Smart Quill

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Handheld computers are being popular now a days and the present trend has started preferring small computers to do computation with the offering of very convenient and handy computation and other computing services. It made computer manufacturers and developers to go for almost gadget like computers. Reducing the size of handheld computers can only be taken so far before they become almost unusable means keyboards become so tiny you require needle-like fingers to operate them and screens that need constant cursor controls to read simple text. The introduction of Smart-Quill has solved some of these problems. Lyndsay Williams of Microsoft, UK is the inventor of Smart-Quill,a pen that can remember the words that is used to write, and then transform them into computer text. This pen is slightly larger than ordinary fountain pen, with a screen on the barrel. User can enter information through it into these applications by merely pushing a button thus Information can be entered using his/her own handwriting. User can use any platform for writing like paper, screenand tablet or even in air. There is also a small three-line screen to read the information stored in the pen. Users can also scroll down the screen by tilting the pen. The pen is then plugged in to an electronic docking station and text data is transmitted to a desktop computer, printer, modem or to a mobile telephones to send files electronically.

Index Terms – ADXL20, AAA, EEPROM

I. INTRODUCTION

Lyndsay Williams of Microsoft Research's Cambridge UK lab is the inventor of the Smart-quill technology, a pen that can remember the words that it is used to write, and then transform them into computer understandable text . The idea behind is that "it would be neat to put all of a handheld-PDA type computer in a pen," came to the inventor in her sleep. “It’s the pen for the new millennium,” she says. Encouraged by Nigel Ballard, a leading consultant to the mobile computer industry, Williams took her prototype device to the British Telecommunications Research Lab, where she was promptly hired and given money and institutional support for her project. The prototype, called Smart-Quill, has been developed by world-leading research laboratories run by BT (formerly British Telecom) at Martlesham, eastern England. It is claimed to be the biggest revolution in handwriting since the invention of the pen because of its usability. This sleek and stylish prototype pen is very much different from other electronic pens on the market today in that users don't have to write on a special pad in order to record and remember what they write. He can use any surface for writing such as paper, tablet, screen or even air. The Smart-Quill isn't all space-age, although -- it uses an ink cartridge to let users see what they write down on paper. Itcontain sensors that can record movement by using the earth's gravity system, irrespective of the platform used. The pen records the information inserted by the user. The real magic is that your words of wisdom can also be uploaded to your PC through the “digital inkwell”, while the files that you might want to view on the pen are downloaded to Smart-Quill as well. It is an interesting idea, and it even comes with one attribute that makes entire history of pens pale by comparison—if someone else picks yourSmartQuill and tries to write with it- it won’t. Because user can train the pen to recognize a particular handwriting. Hence SmartQuill recognizes only the owner’s handwriting. SmartQuill is a computer housed within a pen which allows you to do what a normal personal organizer does .It’s really mobile because of it’s smaller size and one handed use. People can use this pen in the office to replace a keyboard, but the main attraction will be for users who usually take notes by hand on the road and then type them up when returning to the office. Smart-Quill will let them skip the step of typing up their notes.

II. DESCRIPTION

2.1 Working of Smartquill

It is slightly larger than any other ordinary fountain pen. Users can simply enter their information into these applications by pushing a button on the pen and writing down on paper, tablet, and screen or even on air,what they would like to enter.The Smart-Quill does not even depend on a screen to work. The really clever bit of the technology is its ability to read handwriting not only on paper but also on any flat surface – horizontal or vertical. There is also a small three-line screen to read the information stored in the pen; users can scroll down the screen by titling the pen slightly. The user trains the pen to recognize a particular handwriting style – no matterhow messy it is, as long as it is consistent, the pen can recognize it. The handwritten notes are stored on memory of this pen. The pen is then plugged into an electronic "inkwell", and text data is than transmitted to a desktop computer, printer, or modem or to a mobile telephone to send files electronically. Up to 10 pages of notes can be stored locally on this pen. A tiny light at the tip allows writing even in the dark. The beauty is when the pen is kept idle for some time, power gets automatically off.

2.2 TECHNICAL SPECIFICATION

A. FEATURES

Display technology used in Smart-Quill handwriting recognition and signature verification, display scrolls using tilt sensors, communication with other devices memory and power.

