(12) UK Patent Application (19) GB (11) 2476822 (13) A

(43) Date of A Publication 13.07.2011

(21) Application No: 1000356.4

(22) Date of Filing: 11.01.2010

(71) Applicant(s):
Paul Michael Dunphy
Culture Lab, Newcastle University, NEWCASTLE UPON-TYNE, Tyne and Wear, NE1 7RU, United Kingdom

David Kim
Culture Lab, Newcastle University, Kings Walk, NEWCASTLE UPON-TYNE, NE1 7RU, United Kingdom

James Nicholson
Pact Lab, School of Psychology and Sports Science, NEWCASTEL UPON-TYNE, NE1 8ST, United Kingdom

John Nicholson
School of Computing Science, Newcastle University, Claremont Tower, NEWCASTLE UPON-TYNE, Tyne and Wear, NE1 7RU, United Kingdom

Jonathan Hook
Culture Lab, Newcastle University, NEWCASTLE UPON-TYNE, NE1 7RU, United Kingdom

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(51) INT CL:
G07C 9/00 (2006.01) ***G06F 3/048*** (2006.01)
G06F 21/00 (2006.01) ***G07F 7/10*** (2006.01)

(56) Documents Cited:
GB 2456048 A **US 5276314 A**
US 20090006941 A1 **US 20080092245 A1**

(58) Field of Search:
INT CL **G06F, G06Q, G07C, G07F**
Other: **WPI, EPODOC, TXTE, NPL, XPESP, INSPEC, TDB, XPRD, XPI3E, XPIPCOM, XPIEE, Internet**

(54) Title of the Invention: **Authentication by multi-level pressure exertion on multi-touch tabletop interfaces**
Abstract Title: **Observation-resistant authentication method using finger pressure determination**

(57) Observation-resistant authentication methods are likely to become increasingly important, as situated computing technologies such as tabletop interfaces and public displays become habitual. The method includes the user placing the fingers of both hands on a multi-touch surface substantially perpendicularly to each other. A grid is defined by the fingers, the grid containing a number of cells each containing an object. The method further includes the user communicating the coordinate of an object (x,y) by increasing pressure on fingers (x,y) on the edge of the grid. The multi-touch surface records this increased pressure and maps the coordinates to the object in the grid. This is repeated until the user has identified all objects in their authentication sequence and access can then be allowed or denied. The location of the objects in the grid can be varied after each input. Not all five fingers on each hand may be used. The authentication method is particularly resistant to shoulder-surfing.

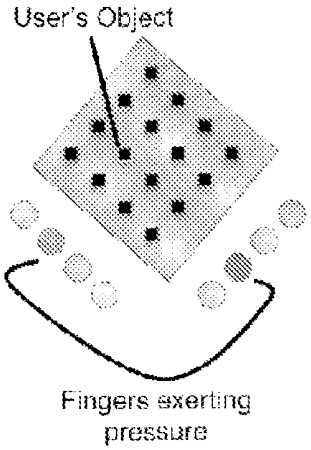

Figure 1

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GB 2476822 A continuation

(71) cont
Pamela Briggs
Pact Lab, School of Psychology and Sports Science, Northumbria University, NEWCASTLE UPON-TYNE, NE1 8ST, United Kingdom

Patrick Olivier
Culture Lab, Newcastle University, NEWCASTLE UPON-TYNE, NE1 7RU, United Kingdom

(72) Inventor(s):
Paul Michael Dunphy
David Kim
James Nicholson
John Nicholson
Jonathan Hook
Pamela Briggs
Patrick Olivier

(74) Agent and/or Address for Service:
Paul Michael Dunphy
Culture Lab, Newcastle University, NEWCASTLE UPON-TYNE, Tyne and Wear, NE1 7RU, United Kingdom

Invention Record Form

1. Title:

Authentication by Multi-Level Pressure Exertion on Multi-touch Interfaces

3. Description

3.1. Background

Knowledge-based authentication systems have an innate vulnerability to being compromised at the point of login using simple observation techniques (or *shoulder surfing*). An attacker can then used information gained to launch a *replay attack* where the observed credentials are re-used at a later time. As pervasive technologies become more widely accepted and deployed, there is a pressing need to explore authentication procedures that are resistant to the observation they are likely to incur.

