Design For The Future Urban Mobile Experience In Intelligent City

Pattern and Context

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Abstract: This paper presents design researches on typical user mobility behaviors and urban interaction pattern in the context of intelligent city. The goal of this research is shaping new seamless urban mobile experience that depends on the quality of sensing, collecting and generating information in public space. We found out three typical roles, including the traveler, socializer and outworker by adopting methods of participatory research and rapid prototyping. Based on methodology of research through design, we designed the urban interaction and application prototype for each type of people, and then developed the basic prototype with adaptable interface and generalized the design pattern, based on the sequences of problem to solve, opportunity to use this pattern, the solution and reasons to use this pattern. This paper considered improving urban mobile experiences, the design pattern developed in research can be used to extend the field of urban interaction design after integrating time and space factor, and transform the researches into the intelligent cities of tomorrow.

Key words: urban experience, design pattern, social interaction, context aware, intelligent city

1. Introduction

This paper is going to explore the research framework and prototype for designing the social and cultural experience of citizens. The backbone of this process is to understand the behavior of the citizens, their needs and motivations. In intelligent city, the built environment would be changed to be perceptual, interactive and transformative, which could better support people's urban activities from more and more sophisticated urban life. On one hand, as an interactive space, the city could effectively realize "what you see is what you think" and fully embodies the collective intelligence to our life. On the other hand, intelligent city system is built based on the social rules, will be the right mediation between the physical environment and human society.

1.1 The Development of Intelligent City

With the support of urban related computing technologies, the sensor, mobile device, vehicle, building, and public space in the urban areas can be connected in a platform to serving people and their cities. People's behavior can be traced or recorded based on social media and personal data through wearable technology, the mobile device and context-aware technology can also provide the proper service when people travel in the city. Under such circumstances, designer will need more efficient research framework to handle the holistic perspectives of urban experience with the integration of technology and society.

1.2 Design Challenges

The intelligent city technologies let citizens know where they are, what they are doing, what they are going to do and whom they are staying with. These technologies can give citizen whatever information they desire and the contextual feedbacks flexibly. They can get personal, shared, and public information from all kinds of media: mobile phone, public kiosk, electronic billboards, and keep informed in proper time, context, format, and depth. Tools and technologies make our lives more and more intelligent, but how to integrated the citizen's activities, media and city together for a better city life which is the big challenge for designer.

1.3 Related Research

Currently, lots of universities and institutions begin to explore intelligent city related design field. For example, MIT Media Lab is working on how new information technologies and solutions can help citizens to live and interact better with the built environment and nature. [1]. Urban Informatics Research Lab at Queensland University of Technology is revealing the emerging field of urban informatics [2]. Project YOUrban at the Oslo School of Architecture and Design investigates tools and means to create engagement and a sense of ownership and responsibility towards our physical, social and cultural world [3]. Revolving around situated urban screens and their potential uses, project Urbanflow in Helsinki aims to envision an operating system for cities. [4]. Project iSpace presents a system to help the human-object interaction in Intelligent Space [5]. Biophilia is a decision support system that reflects human-environment interactions in an urban context, using AHP as a tool to help the city manager to understand citizens' opinion [6]. All these researches and projects, which have explored the multiperspective relationship between people and place, citizen and city, start an experimental research fields in the intelligent urban experience. Though the study presented in this paper also fall under the category of urban experience, it focused on 3 specific kinds of people using different prototypes in certain scenarios. Besides learning from the other researches, the study focuses on the usage of every prototype.

1.4 Research and Design Methods

Many IT companies announced their vision about the future user interface, but many key scenarios looked the same. These trends inspired us to develop new framework and method to discover the urban experience design patterns in different context. In this research, urban mobile design patterns were developed based on ethnographic approach and Activity Theory. Activity theory have two basic ideas: human mental activity emerge, exist and be understood in the interaction of people and the world around them; the interaction or activities determined by social and cultural factors [7]. Research model informed by Activity theory offers an approach to conceptualize relationships between citizen, media and city.



Figure1. User equipment and three levels of urban mobile experience

For the model of interactions between people and place is the core in this study, the framework mainly focuses on people's activities (including motivation and behavior) and environment that provides people with supports. An integrated framework was developed to cover the multi-perspectives of user mobile activities from motivation level, behavior level and support level. In order to correspond with design pattern, the motivation level concerns about the goals people want to achieve; the behavior level reflects people's role, task, action, and method; the support level gives the spaces for interactions and medias might be needed.

