Where am I?

Improved Indoor Localization using Smartphone Sensors

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Goals

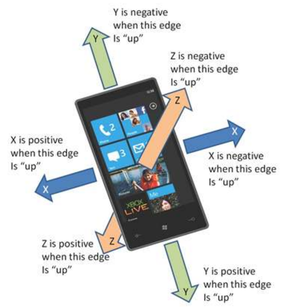
- Improve indoor localization and explore the sensors available in smartphones
- Detect steps by using an accelerometer, and detect direction of steps with gyroscope
- Use a network to communicate between smartphones and clients
- Display a user's location within a building in real time.

Issues with GPS

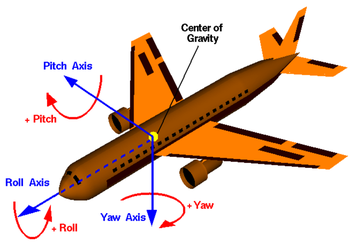
GPS is insufficient to determine a user's location indoors[1]. Location information determined using GPS is affected by satellite visibility, atmospheric conditions, buildings, and terrain. Poor or unreliable signal reception indoors can result from urban canyons and blocked and reflected signals. By using an accelerometer to detect steps and a gyroscope to determine direction, indoor localization can be improved.

Accelerometer

- Measures acceleration along three axes
- Readily available in modern smartphones
- Low signal to noise ratio
- Data must be filtered to be useful



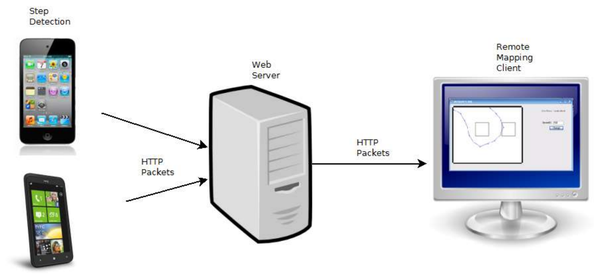
Gyroscope



- Measures the angular rotation of a device on the yaw, pitch, and roll
- Unlike the accelerometer, a gyroscope is not influenced by gravity
- High signal to noise ratio
- Used to obtain user's angular displacement

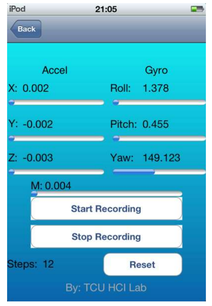
System Overview

1)Steps are detected on a smartphone application
2)The detected steps and associated direction are sent to a Python web service[2]
3)The web service stores the session and step information in a database
4)A client calculates a user's displacement from an initial location.[3] As the client receives steps, it maps the current location and path in real-time



Smartphone Apps

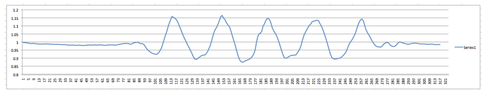
Applications were written for iOS 5[4] and Windows Phone 7 environments[5]. These apps collect data from the sensors on these devices in order to perform step detection. Each time the application detects a step, it will use the gyroscope to obtain the direction of the user's step. This detected step and the associated direction is then sent to a web service so that it may be consumed by a separate mapping application.



Step Detection

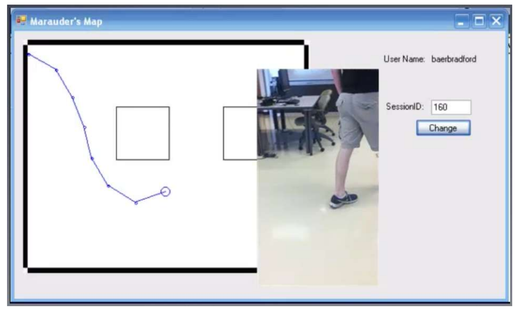
1)The application periodically gathers 3-axis accelerometer readings and calculates the acceleration magnitude
2)A low-pass filter is applied to the acceleration magnitude
3)Local maxima detected in the filtered magnitude data correlate to a user's footsteps[6]

The graph below shows filtered magnitude data from a user taking 5 steps.



Results and Conclusions

The final product is capable of accurately tracking a user's position inside TCU's upper division lab. However, there are still some issues. Errors in step detection (either a dropped or detecting an extra step) will cause a user's subsequent calculated location to be off from their actual location. This will form a cumulative error, since the calculated position depends on all previous steps. These types of problems with detection can occur if the user needs to open a door or suddenly stop walking to avoid a collision. Assuming an accurate and reliable step detection algorithm can be implemented, this method of indoor localization stands to be a feasible means to provide more precise location information for a user while he or she is indoors.



Future Applications

Some potential applications for improved indoor localization include greater care for those in assisted living and a better experience while shopping. In the case of assisted living, caregivers would be able to identify problem situations: falling in the shower or not getting out of bed. These benefits are received with little invasion of privacy, especially when compared to video monitoring. In addition to this, improved indoor localization stands to improve the experience of a shopper. Suppose you are a first-time visitor to a store searching for milk. You could fire up an application to direct you to your milk.

References

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