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

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

![Raw Reading Graph]

Noise Smoothing

![Noise Smoothing Graph]

Noise Smoothing and Suppression

![Noise Smoothing and Suppression Graph]

Velocity Resetting

![Velocity Resetting Graph]

Final Output

![Final Output Diagram]
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
Questions?