Police Analyst Workstation: Towards A Multi-Surface User Interface

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Abstract
Developing applications for multi-surface user interfaces is challenging. Sharing and transferring information between these surfaces requires the need for multi-modal interaction methods. In this paper we describe the Police Analyst workstation for supporting multi-surface interaction for criminal intelligence analysis with sense making using multi-touch and mid-air hand gestures for input. We outline our requirements, design, and an initial implementation.

Author Keywords
Criminal Intelligence, Interactive Surfaces, Multi-Touch Gestures, Mid-air Hand Gestures, Visual Analytics.

ACM Classification Keywords
H.5.2 [User Intefaces)]: Interaction styles

Introduction
The VALCRI project is a large European Union Framework Programme (FP7) project that aims to support visual analytics for sense making in criminal intelligence analysis. One of the goals of the project is to design and build novel interfaces that support analysts with sense making using multi-touch and mid-air hand gestures for input. This involves building an interface for police analysts to explore information across multiple surfaces and to collaborate with other analysts.

Early work by Pierre Wellner produced a novel workstation to support general purpose work with the Digital Desk which was a tabletop computer [2], but does not cater for 3D mid-air hand gestures nor specifically analyst work. IBM's i2[1] is a desktop analyst tool that caters for many analyst tasks but does not provide any novel interaction techniques or use of large displays. Guenther et al. [1] propose using multi-touch interfaces to support cyber security analysis but do not describe the physical configuration of their system. In this paper we give a preliminary overview of the *Police Analyst Workstation* we are developing that utilizes large displays, multi-touch interaction, and 3D mid-air hand gestures.

Requirements Analysis

We conducted some requirements from our end-user police analysts. The various concepts were based on a number of requirements, user expectations, and interviews and discussions. The collection of this data was significant for the design of the analyst workstation.

Collaboration. At the beginning, intelligence analysts work independently when carrying out their tasks. Afterwards, they start discussing their initial ideas, or their possible explanations for the facts present in a case or encountered during the analysis. During such discussions, they analyze various alternatives and banter or debate with each other to discover if there are weak links in the presentation of the case or other ideas they did not consider. Afterwards, they proceed to search for more information or to re-assemble the data. Collaboration in intelligence analysis is unlikely to require real-time group collaboration.

Tabletop. A tabletop display is useful for short discussions with several people standing around the table, but not for working on a case or analysis for long periods. Discussions involving several people happen less frequently than long periods of individual work.

Transferring Data. A significant amount of time is currently spent transferring data (e.g. from one spreadsheet to another, between different applications). This often forces the analyst to open and close several applications, thus breaking the flow of their work in several steps, and forcing them to remember which applications were involved, and why. This transfer of data often occurs due to program incompatibility, because the data is located on different computers, and also due to the lack of appropriate screens, which are too small to accommodate several applications at once.

Timeline. Cases or analyses often can extend over long periods of time (e.g. 13–16 weeks) as new information becomes available and the situation changes. During these periods, however, the analyst works on a specific topic in bursts of a few days. Despite this, the analysts need to keep the case within their sphere of attention, even though it may be "on the backburner" when nothing new has happened. Having information about a case or analysis persistently available (which specific type of information is yet to be determined) helps them to think and see other possibilities and associations.

Status Dashboard. Apart from information related specifically to a single case or analysis, there are other kinds of information that would be useful if displayed in a persistent way. For instance, alerts about new information that might be relevant for the current analysis or investigation, or about information that breaches a user-defined threshold, or about the current intelligence situation, or about cases that should be kept in-view. Moreover, if key information is displayed persistently, it may be possible to minimize forgetfulness, to remember and quickly retrieve transient and

[1] http://www-03.ibm.com/software/products/en/analysts-workstation

changing information, and perhaps to address some issues regarding situation awareness.

Public Display. A vertical large screen display where an analyst would stand in front of, and work on a case or carry out an analysis, is not considered a core part of the work methods that an analyst would use. A large screen display in an intelligence analysis room, to provide a “common operational picture" (or its intelligence equivalent) is also not considered a core part of the analysts’ work methodologies. This happens primarily because the information is likely to be partially or fully sensitive for the police, and not intended for open distribution. A large screen, however, is most likely to be used mainly for briefings among a larger group of people, and perhaps for the display of largely static pieces of information.