B. DISPLAY TECHNOLOGY

The technology used in Smart-Quill for display is Kopin Corp’s Cyber Display technology. Cyber Display is a ¼ inch

diagonal LCD that uses circuitry which is built on a silicon wafer, then removed and mounted to glass. The displays are integrated to miniature monitors using its own backlighting, optics, ICS and packaging.

C. *HANDWRITING RECOGNITION AND SIGNATURE VERIFICATION*

- Accelerometer measures hand movement in 2 or 3 planes,on board DSP converts to ASCII characters for pen applications towrite on paper, flat surface, vertical wall or in airSingle character recognition on pen to record cursive letters and download to a PC for decodingthe passwords by signature recognition. Smart-Quill works by measuring the pen's movements and matching them to the movements that produce letters and words programmed into its memory. It's similar to the way a microphone detects sound. Consistency of handwriting, rather than neatness, is the only condition for accuracy.

There are 2 techniques used for this purpose :-

1. Accelerometer technology
2. Handwriting recognition software

ACCELEROMETER TECHNOLOGY

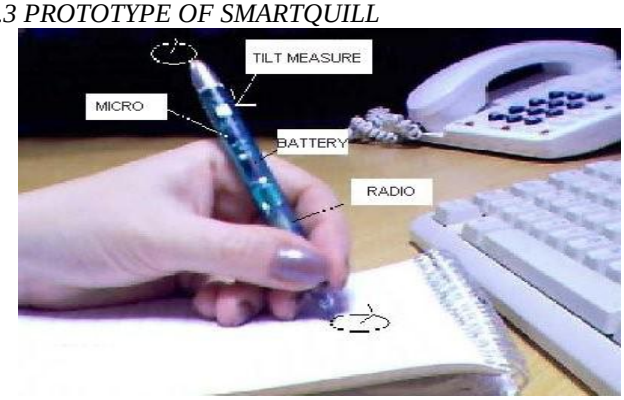
This technology uses a device which is called Accelerometer which is used for measuring motion. A tiny accelerometer in a pen could be used to detect the stops and starts, arcs and loops of handwriting, and then it transmits this information to a small microprocessor that would make sense of it as a text. There's also the possibility of viewing a full page of text through a special monocular magnified "virtual" screen that could be built into the end of the pen. Invisible writing in air is achieved through this unique technology called accelerometer that monitors hand movements and can also be used as a ‘virtual hinge’ to scroll around the small screen on the pen and detect left or right-handed use. It records movement by using the earth's gravity system, whether you write on paper or in the air. Hence it is independent of whatever the surface is used. Movements are stored within the Smart-Quill. This information is then transmitted on to a small microprocessor that would make sense of it as a text displayed on the sleek built in screen.

There are 2 types of accelerometer :-

1.Two Axes Accelerometer :- This accelerometer measures acceleration in two axes. An example for Two Axes Accelerometer is ADXL20 Accelerometer.

2.Three Axes Accelerator :- This accelerometer measures acceleration in three axes. An example for Three Axes Accelerometer is Tronics +/- 2G accelerometer.

2.3 PROTOTYPE OF SMARTQUILL



This Smart-Quill prototype records writing on paper for radio transmission to a pocket pc, desktop, cell phone or tablet computer. The accelerometer tracks the angular movement of the top of the pen at an angle in the air and these angles plotted as x/y position on pc screen.An early hardware prototype picture shows, left to right, tilt sensor , PIC 8 bit microcontroller, batteries, and 433Mhz 1200 Baud radio transmitter. Currently a radio receiver on the RS232 port of a pc records the pen movement for analysis via pc. The pen will power down after a period of no movement so doesn't need an on/off switch. The battery life is approximately 22 hours.

III. HANDWRITING RECOGNITION SOFTWARE

This software embedded in the microprocessor of the pen is used to recognize handwriting of the user who is going to use it for some time. Pen works in conjunction with a regular PC on to which a user installs special handwriting recognition software. The handwriting recognition software translates movements in to the text on screen.

