# *Tilt-Controlled Fisheye Views for Mobile Devices*


Hamilton Institute

**Parisa Eslambolchilar[1], Andrew Ramsay[2] , John Williamson[2], and Rod Murray-Smith[1&2]**

[1]Hamilton Institute, NUI Maynooth,
parisa.eslambolchilar@nuim.ie, www.hamilton.ie.
[2]Department of Computing Science, University of Glasgow,
ramsaya,jhw,rod@dcs.gla.ac.uk, www.dcs.gla.ac.uk.

**University of Glasgow**


### Overview

Navigation techniques such as scrolling (or panning) and zooming are essential components of mobile device applications such as map browsing and reading text documents, allowing the user access to a larger information space than can be viewed on the small screen. Focus in context methods such as fisheye views on mobile devices are a relatively new navigation technique and address the problem of information overload by distorting the view of visual data. The novelty of this application is it unifies rate-based scrolling and magnification to overcome the limitations of typical scrolling interfaces and to prevent extreme visual flow via tilt input sensor (Figure 1) which can then be comfortably controlled in a single-handed fashion without obscuring the screen [2]. Altering the lens parameters via 15 stylus gestures recognized by a two-layer perceptron neural network and predicting the incomplete words written in a proper place via probabilistic languge model are extra features added to the application.

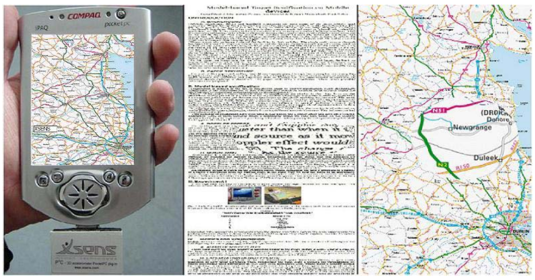

**Figure 1. (Left) Pocket PC and XSENS P3C-3D accelerometer attached to the serial port, (Middle) Fisheye lens in reading mode over a text document, (Right) Fisheye lens over a map in targeting mode.**

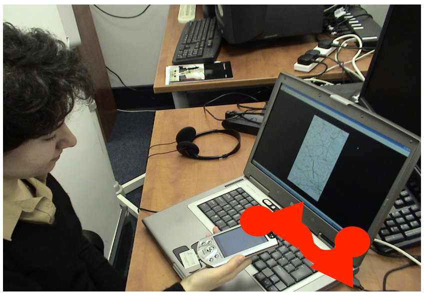

**Figure 2. A Pocket PC and desktop have been paired via Bluetooth connection. Pocket PC sends tilt input sensor data to desktop and desktop controls the rate of scroll and degree of magnification (DOM) of the lens over the map.**

### Dynamic Systems and Interaction

- In modern interaction techniques such as gesture recognition,visual, audio feedback,and so on the user is in continuous, constant, tightly coupled interaction with the computing system (Figure 3) . Interaction takes place over a period of time so it is dynamic.

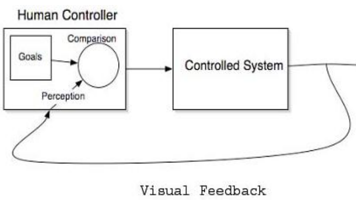


**Figure 3. Feedback helps the users to improve their errors with the controlled system with which they are interacting. This is the main aim in manual control.**

### Control mechanism for fisheye views

- Reading a document or map involves at least two forms of browsing; searching for specific pieces of information and reading all of the document or map information.
- We can imagine a metaphor, where the lens is a floating bulb on the surface of a liquid (Figure 4). So controlling DOM becoms matter of controlling the height of bulb on the surface of liquid.
- The position control mode helps the user to move the lens to the target without tilting the device, just by tapping on the touch screen over the target. So the lens moves to the target automatically.

