



PhonePoint Pen: Using Mobile Phones to Write in Air

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PhonePoint Pen

- **Application for mobile phones to recognize human writing through a built-in accelerometer.**
- **Goal**
 - **Ability to note down information quickly and ubiquitously**
- **Design, Implementation and Evaluation of a functional prototype.**



Use Cases

- **Sketching**
- **Mashing with Cameras**
- **One Handed Use**
- **Assistive Communication for Impaired Patients**



Existing Technologies

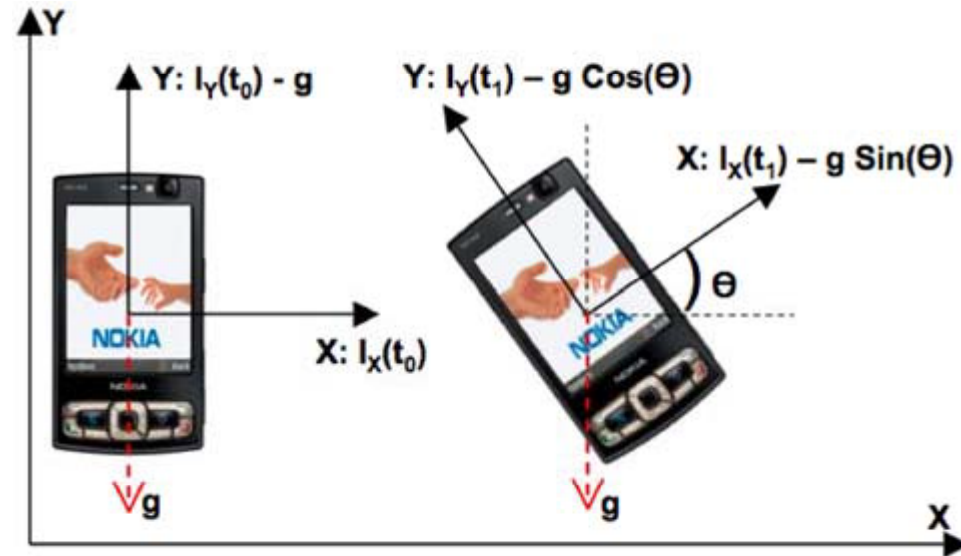
- **SMS**
- **Voice Recording**
- **Keyboards and Styluses**
 - **Multi-touch interfaces?**

Design

- **Challenges**
 - **Lack of gyroscopes**
 - **Background Vibrations**
 - **Computing Displacement of the phone**
 - **Absence of global reference frame**



Lack of Gyroscopes



- Cannot detect difference between rotation and linear movements.

Proposed Solutions

- **Use a non-rotating grip**
- **Use pauses between strokes to identify angular orientation**





Background Noise

- **Accelerometers are sensitive**
- **Sources**
 - Natural hand vibrations
 - Measurement errors in accelerometers
- **Proposed Solution**
 - Smooth noise by applying a moving average of the last n readings.



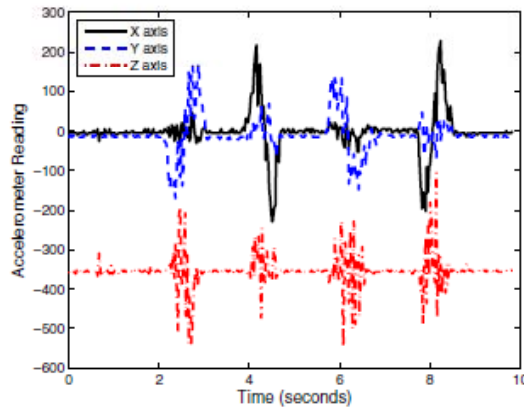
Computing Displacement

- **Calculated by double integrating instantaneous acceleration.**
- **Problem**
 - **Accelerometer errors produce residual constant velocities at rest.**
- **Solution**
 - **Use pauses to reset velocity to zero.**
 - **Pauses are detected using a moving window.**

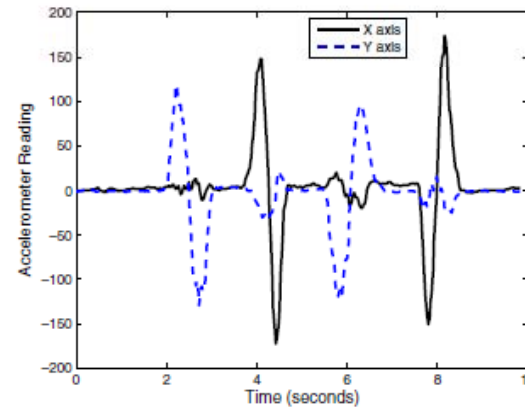


Accelerometer Readings

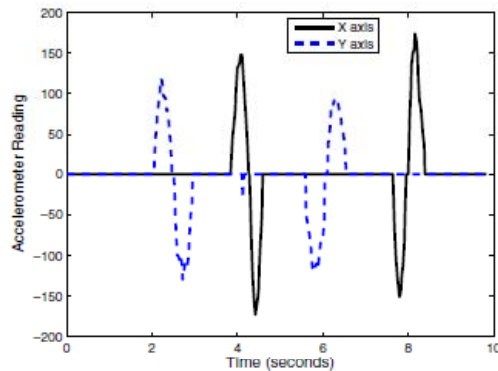
Raw Reading



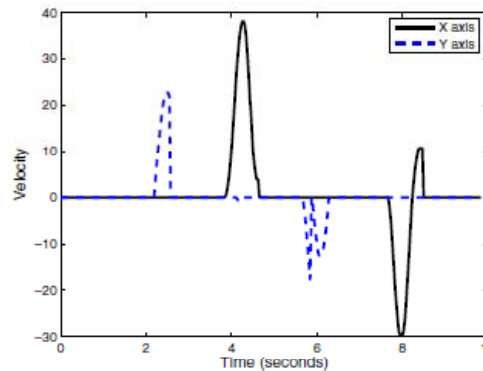
Noise Smoothing



Noise Smoothing and Suppression



Velocity Resetting



Final Output





Absence of Reference Frame

- **Defined global reference frame not present in air.**
- **Problem**
 - Distinguishing between “A” and “ Δ ”
- **Solution**
 - Use impulses generated on the Z axis to detect “lifting of the pen”



Implementation

- **Nokia N95 Mobile Phone**
 - **Software accessible 3-axes accelerometer.**
 - **Python script for obtaining readings**
- **Reading were processed using MATLAB scripts**



Evaluation

- **Only a qualitative evaluation is provided.**
- **Metric**
 - **Readability of characters.**
- **Energy Consumption**
 - **40 hours of continuous accelerometer readings can be sustained with a fully charged battery**



Future Work

- **Real Time Display**
- **Deleting in Air**
- **Character Recognition**
- **Background Movements**
- **Typing on Paper**



Interesting Links

- <http://www.youtube.com/watch?v=Nvu2hwMFkMs>
- <http://www.livescribe.com/en-us/>
- <http://www.unwiredview.com/2008/01/23/nokias-virtual-keyboard-idea/>

Questions?

