

Machine Learning Methods for online Gait Analysis:
Developement and Validation of a Smartphone Application.
Experimental Validation Procedure

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0.1 First trial

We wrapped the IMU on a shoe and went out in the proximity of the laboratory to test if there were problems of any kind. We saved the gyroscopic data locally (i.e. on the IMU) by setting an acquisition time of 400 s. We used Andrea's Smartphone with a metronome app to set a cadence. We walked for about 500 m and back for about 300 m, for a total of about 800 m. We tried to import the data on the IMU to the Smartphone, but then interrupted the procedure, because it was too slow. We imported the data from the IMU to a computer with the WIMU Interface software (written in Visual Basic). We had also acquired GPS data, which we transferred via *DorpBox*TM to Andrea's laptop. We needed a computer to download the WIMU and GPS data, so we installed the WIMU Interface software on a *Dell Latitude E6500* laptop. Since the bluetooth device was not working we used a Bluetooth USB key.

Bluetooth USB configuration Procedure

1. Activate physical radio button (WiFi and Bluetooth)
2. Insert Bluetooth USB key
3. go to Control Panel > Bluetooth Device
4. Follow instructions
5. Once connection is obtained, go to Control Panel > Devices > COM
6. change to COM 2

At this point we could see the IMU from the laptop

0.2 DAY 1

The WIMU was tied up to a running shoe using the laces of the shoe. We took two Smartphones, one with the app, the other for the metronome.

0.2.1 Settings

1. Set sensors:
 - (a) Gyro frequency = 100 Hz
 - (b) Acc Bandwidth = 20 HZ
 - (c) Acc Background = 8 g
2. Start IMU data logging on Smartphone 1 for time given in tables 1, 2
3. Start GPS data logging on Smartphone 1
4. Set metronome freq on Smartphone 2 with cadence given in tables 1, 2

Cadence	100 bps
Time	420 s

Table 1: First data acquisition parameters

Cadence	120 bps
Time	600 s

Table 2: Second data acquisition parameters

0.2.2 Acquisition Procedure

A few meters before the starting line the following was done:

1. start WIMU App on Smartphone 1
2. Sensor setup (20 Hz , 8 g , 20 Hz)
3. From Menu, associate WIMU bluetooth socket
4. Start
5. Start Oscilloscope mode and move IMU mounted foot to verify that the connection has been established, then go back
6. Start Save mode and set data logging time to one of the values [400 s , 450 s , 500 s], then go back
7. From Menu, choose Altro » GPS map
8. Wait for the GPS signal (beep sound)
9. From Menu, choose File > save
10. Start metronome at a frequency of the values [120 bps , 110 bps , 100 bps , 90 bps]
11. Start walking with cadence indicated by the metronome as naturally as possible
12. Every 100 m press on the WayPoint button

Before starting, the subject with the WIMU jumped to mark the gyro signal. Once set we walked around the running field on the innermost track for 400 m . One with the WIMU laced, the other holding the Smartphones.

Every 100 m a GPS way point was indicated to sub segment single subject data in 4 parts.

0.3 DAY 2

The software was changed to get the data logging start time (so that the subject did not have to jump to indicate the start of the experiment). The gyroscope frequency was set to 100 Hz by default. The WIMU was laced to a second subject, and 4 walking sessions were performed. Each time 4 files were saved:

1. Data logging time start: [size = 1]
2. GPS out: [size = 8×318] contains (longitude, latitude,,,) every 100 s
3. Way point: [size = 2×5] contains (longitude, latitude) every 100 m
4. WIMU out: [size = 9×40000] (named *place_SubjectCadence* eg. *Stadio_Andrea120*)

Cadence	120 bps
Time	400 s

Table 3: First data acquisition parameters

Cadence	110 bps
Time	400 s

Table 4: Second data acquisition parameters

0.4 DAY 3

The same procedure was followed on a third subject.

Cadence	100 <i>bps</i>
Time	500 <i>s</i>

Table 5: Third data acquisition parameters

Cadence	90 <i>bps</i>
Time	550 <i>s</i>

Table 6: Forth data acquisition parameters