Large Display. Access to a big display “real estate" with high resolution is preferred, as it would allow the analyst to keep applications open with their respective results persistently accessible, and to keep the necessary information constantly visible. This enables the use of spatial memory to support search and location tasks and also problem solving tasks such as the construction of plans and the free-form assembly of data objects into stories that may explain the data acquired during the investigations. Multiple displays can be utilized for space and explore separation of workflow (focus + content) for multiple case analysis. If multiple displays are used we need to maintain a similar pixel density display between displays to make data presentation consistent when moving from one display to another.

Externalization. The availability of display real-estate will enable the analyst to invoke the use of real-world concepts such as places, proximity, and spatial arrangements, to externalize meanings such as we observe in the physical world, and to assign meanings to actions. The analyst would also be able to assign meanings to object and places: By means of these assignments, also the creation of new information is possible (e.g., by manipulating the information objects to assemble them into an explanatory narrative).

Tactile Reasoning. In VALCRI, data objects can be imbued with physical characteristics (e.g. they look like an index card and behave as an index card in that they can be laid out and can overlap and obscure information, but they can also be augmented with computational power). They can be electronically duplicated, automatically grouped by semantic similarity, or organized by differences, and show occurrences of keywords or concepts across a set of cards. Their placement and manipulation, such as when an analyst drags one set of data objects onto another, can be used to initiate computational processes such as Boolean operations. Such interactional affordances will be effective when there is a large persistent display space. We refer to this form of interaction as tactile reasoning, an interaction technique that supports analytical reasoning by the direct manipulation of information objects in a user interface.

Touch and 3D Gestures. Tactile reasoning, together with large display spaces, can change the way we interact with computers. Large display real-estate affords the possibility of new forms of interactions such as multi-touch and 3D mid-air hand gestures that are impractical with smaller screens. Larger screens should not be considered mainly as a larger view port for observing and manipulating complex visualizations.

Personal Displays. Besides the large displays individual smaller displays such as tablets can be used to interact with data or for reading individual case reports and documents.

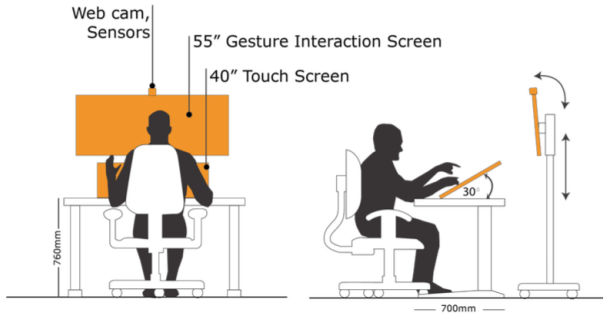
Minimal Cost. We need to construct the workstation with

readily available hardware components as multiple workstations are required to support many analysts.

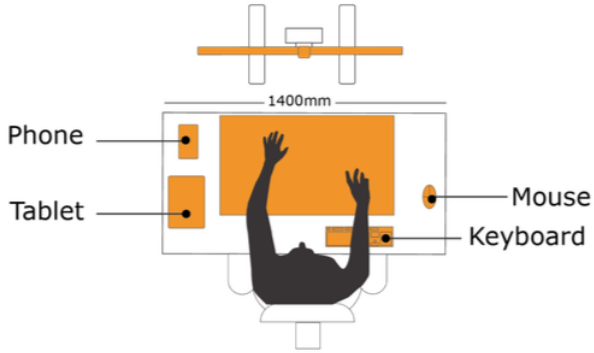
These factors collectively form the basis for proposing a non-conventional design configuration for the Analyst Workstation that breaks away from the standard desktop arrangement that only uses a mouse and keyboard. In summary, the envisioned Police Analyst Workstation is based on three key factors: (i) a large enough multi-touch interface to enable direct manipulation of information objects (including data visualizations and information graphics) that an analyst can interact with in free-form manner that changes the approach to query formulation and query specification; (ii) a large enough display surface that enables places that can be used to persistently display information such as alerts, status information, and on-going cases or analyses that are temporarily set aside but need to be kept in view for awareness reasons as the situation changes and new information may become available – directly or indirectly; (iii) for security and confidentiality reasons, the design of the large display working space, should primarily consider the screens largely as private or personal, rather than shared and collaborative.

