Bring Your Own Device: Ubiquitous approach to digital affinity diagram collaboration

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Abstract
The rise of ubiquitous computing has simplified our lives by providing relevant information and tools wherever we are. However, technologies that allow collaboration between different form-factor devices are rare. While ubiquitous devices might serve individuals well, they don't support high levels of collaboration. We propose a system where groups can participate in onsite brainstorming using various form-factor devices: tablet, laptop, or desktop for collaboration. We utilize socket server technology to achieve a high level of synchronization for all individual actions during brainstorming. High rates of synchronization for real time collaboration is the key for usability and adaptability. Our system uses a method called affinity diagramming in which users illustrate, group and link their ideas to create an easily understood structure. Using ubiquitous devices - both mobile and stationary - in brainstorming can help teams work together to share resources, exchange and organize ideas to build solutions that enhance our lives.

Author Keywords
CSCW, Ubiquitous Computing, Affinity-Diagram, Collaboration, Brainstorming

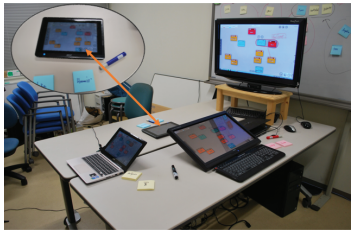

Figure 1: Many form factors can be accommodated: tablet, laptop, desktop, large touch screen

Figure 2: Users collaborating on multiple devices to create affinity diagram

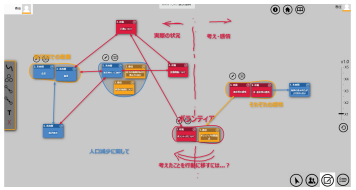

Figure 3: Digital affinity diagram with points, groups and links

Introduction

The origin of great inventions can usually be traced to a dedicated team of individuals working together to craft a solution. In order to create future great products, teams need to share resources, exchange knowledge, and organize ideas. This process of collaboration helps teams generate solutions that enhance our lives.

Great products simplify our lives and make ordinary tasks like communication easier. Yet as time goes by, the demand for new solutions increases, and the problems we face become more complex. As a result, teams require a higher level of collaboration in order to create the next solution. Many different technology form factors are available today (desktop, laptop, tablet), and all bring unique solutions, such as portability, computing power, and interaction style. However, we think these devices are not being utilized to their full potential for collaboration. Many teams prefer to use pen and paper for collaboration, relegating technology to a minimal support role during brainstorming. Ubiquitous computing can provide a better solution to collaborative idea exchange and organizing discussion.

Related research

Affinity diagrams, also known as the KJ method, are a popular discussion organizing tool[4]. Affinity diagrams are often created by writing individual points on sticky notes or cards and, together with other participants, sorting the cards to uncover the points' similarities. Digital discussion organizing tools that utilize ubiquitous technology include Greenberg and colleagues' SharedNotes system [3] which used PDAs to create a private space for users to develop ideas. Ballendat and colleagues'[1] system proposed access to a common wall-board space using distributed tablets. Burtner's Affinity+ board system [2] lets users send their ideas from their tablet, phone, or PC to a common digital board where the text is analyzed to produce cluster visualizations. In these systems, users' distributed interfaces are their input to a single shared group display (SGD) that is the primary area for collaboration. However, if a SGD is the group's focus, users must still negotiate personal space with team members. Shared group displays may be easier to engineer because the system does not have to coordinate synchronous requests between interfaces, but distributed interfaces have the advantage of giving users private space in which to develop their points. Despite the existence of road maps for ubiquitous synchronization like Project Aura [5], a framework for how to coordinate and synchronize resources effectively over a network, and BEACH [6] which lays out the basis for roomware that coordinates input and output for a ubiquitous computing environment, there is still little research utilizing ubiquitous technology and adapting it for use as a collaborative tool. Existing systems that treat distributed devices as inputs only are missing the potential for full collaboration based on ubiquitous personal computing.

Proposed Design

The proposed design is based on a previous system we developed called Discusys[7]. Discusys addressed several challenges by separating private idea generation from common collaborative space and using a synchronous touch-screen interface. Usability studies of Discusys show that a synchronized digital system improves usability compared to the traditional pen-and-paper method. This poster proposes extending that system to different form factors in order to increase the flexibility of collaboration.

