AugMenu- An augmented reality menu system
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ABSTRACT
Nowadays, POS and other information systems rapidly facilitate the management and operation in restaurants. However, rarely technologies are used to improve the traditional menu to make them easy to understand by users. Augmenu introduces an augmented reality menu system which is based on Argon Augmented Reality browser on iPhone. In this system, all the items on the menu are visualized as image and text content and displayed in an augmented reality way. By holding an iPhone, user can browser the specific menu item by taping on it. Also, social tools are implemented in this system. Users can easily get others comments about the dishes by using the built-in twitter search tool and share their preferences via the facebook tool.

ACM Classification: H5.m. Information interfaces and presentation: User Interface – Interaction style, user-centered design

Keywords: Augmented Reality, Menu, Argon, web browser, Social Computing

INTRODUCTION
Recently, researchers in human-computer interaction have been exploring interactive systems in augmented reality for multiple purposes. Some of the challenges discovered so far are registration errors, not intuitive interactions, and difficulties in use. We attempt to develop a system that overcomes those challenges by learning from previous researches and enhance the usability of menus in the restaurants.

RELATED WORKS
Relevant prior work includes researches of augmented reality principles, augmented reality browser framework design, social computing

Augmented Reality principles
The goal of augmented reality interface design is using an appropriate interaction metaphor to support users input and computer output[2]. Clearly distinguished functions between objects are crucial. The two major functions in tangible interfaces can be tokens and references frames. Tokens are the physical elements. The reference frames are the physical interaction spaces. The display form factor should be matched to the nature of the task and collaboration and should not limit users’ awareness and movements. Also, one of the major problems of gesture-based interaction is poor registration [5]. By simplifying gestures and adding constraints, the system reduces the possibilities of redundant actions.

Augmented reality or mixed reality systems should be developed in consideration of three important usability issues: how users perceive virtual information overlaid on the real world, how users interact with virtual information overlaid on the real world, and how the AR interface enhances face-to-face collaboration [12]. Many augmented reality systems are designed for collaborative computing [13]. It is crucial to study how users interact in AR collaborative spaces and how users interact with other users. Share space integrated many novel interaction techniques like augmented reality, collaborative computing, physical interface, spatial 3D user interface and computer vision and tracking registration. By properly integrating multiple interaction techniques, the system can provide richer interaction experience.

Ishii [7] presented that tangible interaction supports both digital technology usage on collaboration, learning, and decision making and human natural ability on grasping and manipulating physical objects and materials. It also enables dynamic sculpting and computational analysis using digitally augmented continuous physical materials. In order to maximize the advantages of tangible interaction, there are principles that need to be considered. Construction of tangible user interaction identifies physical objects, determines their locations, orientations, and physical states, supports annotations on them, and associates them with different computational states. In addition to the functional requirements, the advanced system should support the existing routines of users both physically and computationally. It would help users to understand and utilize the system based on meaning in a familiar fashion [16].

Spatial augmented reality system has developed by many researchers. Marner et al. [14] presented physical tools with logical functions. Visual feedback presents the logical mode of the tool to users by projecting graphics onto the physical tools. This approach makes the tools malleable in their functionality. The change is conveyed to users by changing
the projected information. Sean et al. \[^{[18]}\] proposed Visual hints which are graphical representations in AR of potential actions and their consequences in the augmented physical world. Visual hints enable discovery, learning, and completion of gestures and manipulation in tangible AR. Also this paper discusses the investigation of a variety of representations of visual hints and methods for activating them and a specific implementation that supports gestures developed for a tangible AR user interface to an electronic field guide for botanists, and present results from a pilot study. Moffat et al. \[^{[13]}\] showed that participants took significantly longer to complete the AR 3D version of the game than the 2D version but did so with significantly fewer attempts which implies they were more accurate.

**Empirical Studies of Augmented Reality Interface**

Ivan et al. \[^{[9]}\] pointed out that there are many advanced display and tracking technologies but interaction in augment reality environments has been limited to passive viewing or simple browsing of virtual information registered to the real world. They presented computer-generated entities that become first-class citizens of the physical environment. Users use these entities in the same way as using physical objects. Users select and manipulate them with hands instead of with a spatially-purposed device such as a mouse or joystick. Using physical objects not electronic devices provides intuitive and seamless interaction between physical and virtual world.