Handwriting recognition software constitutes two major phases:

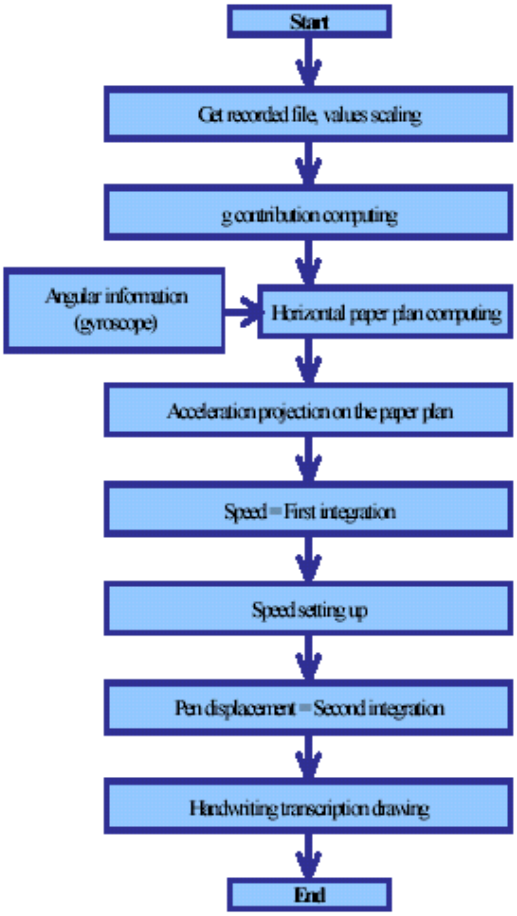
1. Handwriting transcription
2. Handwriting recognition

Handwriting transcription

The recorded acceleration signals are then transcript to its original form. Here this aspect is solved using ‘simple’ double integration method in order to retrace the pen’s tip movement on a paper.

Method
In order for this principle to work properly, we have to solve two main problems:

First, we have to know pen's spatial orientation in order to withdraw the earth gravity component to the measured accelerations.
Second, we have to succeed in the double integration, which is to solve all the derivation problems due to this method. The algorithm which is used for handwriting transcription is the following:



We can see two pictures:

Fig (1) represents the acceleration signals recorded while one is writing a small capital B

Fig (2) is the transcription result obtained with algorithm presented.

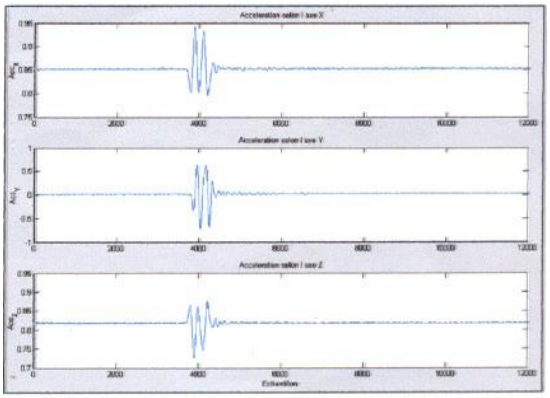


Figure: 1

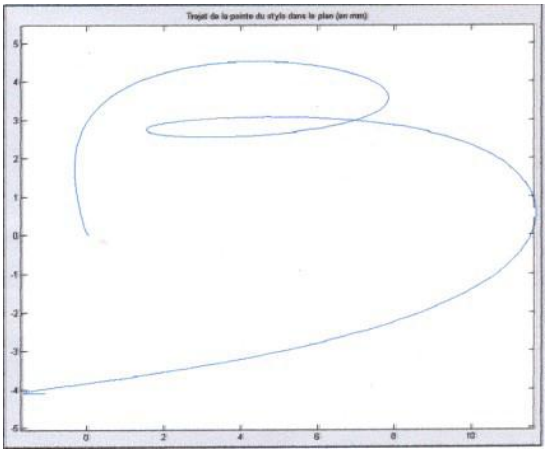


Figure:2

HANDWRITING RECOGNITION
The second huge aspect is the characters and signatures recognition. The hardware (accelerometers plus contact detector) embedded in the pen has proved a really efficient combination for this application.

