GRN

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Global Rugby Network – Developing a system for Motion Sensor Classification

The aim of this project is to develop a system which classifies a select number of basic movements that occur during a rugby match or a training session. The long-term goal is not only to have a real-time system for classifying motions of a given player, but also to develop a tool that would enable coaches to evaluate a player's ability to perform at their peak. This could involve recovery time from an injury or actual performance in a game against potential performance. This project will showcase how useful data can be when trying to classify human motion.

Global Rugby Network (GRN) is borne out of a requirement for team and performance management software for rugby clubs at all levels. Through making this software accessible to any given rugby club, the goal is to support coaching staff in creating stronger, healthier and more successful individuals that can make the teams more competitive. This system is vital for improving the GRN software and hardware used by customers. It will be used during the rehabilitation of injured player and also for coaches to monitor and to control effort level expended by their players.

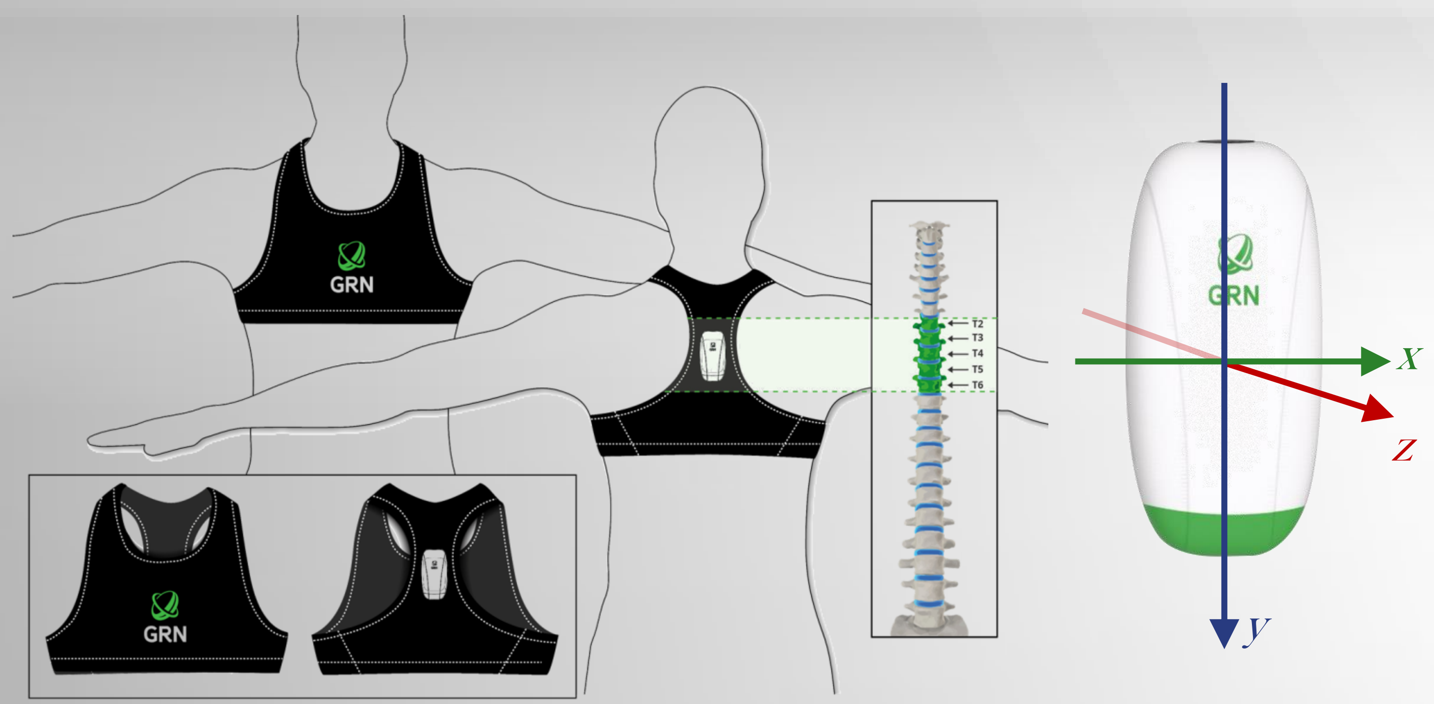
The data is captured through a Player Monitoring Device. A vest is worn to hold the device during a match or whilst training. The device is placed between the shoulder blades; specifically it will sit between the T2 to T6 vertebrae on the spine. This is illustrated in the diagram below.

A tri-axial accelerometer and gyroscope make up the Inertial Measurement Unit of the device. It measures in the x, y and z axes to provide an insight into the body's force and angular rate.