One PIN entry mechanism designed to be resistant to shoulder surfing is the *cognitive trapdoor game* by Roth et al (2004) where the PIN is not explicitly exposed, but knowledge of the PIN is crucial to completion. One drawback is that PIN entry times are increased by ten times over a control group not using the enhancement. Tan et al (2005) proposed a Spy-Resistant Keyboard, although much like Cognitive Trapdoor Game system, it took a long time to authenticate.

Graphical Passwords (Suo et. al 2005) are increasingly proposed as usable knowledge-based authentication mechanisms. These are based on a strong conceptual basis that humans have more effective memory for images than words an numbers. Tari et al., 2006 discovered that non-dictionary alphanumeric passwords were more observable than graphical Passfaces graphical passwords. Wiedenbeck et al (2006) propose the Convex Hull Click scheme where users identify a number of their objects in a larger set of objects (in this case icons) and are required to click within the convex hull formed by the positioning of the objects on screen. This system has the benefit that users do not directly click on their objects, therefore making it difficult to observe. A similar system using text instead of icons was proposed by Zhao and Li (2007) with the exception that the user is required to type a character that is inside the area instead of clicking.

Malek et. al describe a pen pressure-based solution that is based on the draw a secret (Jermyn et. al. 1999). Here the user makes a drawing on a tablet computer and pen pressure at various points of the drawing is encoded as an extra degree of complexity. The difference with our invention is that ours is multi-purpose, we exploit multi-touch technology which is a key design feature, and don't require additional hardware of the user.

Finally, gaze-based password entry has been explored by Kumar et al (2007) using eye-tracking. Although results were positive, eye tracking is still not feasible in real installations due to the high cost of hardware.

3.2. Detailed Description

We believe the invention could be deployed on public displays, tabletop interfaces or any other context that makes use of multi-touch interaction. The invention is also multi-purpose which means it is not restricted to work with one particular knowledge-based authentication scheme. This makes it applicable to graphical passwords (Suo et. al. 2005), PINs, alphanumeric passwords, or even a mixture.

A priori the user must enrol in an authentication scheme that harnesses the pressure-grid. In this process the user is assigned authentication credentials and is given time to remember them or record them in a secure manner. The invention is used in the authentication phase, where the user must demonstrate knowledge of their assigned credentials. Firstly for calibration the user is required to initially place fingers on the interface. Then, relative to the finger positions an N*x*N grid is displayed. The grid is already populated with objects, of which the user is challenged to select any components of their original password sequence that appear in the grid. Objects in the grid are referenced by an (x,y) coordinate system, and one hand of the user is assigned *x*, and the other *y*. Each finger on the hands are assigned x=1, x=2...x=5, or y=1, y=2...y=5. In order to select an object the user is required to exert additional pressure on one finger per hand to communicate an (x,y) coordinate that identifies their chosen object. (**see Figure 1**). The user will only be authenticated if they correctly select all their objects. If a user fails one or more grids, they will not be authenticated and they will have the opportunity to try again.

Figure 1: The grid of objects (grey), green dots indicate fingers resting upon the surface. To select the object in the grid highlighted yellow; pressure is increased on one finger per hand (orange), the intersection of this in the grid communicates the object.

The system is effective as users do not directly touch the desired object, thus not revealing it to any observers. The attacker is required to simultaneously determine which finger on each hand is exerting pressure, and the object to which the pressure maps. Also the solution allows fast entry of authentication credentials, in our own evaluation we have seen PIN entry and Passfaces graphical password entry affected by only a few seconds.