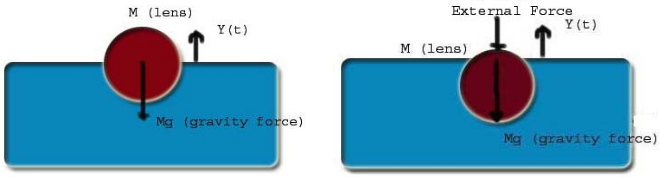


**Figure 4. (Left) The bulb representing the lens floats on the surface from left to right in the reading mode according to Archimedes law. The height of the centre of the sphere above the water line which represents the DOM is a function of time, y(t). (Right) In the searching mode DOM is decreased to a minimum level. The state of tilt inputs changes the control modes automatically in the system.**

### Gesture Recognition and Fisheye Views

- A two layer neural network was used to recognize 15 stylus gestures. These gestures help the user to change some properties of the lens, for instance the speed of the lens in automatic reading mode is changed with left-to-right or right-to-left gestures, DOM is increased or decreased with clockwise and anti-clockwise gestures respectively, and so on (Figure 5).

**Figure 5. Gestures used in altering lens paramers.**

### Language model, Information retrieval, and Fisheye Views

- A simple probabilistic language model [1] is used to infer user intention and produce probability (letter | prefix) (referred to as probability of the letter ) on a per-word basis. A tree with probability information is generated from a corpus.
- Another two layer perceptron NN with hyperbolic tangent activation function was used to recognize 27 characters (26 English letters and backspace) (Figure 6). After recordning the stylus path it is smoothed to few base point. Then these points are transformed to a vector of angles (0-360 degree) and their sine and cosine values are calculated. At last the transformation of a stylus path into a vector of cosines and sinuses is passed to the network's input.
- In each letter writing the language model finds the most probable word(s) in the document close to the set of letters have already been written. If the found word by the model is the word the user is looking for then he can highlight them by fisheye views in the document. Otherwise the user keeps entering letters to find the desired word (Figure 7). This provides a strong link between the probabilities and the display.

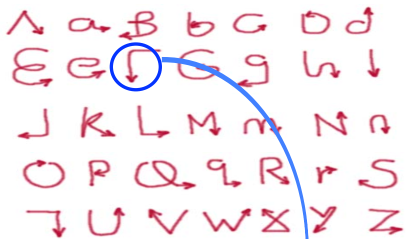

**Figure 6. 26 English letters and their direction of writing using stylus on the touch screen of PPC.**

Stylus path is a set of points (x,y values) in a 2D small screen (240*320). We can write cosine and sine of a point *i* as below:

$$cosines_i = p_i.y / \mathrm{sqrt}(p_i.x^2 + p_i.y^2)$$

$$sinuses_i = \mathrm{sqrt}(1 - cosines_i^2)$$

We get 25 sample points from the stylus path and calculate cosine and sine for each of them and pass them as a vector to the input layer of NN. It means number of neurons should be 50, 25 for cosines and 25 for sinuses.

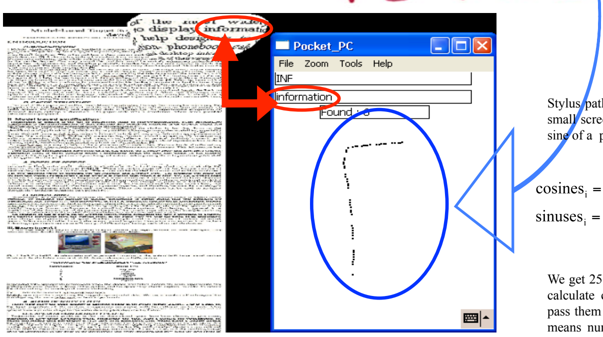


**Figure 7. (Right) On the Pocket Pc the letter recogniser recognizes the letters user writes using stylus. Then the language model puts the letters together and finds the most probable word(s) in the document. (Left) If the word found by the model is the word the user is looking for then he can highlight them by fisheye views in the document.In this example the user has written three first letters of word "*information*" and the language model has found the most probable whole word in the text and fisheye application has highlighted the first found word in the text.**


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