Design Challenge

Challenge:

Figure 1 presents sensor data (3 axis accelerometer, 3 axis gyroscope) collected on the foot of a subject during flat-ground walking.

Two datasets are available here: http://tinyurl.com/dephyDatasets. In both cases, the subject was standing still, took 6 steps (right foot, the one instrumented, touched the ground 6 times), and stopped.

Figure 1: IMU values during flat-ground walking

Write an algorithm that will detect the beginning of a gait cycle (typically, we use the Heel Strike as the start of a cycle).

Bonus: identify gait phases (Heel Strike, Foot Flat, Mid-Stance, Heel-Off, Toe-Off, Mid-Swing).

Rules:

- The algorithm has to be written in C/C++
- The algorithm has to be running in real-time (I.e.: at t=1ms, you can't use data from t>1ms).
- Your classifier needs to detect the beginning of a gait cycle in the first 10% of the cycle's period (faster is better)

Deliverables:

1. Description of your approach
2. Source code (if possible, provide an executable too)
3. Visual representation of the results: plot with markers indicating gait cycle start points (and optionally, phases)
4. References used

Tips & Resources:

- See Figure 2 regarding the sensor's position and axis orientation.
- The heel strike is usually associated with an impact (foot hitting the ground)
- Some of the sensors might not provide useful data. You do not have to use all 6 sensors.
- The sensor we are using is an MPU-6500. It is programmed to have ranges of ±1000°/s and ±4g.
- Here are some links to get you started:
  - https://en.wikipedia.org/wiki/Bipedal_gait_cycle
  - http://www.physio-pedia.com/Gait
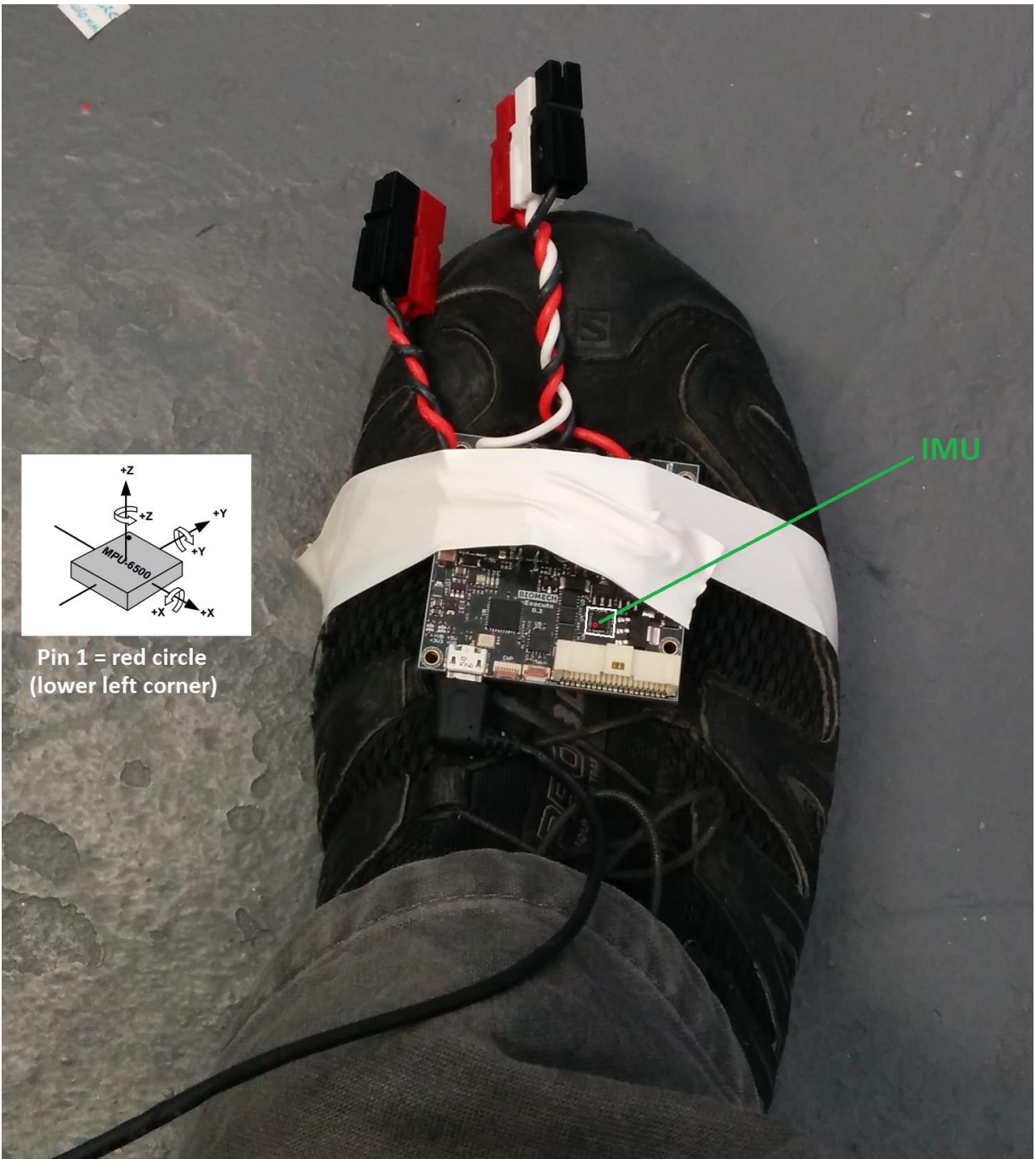 - https://www.invensense.com/products/motion-tracking/6-axis/mpu-6500/

Figure 2: Experimental setup, and IMU axis