METHOD
The same method is used to recognize the characters written by a single user and to find whose signature is the one that has just been done. We use a simple Euclidian distance as the comparison process, and of course the decision process is the smaller distance found. The first step -1- consists in creating the reference database for the characters as for the signatures. For this a mean signal is computed for each recorded symbol. The second step is the recognition process

1. For the creation of database, each symbol was reproduced several times and a mean normalized symbol was computed.

2. For recognition process, the unknown symbol is first normalized, the distance between this symbol and the entire database symbol is computed. Then the unknown symbol is recognized as the one with the lowest distance.

PROTOCOL
The results shown in this part are for signature recognition but they are very similar as the one obtained for the character

recognition .The corpus used for signatures was made by 10 different signatures from 10 different people. They made 10 attempts for the database, and 5 others for the test base. In Fig 1, we can see the accelerometers signals having been recorded during Yani's signing process. Fig 2 shows the distances that are computed between the unknown signature and the one's in the database. Yani's signature was the last one learnt(number 10)and we clearly see in Fig 9 that his signature was very well recognized.

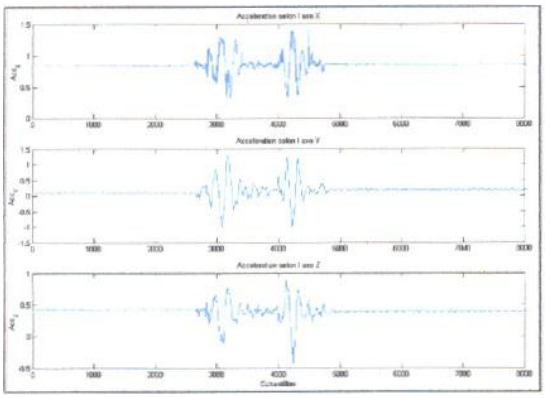


Fig (1)

In Figure 3, the X-axis represents the different symbols of the database, and the Y-axis is the distance from the unknown new symbol to the one's from the database.

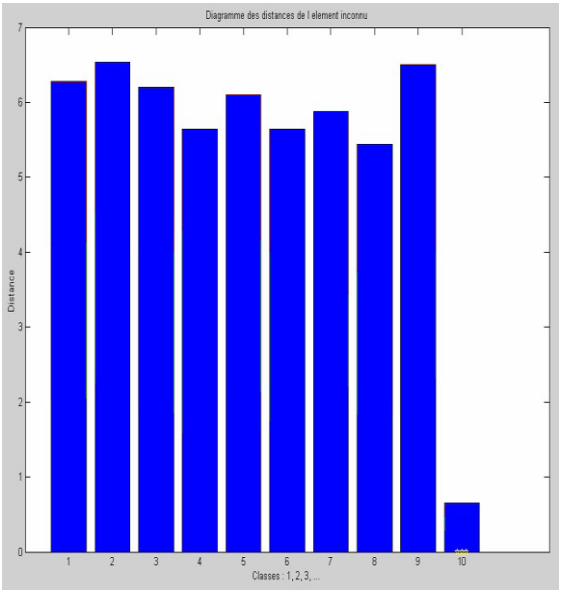
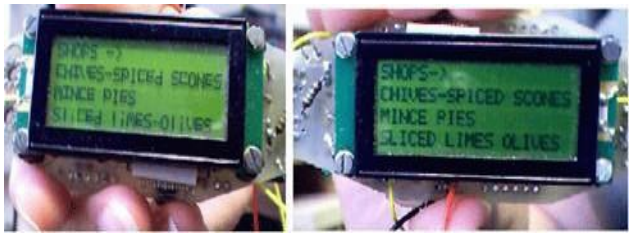


Figure: 3

IV. DISPLAY SCROLLS BY TILTING SCREEN

By tilting the pen, user can choose applications and scroll through them without using the scroll buttons**.** Below is an image of Smart-Quill tilting Screen designed by Lyndsay Williams for BT Labs in 1997. The pen would align text if it was held in left or right hand so the text was the correct way up for left or right handed people. This was done by using Micro Electromechanical Systems (MEMS) tilt sensors to measure tilt angle to earth. The Smart-Quill microcontroller gets the angle and then mapped the large screen display onto the small 4 line display. Smart-Quill could also scroll through pages of display by tilting it in the hand and power off if no hand movement was detected or pen was flat on a desk. The demonstration unit given below shows display inverting as Smart-Quill was inverted in the hand. The choice of words was limited to what characters the LCD display driver could beshown while upside down (left hand picture) – only 14 of the 26 letters of the alphabet were usable. These 14 characters were then processed by anagram software to produce 900 words that used these characters. The shopping list below was produced from this limited dictionary to demonstrate the text inversion



