Indoor Position Tracking for Smartphones as Head Mounted Displays

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MOTIVATION

- Position estimation is a constant need in Virtual Reality and localization applications. Most of times, the solution used is based in GPS systems, nevertheless, at indoor ambients the GPS will not work or will behave incorrectly

- Sensors like Accelerometers, Gyroscopes, Magnetometers and Vision sensors are very common in most smartphones and they can be used in indoor environments for position estimation

- When smartphones are used as Head Mounted Displays (HMDs) they get an advantage when comparing them when used as pocket or hand applications, because in HMDs applications you are able to use Vision sensors such as the camera

Plastic 3D printed HMD case (white) with a Nexus 5 phone (black) inside.

PROBLEMS

- Accelerometers provide discrete data and have stochastic error, so they are very sensible to the integration method used
- With accelerometers, double integration makes the error term grows quadratically in respect with time
- Ex.: 3 meters translation, graph origin from when device stopped moving.
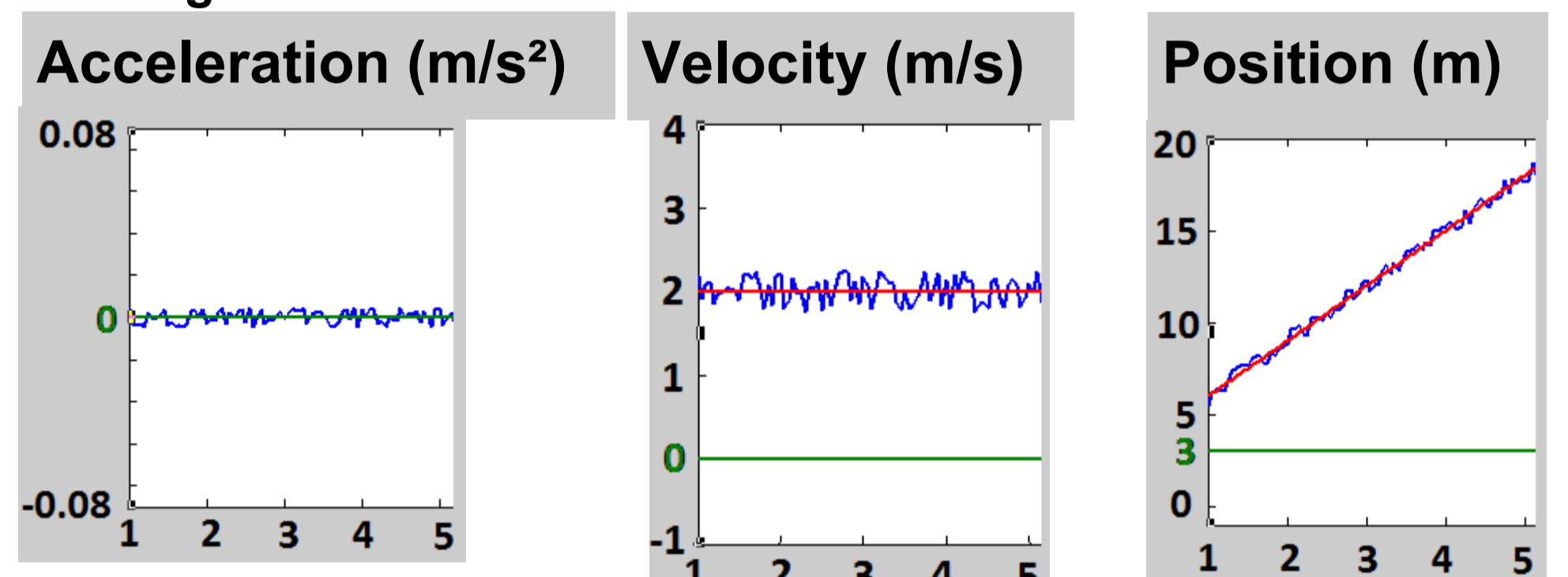
Acceleration (m/s²)	Velocity (m/s)	Position (m)
For acceleration **Green**: Real **Blue**: Measured	**For others** **Green**: Real **Blue**: Calculated	**X axis: Time (Seconds)**

There is a residual velocity caused by measurement precision error in acceleration, when velocity should be zero in this hypothetical situation, making the position diverges in respect with time.

- The lack of precision of accelerometers creates translation drift, and in gyroscopes, rotation drift
- Magnetic fields produced by electronic devices interfere on magnetometers readings.

SOLUTIONS

- Choosing the ideal integration method to minimize the error term

- Using the camera, with motion tracking algorithms, position and velocity can be inferred and it is possible to identify moments when the device is not moving, being able to reset velocity, so do the residual error term from acceleration integration

- Fusing correctly the different kinds of data from sensors gives the possibility to decrease errors and drifting problems

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