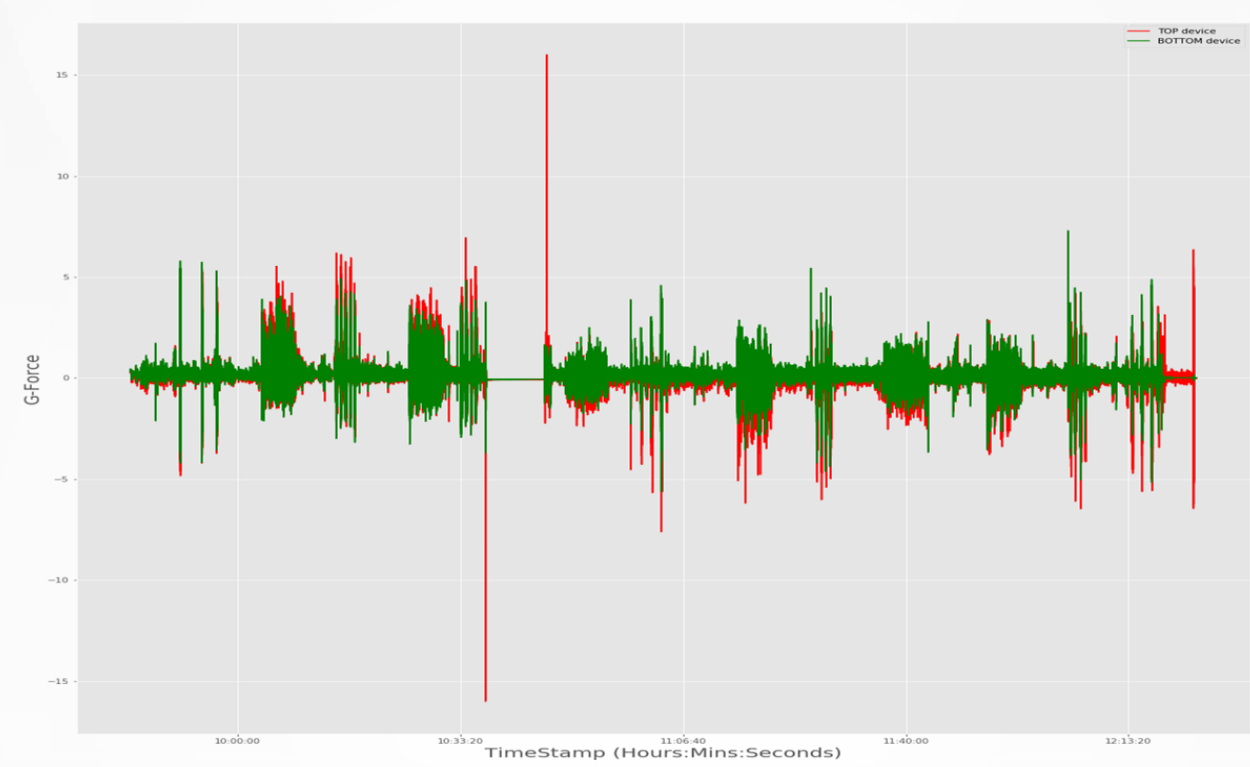
A GPS unit is used for Player tracking to provide an enhanced set of statistics about the players speed and movement throughout a match.

The motions to be classified are:

- Walking
- Jogging
- Cruising
- Sprinting
- Standing
- Horizontal Jump
- Vertical Jump
- Passing



Accelerometer_X Signals for top and bottom devices of a participant



Challenges

There was a lack of available data to use as training data due to how new the devices are. To overcome this, a routine of activities was created to gather and label some of the aforementioned movements. Participants wore two devices to investigate how the signals would vary depending on the positioning of the device. The average between the two files for each timestamp will be used as the value for that participant.

The appearance of the raw signal can vary greatly based on a number of different factors such as:

- Strength, endurance and fitness of an individual
- Variation of technique whilst performing an exercise
- The positioning of the device due to the fit of the vest
- Environmental factors such as temperature which can contribute greatly to exhaustion levels.

Step 1: Research

An extensive literature review on motion sensor classification and signal processing was carried out in order to decide upon the best techniques to use.

Step 2: Data Pre-Processing

Processing of data for training and machine learning purposes requires advanced signal processing to reduce the signal to noise ratio. First of all the signal was smoothed using a median filter.

Next, any remaining outliers had to be removed using a low pass Butterworth filter. After this the two files per participant were combined.

The accelerometer signal also had to be split into body and gravitational components; only the body was of interest so gravity was discarded.

Step 3: Development of prototype system:

An existing repository (Guillaume-Chevalier) has produced good results for human activity recognition, with an accuracy rate of 91%. This has been used to adapt code for GRN's data.

NEXT STEPS

- A Long Short-Term Memory Recurrent Neural Network will be used to classify these movements. An LSTM is well-suited to learn from experience to classify, process and predict time series - it will be developed using TensorFlow for Python.
- The output will show a confusion matrix to exhibit how well the network performs when trying to classify the GRN data.

python TensorFlow R