**Designing Augmented Reality Interfaces**

The goal of augmented reality interface design is using an appropriate interaction metaphor to support users input and computer output. The paper explains principles of tangible augmented reality, and these principles guide us to compliment easy user interaction design. The author emphasizes that clearly distinguished functions between objects are crucial. The two major functions in tangible interfaces can be tokens and references frames. Tokens are the physically manipulatable elements, and the two cubes in our project will be the tokens. The reference frames are the physical interaction spaces, and the space that the two cubes will be used and webcam will project will be the reference frames. The display form factor should be matched to the nature of the task and collaboration and should not limit users’ awareness and movements. Our system will allow users to have their full awareness and to freely use their two hands so that it can provide a work station without constrains on users’ natural behaviors.

**Movement-Based Interaction**

Eva et al. \[^{[5]}\] describes three concepts, space, relations, and feedback, of motion-based interaction. Camera space has the shape of a pyramid. The closer the distance between a camera and the tracked feature is, the smaller the space becomes. Therefore, it is important to set the scale to optimize the camera space. Relation means the connection between a camera and the tracked features within the camera space. Feedback is one of the most important elements that make the smooth experience possible. The problem occurs when users cannot see what the camera registers. Input feedback and application feedback need to be implemented in order for users to visualize the interaction. Various ways of using marker have been studied using ARToolkit to implement motion capture \[^{[18, 19]}\].

**KHARMAR: An Open Platform for Delivering Mobile Augmented Reality Experiences**

The KHARMAR\[^{[20]}\] framework is a new open platform for augmented reality that lets users create content using web development tools already in widespread use including HTML, CSS and JavaScript. In contrast to other proprietary augmented reality (AR) browser solutions, this approach uses standard web servers for content delivery and lets users deploy almost any web-based technology into the surrounding scene, resulting in far richer AR experiences. We have developed a reference client that implements most features of the KHARMAR framework for the iPhone.

The KML/HTML Augmented Reality Mobile Architecture (KHARMAR) seeks to address several practical problems related to mobile AR development and delivery. The platform allows content developers to create content using an extended version of the Google Earth markup language and host it using KML files on standard HTTP servers. It establishes a framework for multiple simultaneous channels to utilize content delivered by multiple sources such as tracking information and building infrastructure. The KHARMAR framework is focused on respecting the integral role of tracking and infrastructure within the authoring pipeline both offline and at runtime. And, perhaps most importantly, the platform implements several techniques for overcoming the uncertainties of current tracking technologies and preparing for the future widespread use of vision-based tracking.

The KHARMAR framework is built upon several unique contributions to mobile AR experience delivery: channel servers, Infrastructure servers, GEOSpot servers and an open source standards-based mobile client. See figure.1
User expectations for mobile mixed reality services: an initial user study

In this paper, the researchers conducted altogether five focus group sessions with varying user groups. They investigated the early impressions and expectations of MMR as a technology by evaluating various usage scenarios. Based on this initial study, we found relevance issues (what information to receive, how and when) and the reliability of MMR information to be the most salient elements that were anticipated to affect the overall user experience. In mobile and busy situations the MMR information content has to be something that is very important or useful for the user, especially if receiving the information or interacting with it draws the user’s attention away from the tasks executed in the real world.

SYSTEM DESCRIPTION
AugMenu introduces an augmented reality based menu system. In this system, all the items on the menu are visualized as image and text content and displayed in an augmented reality way. User can browser the specific menu item by tapping on it. Also, users can easily get others comments about the dishes by using the built-in twitter search tool.

Development Environment
The development and testing were conducted on an iPhone 4 with iOS 4.2 running Argon Augmented Reality Web Browser. The version of Argon is 1.1.2 which is current the latest version available on Apple App Store.

Task Analysis
A hierarchical task analysis is employed to describe the basic task in this system. Figure. 2 show the task details and relationship among tasks.

Prototypes
Storyboard
To design the mission statement of this system and better design user’s need, storyboards are used to rapidly shape the design ideas.

Story1.
George, A native American user comes to a Chinese restaurant. When he is reviewing the menu, he finds that most of the names are Chinese-style ones which are too hard to understand. He feels very confused and wants to turn to others for help. At this time, he was provided the AugMenu, he simply looks up the new order rendering in this app and interacts with its content. Shortly, he can easily grasp the meaning of the dishes by viewing the pictures and description of the certain dish. Figure.3 illustrates this story.
Story2

When George finishes ordering his dish, he decides to check out other information about Chinese dishes to kill the waiting time. By using AugMenu, he can browse other Chinese dishes and view more information like the stories behind the dishes and the recipes to cook them. Figure.4 illustrates this story.

![Figure 3: Story 2](image1)

Design alternative

In the prototype design phase, one design alternative is also came up to solve this problem.

In this alternative design idea, a new physical menu will be created. Each of the dishes is attached with a unique black and white marker. See Figure. 5. A marker tracking system will be used to recognize the markers and register their position and implement the augmented reality content as the overlay information.