Design pattern is formal way of documenting a solution to a design problem, each pattern describes a problem that occurs over and over again in our environment, and then describes the core of the solution to that problem. [8] The simplified design pattern structure was adopted to combine with the framework for the pattern of urban mobility experience. Abstract UI frame with basic functions were designed based on the user needs, and then UI prototypes were tested in a focus group for validation. Three research frameworks were built for three typical users: traveler, socializer, and outworker. The design patterns reflected in three different interfaces, including specific interactions between people and the environment, people and people, and people and things. These preliminary pattern studies can provide a new thought and method for the future city experience design.



Figure 2. User activity and context with design pattern

2. User research and prototype design

The research aims to explore the urban mobile scenarios and possible interfaces pattern for intelligent city. During the research phase, three typical users were segmented, including traveler, socializer and outworker. Each typical user played a context-related role when they interact with people or city. For example:

Traveler wants to use the urban information and interface to support their activities in the urban environment. Travelers like tourists and commuters need to gather the information in the real point of interests in the city. Location-aware and time-aware data will be collected from the urban environment to trigger different sceneries and information simultaneously, forming the location-based and context awareness urban experience for traveler.

Socializer wants to build up relationship with other people based on ephemeral social network in a public place. People will use social network in public place to shape the formal or informal urban experience in social events such as parties, concerts or sports, etc. both locally and remotely. For supporting event attendee's social activities in the public built environment, participatory social network and environmental service will be provided for people to share index and augment social connections in the place.

Outworker who works outside of office or company will care more about the mediation between people, media and urban physical places. Outworker such as couriers and outside reporters will need more situated information to accomplish specific tasks in different places, traversing both virtual information and physical space smoothly, modifying the way of outworker access and sharing contextualized content with their colleague in and out of the office.

2.1 Traveler

When tourists and commuters travel locally and remotely, they carried the cameras, mobile phones, MP3/MP4, backpack, or purse, etc. They looked for detailed information about tourist spots, people's comments, and the way to reach the place before the travel. They also used mobile map application to find a location while traveling. They used MP3/MP4 to listen to the music or watch videos to pass the time. Some travelers didn't carry a camera because they thought the mobile phone could meet their requirements in many cases. If travelers only had short time to plan their travel, learning about the city or the sightseeing spot via mobile devices on the way would be important for them.

Based on the user research, tourist (commuter) needed three kinds of data, i.e., geographical data, action planning-related data, and user-generated data. Materials from five users' analyses were analyzed and summarized by the research framework, and user behaviors under a certain mobile context as follows:

Motivation level	Objective	Know the place; reach the place.		
	Role	A tourist or a commuter.		
Behavior level	Task	a) Know more about an unfamiliar area.		
		b) Know more about the surrounding environment.		
		c) Reach the destination.		
	Action	Search or view recommendations; Open the device to get detailed		
		information, comments, geographic information.		
	Method	a) Four tabs: search, comment, location, and collection.		
		b) Hold the device horizontally to get recommended information.		
		c) Hold the device vertically: open the device to have		
		recommendations on the left screen and the map on the right screen.		
		d) Drag a recommendation to the map to get geographic information.		
		e) Click "comment" to get comments.		
		f) While no other recommendation is selected, it presents the previous		
		geographic information when it is open.		
	Service	a) Environment: media wall, kiosk, mobile devices, and info-systems		
		for tourist spots.		
		b) Services: The system of different places such as a restaurant or a		
Support level		museum gives recommendations to the mobile device of the user		
		based on cloud computing and pervasive computing systems. The		
		Internet of things locates the user by getting information from his		
	T 1	surroundings, like a media wall, to give him a suitable traffic plan.		
	Tools	a) Tool: mobile devices, angle sensor, cloud computing technology,		
		pervasive computing technology, and the internet of Things		
		tecnnology.		
		b) Content: recommendations, geographic information, and personal		
		comments generates by the systems of tourist spots.		

Table 1. Research Framework of Traveler

In the scenario of travelling, user interfaces (Figure.3) were designed based on the research framework. a) The initial interface presented recommendations with detailed information. b) When the user decided to know more about a specific place, he could unfold his mobile device to get more detailed information: recommendations presented on the left screen while the right screen showed the map. User would find out his location on the map when he unfolds it. By dragging a recommendation like a special local diner into the map, he'll get the location of the restaurant, distance and recommended route to reach there. c) User could click "comment" icon to read personal comments from earlier visitors. The comments displayed lengthwise from the highest rate to the lowest. The three interfaces presented here correspond with the behavior level of the framework.

The final prototype focused on the relationship between people and environment. During the travel, the scene shifted accordingly and the device could receive or generate information at the same time to shape a location-based city sensory experience with the combined perspectives of macro and micro.



