

## POEMS: A PAPER BASED MEETING SERVICE MANAGEMENT TOOL

*Chang Hu<sup>1</sup>, Qiong Liu<sup>2</sup>, Xuemin Liu<sup>2</sup>, Chunyuan Liao<sup>1</sup>, Paul McEvoy<sup>2</sup>*

<sup>1</sup>Computer Science Department, University of Maryland, MD 20742

<sup>2</sup>FX Palo Alto Lab, 3400 Hillview Avenue, Palo Alto, CA 94304

### ABSTRACT

As more and more tools are developed for meeting support tasks, properly using these tools to get expected results becomes too complicated for many meeting participants. To address this problem, we propose POEMS (Paper Offered Environment Management Service) that allows meeting participants to control services in a meeting environment through a digital pen and an environment photo on digital paper. Unlike state-of-the-art device control interfaces that require interaction with text commands, buttons, or other artificial symbols, our photo enabled service access is more intuitive. Compared with PC and PDA supported control, this new approach is more flexible and cheap. With this system, a meeting participant can initiate a whiteboard on a selected public display by tapping the display image in the photo, or print out a display by drawing a line from the display image to a printer image in the photo. The user can also control video or other active applications on a display by drawing a link between a printed controller and the image of the display. This paper presents the system architecture, implementation tradeoffs, and various meeting control scenarios.

### 1. INTRODUCTION

Today's fast-developing technology is posing a challenge for meeting support systems. On the one hand, more and more tools are incorporated into meetings. The devices used in a normal meeting may include pens, paper pages, projectors, TVs, VHS/DVD players, clocks, printers, light switchers, white boards, smart boards, laptops, tablets, PDAs, presentation controllers, reference books, calculators, cameras, pointers, laser pointers, remote controls or even cell phones. On the other hand, it is hard for a meeting participant to learn and recall so many meeting support functions. It is also cumbersome to switch from one support function to another. To deal with this problem, multiple integrated meeting support systems have been developed. ePic [14] is one attempt to integrate various meeting controls. With ePic, users can show presentations on three juxtaposed screens, they can also control devices such as printers and cameras through a video window on a computer. However, the requirement of a Tablet PC, laptop

or desktop PC for showing the interface makes it expensive to deploy and hard to carry for daily meetings. Moreover, some meeting participants may be reluctant to install the control interface on their PC because of security reasons.

In this paper, we propose POEMS, a modularized meeting service management system which uses a digital pen and paper as its interface, which supports paper buttons, controls based on time-stamped drawings, scribbling, and a new type of interaction, Dynamic Buttons that a user can draw and define on the paper. Paper has been the most popular media in meetings for years due to its low cost and flexibility, and the pen is the major tool for writing notes on papers. Since many people use this media and tool set regularly, this set of interface requires minimum learning effort on the user side. Using pen and paper also guarantees low cost, and light weight. Moreover, as the meeting context and supporting hardware are rapidly changing, the proposed meeting support system is modularized to enable frequent reconfigurations.



**Figure 1. The deployment environment and interface of POEMS.**

POEMS is deployed in a corporate meeting room with three large public displays. Figure 1 shows the deployment environment and a meeting service management interface. With this tool, the screens are automatically started when a pen is pressed on a piece of paper. A presenter can control the presentation progress with time-stamped paper tap or drawings. A meeting participant can use the paper interface to initiate a white board on any public display for scribbles. Users can use a digital pen to point or write at any place on a screen for group discussions. They can also initiate an

onsite screen printout by a time-stamped paper drawing from a screen image to a printer image.

## 2. RELATED WORKS

Pen-based meeting support systems date back to the early 90's. The WeMet system [12] integrated handwriting into meeting support with the design rationale that sketching is one of the most important ways to communicate during a meeting. User studies showed promising results. However, WeMet system didn't go further beyond simple sketch support on PC-based meeting environment. One step beyond sketching without recognition, Saund et al and Rubine et al [9, 10] proposed various PC-based approaches with handwritten text and gesture recognition. Devices bearing an active writable display (like Tablet PC's and PDA's) can be expensive to deploy. Moreover, those devices can be too large for the users to pass around, hindering users from sharing sketches and notes on them.

As the most historic and convenient media, paper has long been integrated into meetings and offices [11]. The PaperPDA [5] technology explored ways to give paper more electronic capability by decoding registration marks in scanned paper documents and transforming these marks into document processing actions in electronic world. The DataGlyphs technology from PARC [3] was a forerunner that shows some of the possibilities for building a pen-paper based interface. One of these possibilities was explored in [2] on meeting video activation by clicking images on a paper printout. PapierCraft [6] investigated a set of gesture based scope selectors for bridging paper document and electronic document. Palette [8] tried slideshow control with barcodes on paper and PaperButtons [16] enhanced Palette's slide control with a paper button. Beat and Moria's PaperPoint [13] can use slide handouts printed on paper to control regular PowerPoint presentations and add annotations. Liao et al [15] proposed Pen-top feedback for paper based interfaces. Even though all these research prototypes can be used to support meetings, neither system supports interacting with diverse meeting support devices in different scenarios. The focus of this paper is a system that enables users' interactions with diverse devices through a pen and a photo.