Three key functionalities are considered to be implemented in this system: Augmented Reality overlay information, user’s comments, and recipes and history of the dishes. See figure. 6.

From the technical perspective, this system is based on Flash framework. By leveraging a Flash Augmented Reality library “FLARtoolkit” and 3D flash engine papervision3D to generate and render augmented reality content.

Menu

1. Ants Climbing Tree

![Figure 5: Marker design of the design alternative](image2)

Issues and drawbacks of this design alternative:

1. The layout of the new physical menu: because of the minimum size of the marker that can be identified correctly is much larger than the space for on dish item. After the detailed assessment and test, the content on the menu is difficult to layout without increasing the length of the menu significantly.

2. Robust tracking and registration algorithm is needed to be suitable for various environment conditions (luminosity) and tracking perspectives [1].

3. Less support in web services. Most of the web services like Yahoo Flikr, Google Picasa, Twitter, Facebook API are not well supported by this platform.

4. Lack interactivity. Most of the augmented reality content based on this framework is not interactive. It is to a large degree limit the user experience.

5. Compatible issues for mobile devices. FLARtoolkit and papervision3D are primarily designed for the desktop augmented reality applications. It is not well supported on the mobile devices running iOS or Andriod. That becomes the key issue that hinders the progress of switching to his design idea.
System Implementation

Key Modules
In this system design, three key modules are implemented to provide both interactive and social augmented reality experience. Figure.7 illustrates the framework.

Figure.7 Framework for AugMenu

Augmented Reality Content Module
The augmented reality contents are generated using web-front end technologies like HTML, CSS and JavaScript. Since KHARMA is based on Google Earth/Map KML and GEOSpot and infrastructure API, the HTML content is wrapped by KML tags and each individual AugMenu item is an individual Placemark which is registered in the system by its specific longitude, latitude and altitude. By identifying the Geo-location data retrieve from the Placemarks, the Webkit based front-end browser and render the Augmented Reality content on the top of the video stream layer which comes from the iPhone camera. See figure. 8, 9

AR content module:
<kml>
  <placemark>
    HTML+CSS+JavaScript
  </placemark>
</kml>

Figure. 8 Structure of the AR content

Twitter Comments Module
This module leverages the Twitter API to search all the geo-location based tweets within a certain distance to the user’s device. If user just curious about the Chinese dishes, they can search their names as keywords. All the tweets will also rendered as the augmented reality content which is register by their geolocations retrieving from the twitter server. See figure. 11.

Figure. 9 AR content

Figure. 10 content jumps to the front to show details

Powered by the features of Google Earth/Map KML, all the placemarks are interactive content. If user clicks on any item, the content will pop up to the front. See figure.10:
Share Module

In the share module, this system leverage Facebook API to allow user to share their preference to the dishes. In this case, this module will generate the dialog message as the screen overlay content. User can choose “like” button to publish their preference to their facebook accounts.

Evaluation Methodologies

Data Collection:

Non-Participant Observation
- Observe the process of a customer ordering
- Taking notes about what he does while viewing the menu and what questions he asks.
- Carefully capture the details of user’s non-verbal motions
- Video record this process(Permission)

Interview: semi-structured interview
- the customer
  - Focus on what problem they met

- What kind of menu they want to use
- Waiters
  - How many customers feel confused about the menu?
  - What is their typical explanation for this kind of questions?
  - How to improve the menu?
- Predictive Analytic Evaluation
- Heuristic Evaluation
  - In formative phase, check the low-fi prototype according to design criteria.
    - Most relevant criteria:
      - speak user’s language
      - clear affordance
      - informative feedback
      - be consistent
      - minimize user’s memory load
- Cognitive Walkthrough
  - Walk through each interaction steps and answer questions to avoid design flaws.

Discussion

In this section, we discuss the implications of the system.

Limitations and Future Research

The current version of this system only support user to obtain information but not create information. In the future, built-in twitter API should provide possibilities for user to generated own tweets without quitting the Argon browser.

Another improvement should be implement in the future is enabling multimedia in the system since the current version just present the visual HTML elements without audio and video. With the development of Argon browser, new features will become easier to implement in the next version of AugMenu.

Beside the current interactivity, more ways of interactions should be added in this design to meet various requirements from the users.

Empirical study is needed to get more quantitative data to discover more usability issues from the users.

Conclusion

To sum up, this AugMenu system provides a solution to presenting restaurant menu in Augmented Reality way. It provides the core functionalities for gaining and sharing contents. With the completion of the evaluation, some of the issues had been found and more possible solution methods are discovered. With the maturation of this concept, we are please to find out Augmented Reality as a new media rather than a technology to serve more areas and bring users with fresh and compelling experience.
REFERENCES