Figure.3 Pattern of Tourists and Commuters

2.2 Socializer

When socializer (event attendee) attended a lecture or private party, they would carry cameras, mobile phones, MP3/MP4, backpack, purse or book. During the preparation for the event, they contacted each other in advance online or via phone before making decisions. When participating in the event, people appointed for a specific place to meet. After the arrival, they contacted each other by telephone or WeChat (a social real-time chatting app). They used MP3/MP4 to listen to the music, watch videos, and do some reading to pass the time. The event attendees thought it was good to find a person via GPS positioning in squares, shopping centers, or art galleries.

Based on the user research, an event attendee needed two levels of data, i.e., contact related data and action planning-related data. Five users' interview materials were analyzed and summarized by the research framework, the user behavior under a certain mobile context as follows:

Motivation level	Objective	Meet up with others; contact the participants; share contact details.
Behavior level	Role	A socializer (event attendee).
	Task	a) When a user yet reached the destination, or waiting for the other participants.b) When it's not easy to find one another.c) When users share contact details.
	Action	Arrange gatherings; add members; Press a member's avatar to contact him; unfold the device and drag a member's avatar into the map to

Table 2. Research framework of socializer

		obtain the geographic information; use the device to scan the crowd and find the member of the gathering group; automatically display the contact details when two or more gathering-mode phones are put next to each other.
	Method	 a) Four tabs: scan, contacts, calendar, and history. b) The gathering group avatar: a group member interacts more with the user, his avatar appears closer to the user's avatar. c) Automatically display the new attendees' avatars when two or more gathering-mode devices are put next to each other. c) Press a member's avatar, to contact via massage or phone call. d) Click on a member's avatar, to get his basic information and geographic information. e) Fold the device, back to the initial interface. f) Scan the crowd with the device, get the public information from network. When a gathering group member gets into the scan range, the device will remind the user.
		g) Stop scanning the crowd with the device, the interface returns to the initial state.
Support level	Service	 a) Environment: public transportation, the info-system of shopping mall, mobile devices. b) Services: Based on cloud computing, pervasive computing, augmented reality technology and the Internet of Things technology, the mobile device records every interaction during the gathering; real-time geographic information pushed to the mobile device; connect mobile phones to share contact details with one another; obtain personal public profile information from social network.
	Tools	 a) Tool: mobile devices, sensors, cloud computing technology, pervasive computing technology, the Internet of Things technology, facial recognition technology, and augmented reality technology. b) Content: personal basic information, geographic information, and personal public information generates by the mobile devices, the systems of the public transportation, and the shopping mall.

In scenario of socializers, user interfaces (Figure.4) focused on the social interaction. a) The user could directly see gathering group members' avatars around him from the initial interface. He could interact with attendees based on the distance and the size of their avatars. b) People's public profiles appear when the user holds the device to scan the crowd, including avatar, username, status, and public information. c) The device could be unfolded to display the avatar interface on the screen below while the top screen showed the map . d) When switched to multi- attendee mode, the device could share personal basic information with others. The three interfaces presented here correspond with the behavior level of the framework.

The final prototypes focused on interpersonal relations. It worked as an elastic social application that could reflect the citizens' social interactive behaviors and patterns in certain context.



Figure.4 Pattern of Socializers

2.3 Outworker

When outworkers like couriers and outside reporters conducted an interview or a product research, they carried the cameras, mobile phones, laptop, record pen, backpack, purse, and notebook, etc. Couriers and outside reporters always took the initiative to find and collect information when they were working outside of office, observing the environment with cautiousness. Once they noticed any work-related thing, they would try their best to get detailed exhaustive information including: video, audio, text, etc. They used the camera or mobile phone to take pictures, use mobile phone or record pen to do recording, and take notes on notebook or on a mobile phone. After the information collecting they organized and analyzed the information in a coffee shop or in the office later. Editing was a laborious task, which took a long time for them to clarify the logic as well as to organize the materials. They were also eager to receive opinions from others to help themselves to be more objective and comprehensive when dealing with reports.

Based on the user studies, an outworker had three kinds of action: information collecting, information filtering, and information organizing. The user behaviors in a certain mobile context could be framed as follows:

Motivation level	Objective	Work outside of the office to collect, save, filter, organize, and share information.	
	Role	An outworker (couriers and outside reporters).	
	Task	a) When the user is outside of the office to collect information.	
		b) When the user needs to filter the collected information.	
		c) Share the well-organized data.	
	Action	In the context of collecting interface, aim at the target with the device, circle it, and get related information; unfold the device, click to read	
		every information in detail, tick to save it, cross to delete it; drag and	
Behavior level		drop the information into the edit box; modify the data; share the well-	
		organized data.	
	Method	a) Five tabs: collect, map, edit, share and history.	
		b) Aim at the target with the device, circle it, get the relevant	
		information: introduction, comments.	
		c) Editing interface: the information is presented in the left area. This	
		information area can be hidden.	
		d) Subject box and edit box is in the right area, can be expanded.	
		e) Gesture: from left to right, back to the initial interface.	
Support level	Service	a) Environment: the info-system in the coffee shop, etc.	