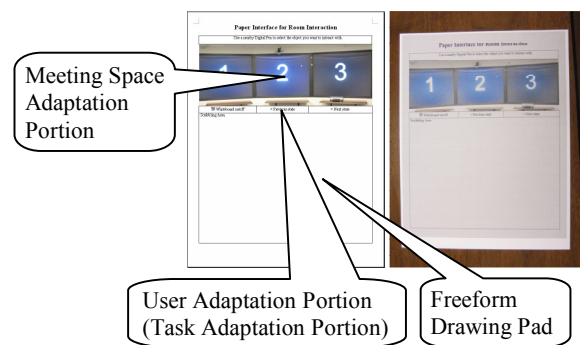
## 3. SYSTEM DESIGN AND ARCHITECTURE

The proposed system is modularized based on .NET services. Its interface is printed on Anoto paper [1], which accesses a number of back end services. These services include whiteboard drawing, pointing, presentation control, printer, screen switching and handwriting recognition.

### 3.1. Interface design

The images in Fig. 2 illustrate one type of interface designed for our conference room, which has three public displays and a printer. This interface is designed for users who simply want to play slides, do whiteboard drawings, or print

out displays for memos. In Fig. 2, interface design is illustrated on the left, with a printout on the right. The paper used in the system has an underlying image pattern and three functional portions. These three functional portions are: meeting space adaptation portion, freeform drawing pad, and user adaptation portion (or task adaptation portion). Because the underlying image pattern is printed with black toner, the real interface has a grey tone. The Anoto io2 digital pen [7] in the interface can locate itself on the paper by recognizing the underlying image patterns and transmit the location information to a computer through Bluetooth connection in real time. The information is then interpreted and routed to corresponding meeting services.



**Figure 2. The paper interface: design (left) and actual (right)**

The meeting space adaptation portion is an image depicting a meeting space. By performing drawings in this portion using a digital pen, a user can control the information flow among devices. For example, a display can be selected for drawing by tapping its image in the meeting space adaptation portion. Displays can be printed by drawing a line from a display image to a printer image (drag-and-drop). Slides on one display can also be moved to another display by dragging-and-dropping from one display image to the other.

The freeform drawing pad is a blank space on the digital paper. Depending on the drawings performed in the meeting space adaptation portion, drawings in this portion can be private notes seen only by the paper user or public drawings. Drawings on this pad can be also separated into multiple public and/or private layers with multiple level of privacy according to their time stamps.

The user adaptation portion is a control portion in the freeform drawing pad customized by each user. Its purpose is to facilitate the activation of predefined functions. It includes a minimum number of pre-printed static control buttons and a number of dynamic buttons drawn by users. A dynamic button is defined by writing a function name surrounded by a continuous closed curve (illustrated in Fig. 3). This concept of dynamic buttons simplifies the interface without compromising the system's functionality.

Copies of the paper interface can be printed through a simple mouse click. The alignment between the interface and its underlying Anoto pattern is done during the interface design process. Since most printers' misalignments are very small, no recalibration is needed for one design.

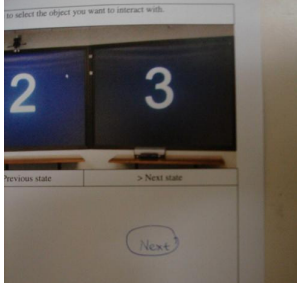


Figure 3. A dynamic button (on lower right)

### 3.2. Back end services

The back end of this system consists of various services communicating through service calls. These services include one or more pen services reading strokes from Anoto pens, an interpreter service interpreting strokes, a whiteboard service showing public drawings from freeform drawing pads, a switching service maintaining specific screen and computer connections, a presentation service controlling slide shows, and a printing service for printer controls. The relations between these service modules are illustrated in Figure 4.

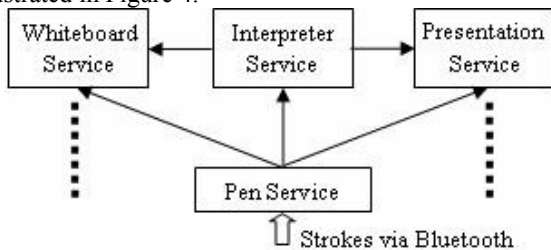


Figure 4. System architecture. The Pen service receives pen strokes via a Bluetooth link and distributes them to all subscribers. The interpreter service sends identified action commands to other services. Switching and presentation services are not shown in this figure.