Figure 5: Individual point card with user's name and text of point in identifying color

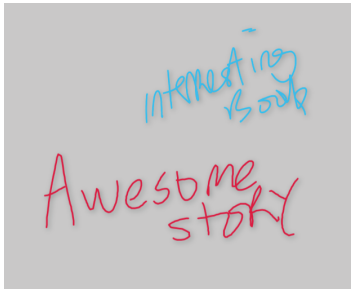

Figure 6: Drawings are converted to vector objects in user's identity color and can be moved and resized

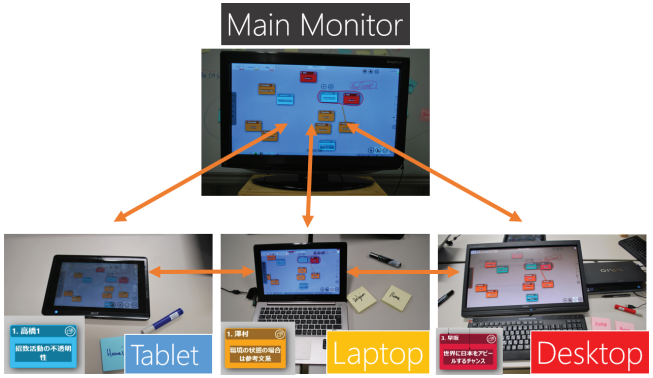

Figure 4: Synchronizing multi-form (tablet, desktop, laptop) system for collaborative affinity diagram

Our intention is to explore how ubiquitous technology with different form factors can work together to achieve real-time collaboration. Our proposed solution is a distributed synchronized interactive board that can be used across tablet, laptop, desktop, and shared touch-screen displays (see Figure. 2). We use socket server technology commonly used in multiplayer gaming systems to make face-to-face collaboration easier using ubiquitous computing platforms. The network socket server allows users to interact concurrently on the same collaborative board from different platforms (see Figure 4.). All actions are coded to be broadcast to other clients, and vice versa to maintain synchrony between all clients. To synchronize events between servers and multiple clients' collaborative boards, the socket server processes all of the system's main commands and updates. Changes are frequently updated (up to 50 updates/sec). The server is optimized for low latency, to deliver the good performance for concurrent multi-user collaborative work.

Affinity diagram is a discussion process that can benefit from ubiquitous technology. More people would be able to participate in the affinity diagram process from the comfort of their seat rather than crowding in front the white board. We identify 4 main functions that support the affinity diagram process, which are addressed by specific features of our proposed system: arranging points (Synchronous Card Movement), illustrating points (Vector Drawing), grouping points (Smart Grouping) and linking points or groups (Arrow Linking).

Synchronized Card Movement
Our system uses separate interfaces for point card creation and affinity diagram creation, that users can switch between. Each user creates points in a private menu (see Figure.5). After typing the text for their point, saving the point publishes a card to the collaborative interface. In the collaborative interface, users can move any point using touch interaction. All users can move points at the same time, and their moves are synced automatically to all displays by the socket server. Synchronization across distributed screens will give users a stronger sense of control over card manipulation.

Vector Free Drawing
Drawing is an important part of creating an affinity diagram, and illustrations can often communicate more effectively than words. Our system proposes a drawing feature that creates vectored image components from each free-form drawing on the collaborative board (see Figure. 6). If one user draws an object, another user can resize the whole object or just a part of the object, delete a part, or create a new part of the drawing. Editing these objects can be done with a stroke-by-stroke undo process instead of an eraser function. Vector drawings allow users more flexibility to create symbols and diagrams on the spot.

Figure 7: Smart Groups are created by drawing a circle around cards and can be moved and reorganized by moving card in and out of the group

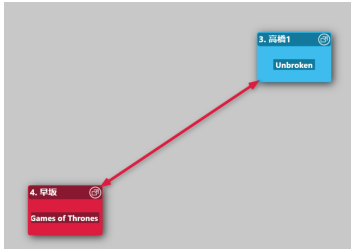

Figure 8: Arrow Links stay attached even when points are moved

Smart Groups
Analog affinity diagrams require users to make groups of sticky notes manually that cannot be moved as a unit. However, grouping in computer-based collaboration can involve complex un-grouping and regrouping steps. The proposed system's Smart Grouping allows users to pull individual cards out of groups and push new cards into groups, and the group re-forms automatically around the new card (see Figure. 7).

Arrow Linking
In analog discussions, users can draw linking arrows between two points or groups to point out a relationship. However, this link needs to be redrawn if the group changes. The proposed system's linking feature is a simple two-click process. Users move points together that they think are similar, and draw a circle to create a group (see Figure 8). Users can also draw links between cards and groups that stay attached to their targets, even if groups are moved to a different part of the board. Groups that organize their ideas using an affinity diagram can use our system without changing the technology form factor that is comfortable for each team member. The result of their brainstorming can be saved and shared digitally, which improves on the traditional whiteboard method.

Conclusion
Currently, many different touch-interface devices are available in a variety of form factors. Our proposed system suggests that synchronization technology is necessary for multiple form factors to be usable in true interactive collaboration. Future research will explore users' experience of this system through usability testing, to show whether it makes collaboration with ubiquitous technology more flexible. Ubiquitous computers will continue to simplify our lives, and future designers should focus on creating new ways to engage in interactive collaboration in order to inspire the next great invention.

Author Notes
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