3.3. References

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4. Claims

1. An authentication entry method on multi-touch interfaces that involves the user placing fingers of both hands on a multi-touch interface; an NxN grid of objects is displayed relative to the hands, the dimensions determined by the size of the hands; within the grid, each cell contains objects and are each assigned an (x,y) coordinate; fingers of the user are also assigned x or y coordinates; with the user making selections by exerting additional pressure upon the fingers that communicate the desired (x,y) coordinate; the system then translates the finger pressure into selection of object (x,y). The objects in the grid can then either be changed everytime the user makes a selection, or kept static. This is repeated until the user has entered their entire authentication sequence and the system gives feedback as to whether the user has entered the correct sequence. If incorrect the user is able to try again.
2. As in claim 1. Where coordinates are assigned to fingers through the use of pressure zones that are used make easier the translation between finger pressure and an object. Pressure within the zone is used to associate pressure with a finger.
3. As in claim 1 Where pressure thresholds are calculated for each finger individually depending on perceived dexterity or strength, in order to determine "additional pressure".
4. As in claim 1 where the user is expected to select multiple objects in the same grid.
5. As in claim 1 where no on-screen feedback is given as to each object selected.
6. As in claim 1 where the positions of objects in the grid are randomized at each new authentication attempt.
7. As in claim 1 where less than 5 fingers per hand are used in the interaction.
8. As in claim 1 where objects can be symbols, images, numbers, alphabetic characters, colors, or any object representation that can be formatted into the grid.

Amendments to the Claims have been filed as follows

CLAIMS

1. A dynamically calibrated and positioned input method for user authentication on a multi-touch interface comprising:

the user placing the fingers of both hands upon the interface approximately one hand-width apart;

whereby a grid consisting of cells that each contain an object is dynamically sized to reflect dimensions of the hand and the spacing of fingers is positioned relative to the hands, and extended to form selection zones around the fingers of each hand;

enabling the user to discreetly select an object within the grid by increasing pressure upon one finger per hand that can be interpreted as selection of one row and one column.

2. An authentication entry method on a multi-touch device as defined in claim 1 where hands are further spaced apart, or closer together.
3. An authentication entry method on a multi-touch device as defined in claim 1 where fewer than 5 fingers per hand are used in the interaction.
4. An authentication entry method on a multi-touch device as defined in claim 1 where one dimension of a Cartesian 2D coordinate is assigned to each hand, and particular values within that dimension to each finger.
5. An authentication entry method on a multi-touch device as defined in claim 1 where pressure capabilities are recorded for individual fingers to inform calculation of a threshold for detection of selections by each finger.
6. An authentication entry method on a multi-touch device as defined in claim 1 where no on-screen feedback is given as to which object was selected.
7. An authentication entry method on a multi-touch device as defined in claim 1 where objects within the grid can be symbols, images, numbers, alphabetic characters, colors, or any representation that can be formatted into the grid.
8. An authentication entry method on a multi-touch device as defined in claim 1 where the user is able to select a sequence of objects.
9. An authentication entry method on a multi-touch device as defined in claim 1 where the selection zones are not explicitly displayed.

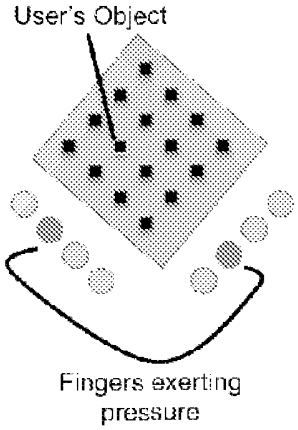

Figure 1

Application No:	GB1000356.4	**Examiner:**	Andrew Hole
Claims searched:	1-8	**Date of search:**	30 September 2010

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	US 5276314 A (MARTINO et al.) Please see abstract.
A	-	US 2009/0006941 A1 (FUNAI) Please see abstract.
A	-	US 2008/0092245 A1 (ALWARD et al.) Please see abstract.
A	-	GB 2456048 A (DUKE) Please see abstract.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

G06F; G06Q; G07C; G07F

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, TXTE, NPL, XPESP, INSPEC, TDB, XPRD, XPI3E, XPIPCOM, XPIEE, Internet

International Classification:

Subclass	Subgroup	Valid From
G07C	0009/00	01/01/2006
G06F	0003/048	01/01/2006
G06F	0021/00	01/01/2006
G07F	0007/10	01/01/2006