The pen service adjusts pen behavior according to a pressure activated function illustrated in Figure 5. Based on this function, the pen acts like a pointer in phases 1 and 2, where pressure is lower than a certain threshold. After the pressure exceeds an upper threshold (phase 3), a stroke with thickness will be generated. In phase 4 and 5 where the pen pressure varies above the upper threshold, the stroke thickness changes proportionally. When the pressure drops below the upper level, the pen still keeps a minimum thickness (phase 6), until the pressure reaches the lower threshold (phase 7), which returns the pen to the pointer mode (phase 8). In this manner, the pen can be used for both pointing and writing on a public display. This pointer/pen dual mode helps users interact with displayed

contents (e.g. to draw on existing drawings). After attaching thickness, the pen service redistributes the stroke to all service subscribers including the interpreter service, whiteboard service and presentation service.

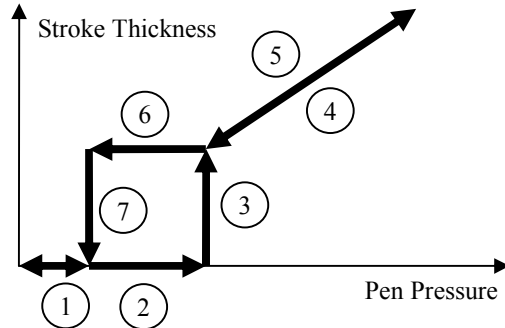


Figure 5. Pressure activated stroke rendering function

The interpreter service interprets strokes whose starting and ending points are in the same portion. A stroke starting and ending in the environment adaptation portion is interpreted as a corresponding command. If a stroke is in the freeform drawing pad, it then goes through a recognizer to test if it matches some predefined drawings or qualifies as part of a dynamic button. More specifically, if a closed curve is drawn, the recognizer extracts and attempts to recognize all strokes enclosed. If those strokes form a command, the area enclosed by the curve will be registered as a dynamic button, which behaves just like a predefined static button. Commands can be text strings or drawings that control slideshow, whiteboard, display switching and printing. Strokes that cannot be matched to predefined commands are treated as freeform notes or a pointer's moving paths.

The whiteboard service provides a platform for integrating users' public drawings. It receives strokes from the pen service and renders public drawings according to the pressure activated function. The switching service communicates with a hardware switcher which in turn controls connections among meeting support devices. In current implementation, it is used to turn on screens when one pen is removed from its charging cradle and turn off screens when all pens are set in cradles. The presentation service and printing service are designed to perform linear/non-linear slide flips and document printing respectively.

## 4. DEPLOYMENT AND EVALUATION

POEMS is deployed in our meeting room shown in Figure 1. In meetings, the speaker grabs a copy of POEMS's paper interface and a digital pen while the screens switch on automatically. After loading a presentation, the speaker taps the buttons on the paper interface to flip slides or drags slides to screens whenever needed. The speaker can also bookmark a slide with a dynamic button. The button can be formed by writing a slide numbers in the

freeform drawing pad and circling it. The speaker may print out an important slide on a screen by drawing a line from the screen image to a printer image on paper. During Q&A time, meeting participants may use their copies of paper interface to scribble on the slides, they can also tap on a (dynamic or static) whiteboard button to start a whiteboard for further discussion. After a presentation, each of the audiences may keep a copy of the paper interface for future reference, whereas all interaction on the paper interface is already kept in digital form.

An informal user evaluation is conducted to give a preliminary comparison between POEMS and other systems. The 5 users in this evaluation are mainly researchers and programmers, with one artist. They are very familiar with ePic and ordinary meeting support devices. During the evaluation, a user is given the paper interface with a brief explanation. Then the user is asked to do some usual tasks during a presentation in meetings, e.g. navigating through slides, printing handouts, etc. None of them reported POEMS being more difficult than its counterparts. Some gave the comments that it's very natural. Users also showed great interest in the concept of dynamic button and the range of commands it is able to define. All of them found the dynamic buttons easily distinguishable from plain drawings.

The delay between drawing on paper interface and displaying has a great impact to users' overall judgments. With one pen connected to the system, we interviewed 5 users and none of them could feel the delay. To test the system with multiple pens, we deployed the pen service to multiple computers and connect one pen to each of them. On our 10M corporate intranet, we tested the system with 2 pens and 3 pens and the delay is still negligible. Since the data rate of each digital pen is not very high, we believe this system is scalable in normal meeting or class scenarios.

## 5. DISCUSSTION

First time users might have problems drawing things related to displayed content. In this case, they have to be trained to utilize the pointer mode with small pressure. For many users, this trick is easy to learn but not very intuitive at the beginning. To overcome this problem, we are considering adding light-color grids on freeform drawing pads and user selected public displays. Moreover, the pen hardware design makes it a little difficult to control the pen-tip-pressure range accurately for some users. With this drawback in mind, all users agree that the pen system is still much more convenient than a mouse on meeting-related drawings.

Video playback control is also tested with a pen and a paper controller printed on an interface. There is no problem for video playback or volume control. However, the fast forward and rewind controls are a little sluggish. We are not very clear to the reason of this problem yet.

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