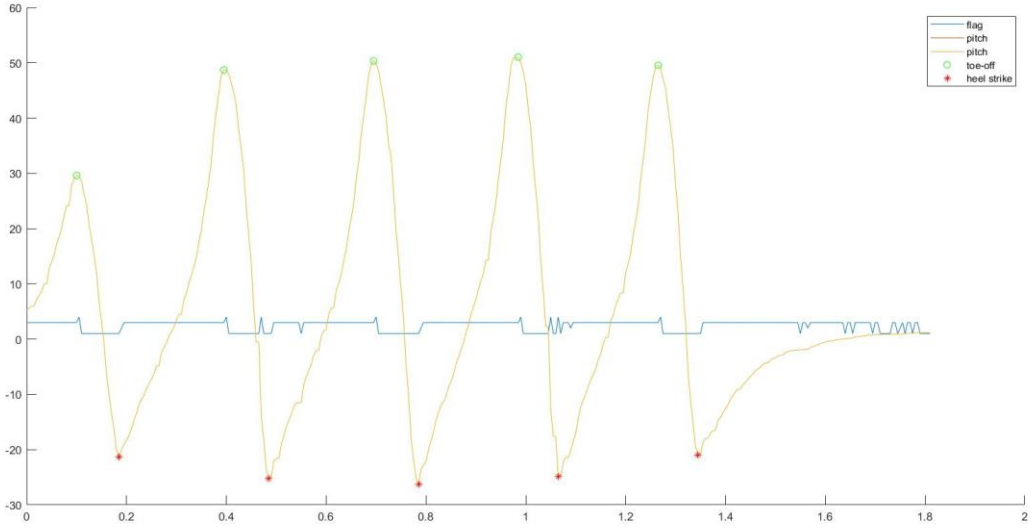
The above points were found using the results from this following paper. gait analysis using IMU

REALTIME PROCESSING ON ARDUINO

ALGORITHM





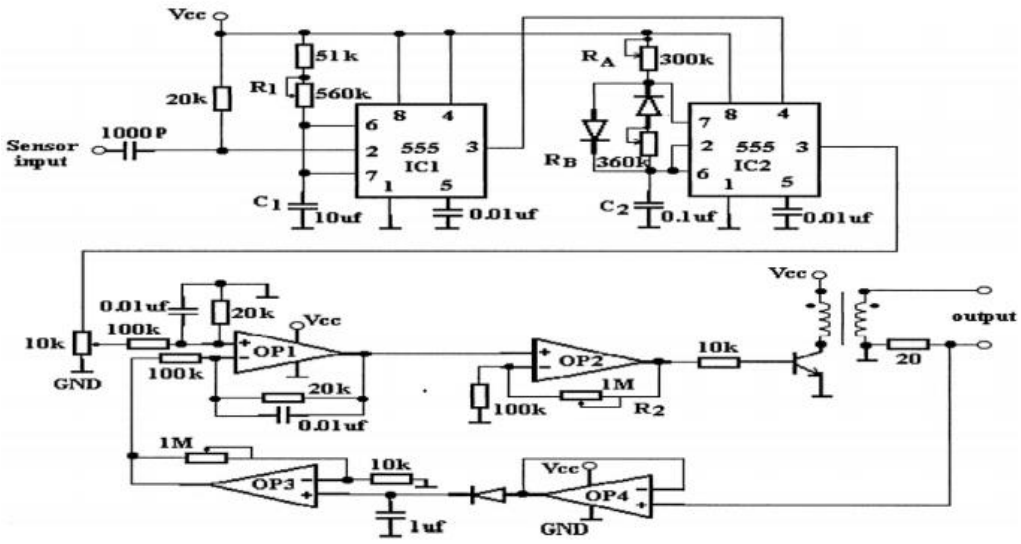


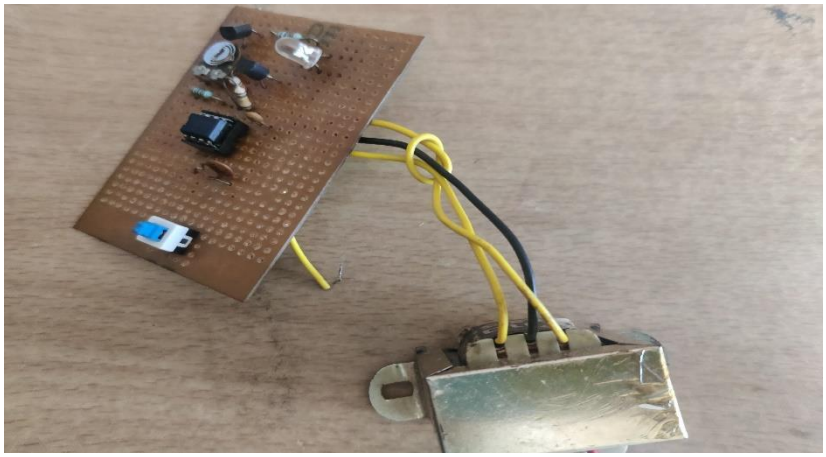
Observed data for the pitch_direction. [data]

[ARDUINO CODE] (SIMILAR MATAB PROCESS FROM ABOVE)

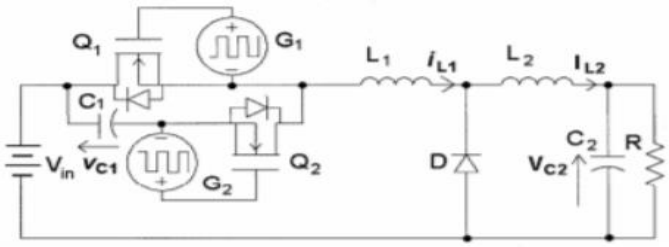
3. Stimulation

The generic use of circuit requires a step-up transformer which increases the load of the circuit mounted on the leg.





This uses a transformer but I try to improve upon this by using a lesser load circuit instead of the transformer and try to perform the same function



The device stimulates when flag conditions are fed into the sensor input for pitch_direction for the specific condition. Given below is the video link for the stimulation of femoral nerve.

electrical stimulation https://vimeo.com/490667523