Police Analyst Workstation

Based on our requirements we are designing and building the Police Analyst Workstation (see Figure 1). The individual workspace (Figure 1(a)) consists of a desk, 2 screens including security filters, keyboard, mouse, phone and tablet. The 1st display (X) is 40 inches and is multi-touch, located on a table in a 30 degree (adjustable) angle. The 2nd display (Y) is 55 inches with technology that allows mid-air hand gesture interaction recognition and multi-touch. The display is located on a stand that allows the height and angle to be adjusted as well as moving the screens together for collaboration purposes. Figure 1(b)



(a) Conceptual design, two displays configured in X and Y positions.



(b) Birds eye view.

(c) Multiple analysts collaborating.

Figure 1: Police Analyst Workstation Design - consisting of two touch screens, phone, tablet, mouse, keyboard, and 3D sensor to support mid-air hand gestures.

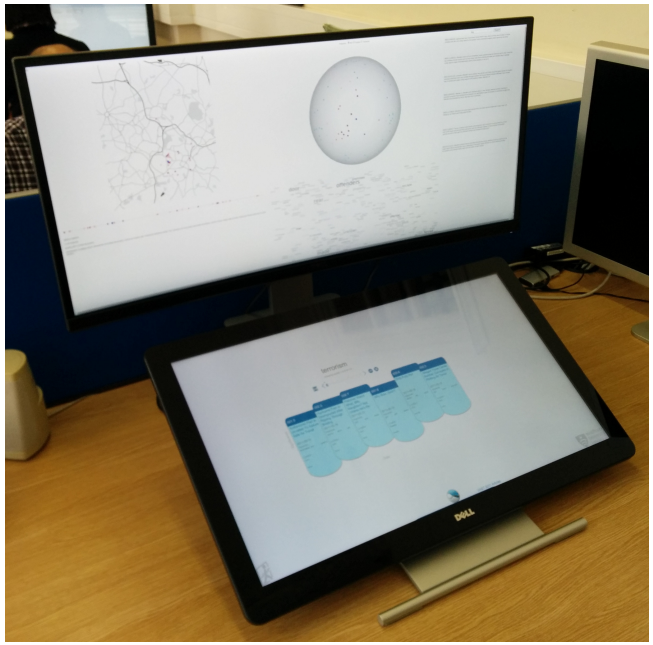


Figure 2: Police Analyst Workstation - preliminary implementation: 27 inch horizontal display (X) and 34 inch vertical display (Y). Content can be transferred between displays using multi-touch and 3D mid-air hand gestures.

shows a birds eye view of the workstation that also supports displaying and sharing information on a mobile phone and tablet. The workspace can be also be used in a collaborative environment by moving the screens together to help support police analysts working together (Figure 1(c)). We are currently in the process of designing the various user interface components and how data would be shared between devices using gestures.

Our first attempt meeting the requirements and design involved exploring the Dell SmartDesk. Figure 2 shows the SmartDesk setup, which utilises a 27 inch 1920 x 1080 pixels monitor with touch-capacitive (X), and a 34 inch curved 5 megapixel display (Y). We adopted an X-Y configuration such that physical interaction tasks can occur on the horizontal (X) display, while data analysis tasks can occur on the vertical (Y) display. The two screens show different data visualizations from the VALCRI application of criminal intelligence activities. We are currently exploring a larger configuration setup where each display is 40 inches and 3840 x 2160 pixels (4K).

In summary we have presented the analyst workstation setup for police analysts to explore data for criminal intelligence. We described our requirements, design and an initial implementation. We are currently exploring a larger physical setup, evaluating what the optimal setup is for analysts, and developing our VALCRI software applications further.

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