V. COMMUNICATION WITH OTHER DEVICES

In early age Smart-Quill models developed by BT laboratories communicated with the PC via a radio transmitter, but now the current prototype hooks up to a PC via a cable and electronic docking station called an "inkwell." .The data stored in the memory part is uploaded to the personal computer when it is placed in to a docking station. An electronic docking station is a small cabinet to which a laptop or notebook computer can be attached for use as a desktop computer; usually have a connector for externally connected devices, such as hard drives or scanners and ports that can be linked to components such as keyboard, monitor and printer. It can also be connected to printer, modem or mobile phones to send data electronically. The signals given by the output accelerometer from the pen are digitized with a National Instrument capture card with a frequency Fe of 1000Hz and a low pass filter at Fc=1/3*Fe .

Future models could receive e-mails and pager messages via a wireless messaging system .This enables two-way wireless communication with other computing devices.

VI. MEMORY

Initially Smart-Quill has 4MB EEPROM memory. At a time, up to 10 pages of notes can be stored locally on this pen. The data is stored in the memory on the pen until it is uploaded to the personal computer. Smart-Quill works by measuring the pen's movements and matching them to the movements that produce letters and words programmed into its memory. It's similar to the way a microphone detects sound input given to it.

VII. POWER

Smart-Quill is powered by AAA battery. It will run for about 25hrs on a single AAA battery. The pen exhibits automatic power on/off system. The pen will power down after a period of no movement. So it supports automatic on/off system.

VIII. APPLICATIONS

1. Smart-Quill isn't all space-age. It contains an ink cartridge so that users can see what they write on paper .Hence a simple application of Smart-Quill is that it writes notes on paper. This information recorded in the pen is then downloaded to PC.
2. The information stored in this pen can be input to other devices such as mobile phones, printers, modems, desktop computers etc for different applications.
3. It also provides handheld computer applications such as digital diary, contacts, calculators etc.
4. It is used for receiving pager and e-mail messages. This is possible through recent technology involved in Smart-Quill, the wireless messaging system which allows two way communications between devices.
5. Smart-Quill synchronizes files, e-mails and messages to PC.
6. Smart-Quill can be used for voice record and supports speech recognition. Voice record is made possible through ADPCM speech compression.
7. Smart-Quill also allows third party to add on applications.

IX. ASSETS

1. One of the major assets is that Smart-Quill does not need a screen to work. This is possible through revolutionary "Spatial Sensing" system which uses semiconductor accelerometers. Accelerometers senses pen/hand movement instead of shapes.
2. Smart-Quill provides intuitive user interface.
3. Security – Security is another important feature. It is made possible through two facilities:

a. It enables handwriting recognition .User can train the pen to recognize a particular handwriting style. The symbols regularly used by user get stored in the memory, by frequent use of the pen. Hence the pen accepts only the owner's handwriting and rejects intruder's handwriting.

b. It enables signature verification. Hence Passwords could be entered in the form of signatures.

4. The Smart-Quill is also a 3D-mouse, when twisted in air in a certain way it enables scrolling of the screen. It also automatically detects left or right handed use.
5. Power saving

a. Small screen size requires less battery power.

b. No movement of the pen causes auto power down

6. Smart-Quill is all mobile, smaller in size and enables one-handed use.

X. CONCLUSION

Smart-Quill will be brought to the market by the end of 2004.The estimated cost of this futuristic pen is around $200.SmartQuill supports two factors: small size an convenient use. The future of Smart-Quill ensures all computation power the user needs right inside the pen. Reducing the size of handheld computers can only be taken so far before they become unusable. Keyboards become so tiny you require needle-like fingers to operate them and screen that need constant cursor controls to read simple text. The introduction of Smart-Quill is the best solution for this problem.

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