Crowdboard: An Augmented Whiteboard to Support Large-Scale Co-Design

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ABSTRACT
Co-design efforts attempt to account for many diverse viewpoints. However, design teams lack support for meaningful real-time interaction with a large community of potential stakeholders. We present Crowdboard, a novel whiteboard system that enables many potential stakeholders to provide real-time input during early-stage design activities, such as concept mapping. Local design teams develop ideas on a standard whiteboard, which is augmented with annotations and comments from online participants. The system makes it possible for design teams to solicit real-time opinions and ideas from a community of people intrinsically motivated to shape the product/service.

Author Keywords
Creativity support; crowdsourcing; real-time collaboration.

ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

General Terms
Human Factors; Design.

INTRODUCTION
Research in co-design [2] explores the process of involving community of potential users in the design process. Designers with this co-design perspective can leverage Open Innovation platforms [1] to gather many diverse ideas, but the interactions are often asynchronous. We designed the Crowdboard system to allow a co-located design team to gather real-time input from online participants while sketching concepts on a whiteboard. We augment a studio space with Web cameras to capture and broadcast whiteboard activity to online participants (see Figure 1). Community members can annotate the conversation by placing new comments at X-Y locations or adding to an existing thread. These online conversations appear projected onto the physical whiteboard as red dots that the team can expand to see details. We hypothesize that real-time input from online crowds can help design teams generate ideas and consider diverse viewpoints around evolving design.

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Related work has explored remote meeting support systems [6], crowd-based creative work [4, 7], and augmented paper and whiteboards [3]. The existing meeting support systems are typically designed for small group meetings and lack the ability to scale to community-wide discussions. Conversely, open innovation platforms scale up, but typically do not support real-time input as teams discuss concepts.

Crowdboard helps teams shape the design of products or services. It can also provide support for gathering issues and potential solutions for problems of public interest. The system enables the team to take full advantage of the expertise and ideas of intrinsically motivated people with diverse perspectives. Besides the envisioned advantages for the design team, we believe the system may be also an important tool for the community, allowing people to feel like their voice has been heard.

SYSTEM DESIGN
The Crowdboard system is comprised of a typical whiteboard, a webcam, a projector, a Microsoft Kinect, and a laptop (Figure 1). Video of the meeting is broadcast using USTream [5].

Team members draw on the whiteboard with regular markers and interact with the projected crowd comments using touch gestures. Using the depth camera on the Kinect, we capture touch gesture using a background subtraction technique and a noise removal algorithm. The crowd-generated discussions are positioned at X-Y coordinates on the whiteboard, allowing the conversations to specifically refer to something drawn on the board. Each discussion thread has a title and one or multiple comments from different participants. Team members can expand or collapse the discussions using a tap gesture, move them around the whiteboard by tapping and dragging the discussion markers, and turn them to oval shapes by tapping on the title of the discussion thread.

Online participants interact with the team by using a web interface (Figure 2). The left panel contains the live video broadcast of the meeting from the web camera, a group chat window and the list of online participants. The right panel contains a synchronously updated view of the studio whiteboard. Online participants can create a new discussion in a particular (x,y) position on the screenshot with a simple double click. They can also expand and add to an existing discussion. Under the whiteboard view, online participants can manipulate a timeline interface; the videocast, the whiteboard state, and the comment threads will update appropriately.

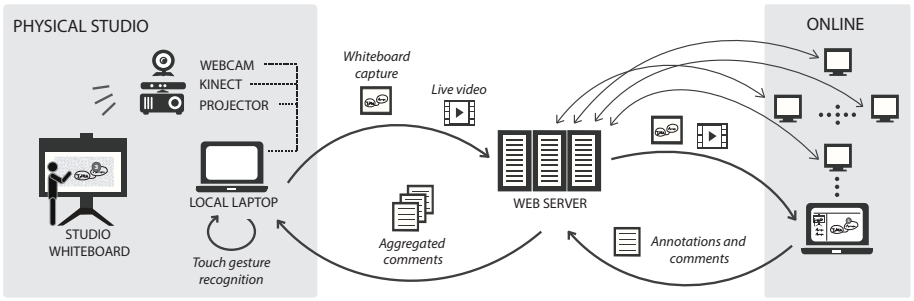

Figure 1. System architecture and information flow.

The system comprises five main modules:

- A Node.js server that stores the status of the system on a Mongodb database and keeps the clients synchronized by using the socket.io library;
- A web interface Backbone.js-powered for the crowd;
- A web interface Backbone.js-powered for the team (the computer that runs it connected to the projector);
- A C# routine for the depth-camera-based interaction;
- A module that uses Java and OpenCV to capture and upload whiteboard screenshots to the server.

ENVISIONED USAGE SCENARIO

To give an idea for how we envision Crowdboard in action, we imagine scenarios where a design team wants to engage the community directly affected by the design. For example, imagine a university who hires consultants to investigate a new fingerprint-based technology to replace the current pay stations across campus.

The consultants promote the upcoming design conversation through social media (e.g., Join the design team on July 11th at 4pm EST). On that day, they startup Crowdboard and what for people throughout the university to log on to participate.

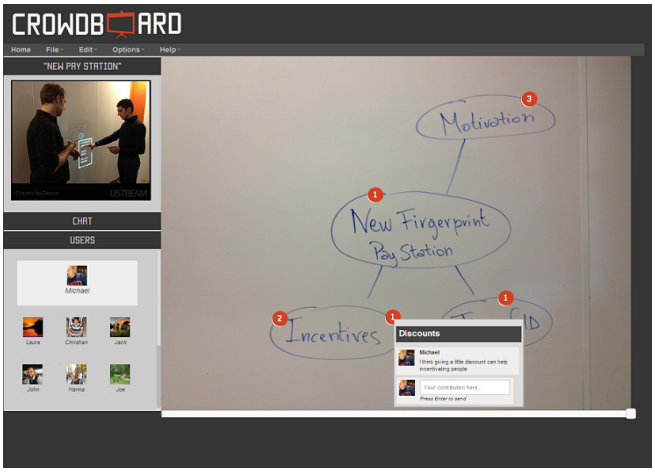

Figure 2. CrowdBoard's Web interface where participants see a live broadcast of the design conversation (upper left) and whiteboard activity (right). They can leave comments that get projected as virtual markers on the actual board.

The team starts discussing the functionality of the system and highlights some of the key issues as a mindmap. Meanwhile online participants follow the conversation and click on top of the whiteboard view to add comments. For example, at a local dorm, a student named Jack decides to raise the issue of whether the fingerprint system should require additional identification numbers. Back in the physical studio, the team notices the new conversation annotation icon, and expands the list to see the issues raised by the larger community. The design team discusses the tradeoffs of introduing personal id numbers as part of the system.

The design consultants and the online university crowd continue to work together to fill the whiteboard with comments, ideas, and potential solutions. At the end of the session the design team and the University both feel satisfied because the key issues and opportunities have been addressed.

FUTURE WORK

Future iterations of the online interface will include support for sketching, uploading images, recording audio, and rating others' contributions. We plan to conduct user studies to test the effectiveness of the system, recruiting small teams and asking them to complete design tasks in the traditional way and then with the Crowdboard system.

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