Table 3. F	Research	framework	of	outwor	ker

	b) Services: Based on cloud computing, pervasive computing, the Internet of Things, LBS, and augmented reality technology to collect information freely; to save audio, picture, and text without hesitation; to organize information methodically; to share information precisely.
 Tools	 a) Tool: mobile devices, sensors, cloud computing technology, pervasive computing technology, and the Internet of Things technology. b) Content: Information generates by the user, like audio record, photos, and text. Information generates by the swap shop including basic introduction, product information, and comments by customers.

In scenario of event attending, three interfaces (Figure.5) were developed for further testing. a) The initial interface helped to collect information when holding horizontally. It can switch to camera mode when the user holds up it in front of his eyes. b) By unfolding the device, the left screen used for collected data while the middle and the right screens were used for article structure (The news report structure is used as an example here.). The left edge of the unfolded device was a portal for information from other sources, like mobile phone, record pen, etc. Replies from colleagues or partners displayed on the top of the middle screen. c) The "gather" and "spread" gesture was created to view the detailed contents or to show the structure quickly. The four interfaces presented here correspond with the behavior level of the framework.

The prototype reflected interaction design for outworkers focused on the relationship between people and media. To accomplish a specific task in intelligent environment via mobile device needed to combine virtual with reality. The user constantly obtained controllable information during a mobile working process. It utilized the concept of "crowdsourcing" and combined itself with the intelligence of the public (collective intelligence), helping outworkers to dig out value from the growing accumulation of city information.



Figure.5 Pattern of Outworkers

3. Discussions

In user testing phase, five participants were invited into the focus group. The participants' feedbacks focused on four respects: functions, the way to use, the device material, and the support from the intelligent city.

• For pattern of traveler, the feedbacks shown: a) Interest and location based recommendations were very important to travelers. Sometimes the users liked to spear a whole afternoon to visit the city for business.

They have no time for a long trip but eager to take every opportunity to know more about the place. If every city can provide visitors with this kind of service, it will advance the development of their cities. b) Users liked using a thinner and lighter travel guide. When opening a travel guide on mobile device, they liked to see well-arranged quality information. c) It would be very helpful in daily life to find ways and places around the city for users. d) Users preferred the traditional methods to search things. They thought it was inconvenient to unfold the device when they were in hurry.

- For pattern of socializer, the feedbacks shown: a) Users liked the way that they could access to every friend after they made calls. b) Users thought it was good to know where their friends were because it reduced phone calls, insecurity feelings and help those who are waiting to make proper plans. c) It's more convenient for user to exchange personal basic information with a new friend via mobile device in multi-attendee mode than to input everything on their own. d) Users thought it was impolite to trace a friend's location because their friends deserved some privacy. e) Users felt it was cool to have a transparent foldable device for it was too slim to take up much room in their bags or pockets.
- For pattern of outworker, the feedbacks from reporters shown: a) It's convenient for users to do editing work and review the firsthand information at the same time. b) Different report should be shared with different people. Some part of the work report can be shared to the public and other part of it can only be shared to colleagues. c) This share function was not very important to some of the users. Reporter said they only cared about feedbacks from the boss. d) They liked the way to collect information. Sometimes they need to write down every idea that accidently appears in their mind. And this can help them to collect ideas at once. e) The co-working part was important for junior journalist. They need to know every opinion form this mentor for a specific report. Also the structure function can help them to balance the different parts. f) Users liked the device, because it can be folded into a smaller shape and unfolded into a bigger one when they want to write something.

Through the user testing, the research framework could give efficient guides for developing the typical mobile patterns in different contexts. This method could help the designer to generate new design solutions and identify the design pattern of urban mobile experience as well.

4. Conclusions

The final deliverables of this research were context-related research framework and design patterns, which include typical user behavior, interface model and context. This framework gave the solution of identifying the urban experience, using this pattern during development of the new user interface, it gave a solution to comprehensive human behavior and showed how new technology made these patterns work. The results obtained in focus group testing allow the conclusion that this framework is a suitable tool for understanding and designing the future user interface and experience. It can also help the planer and manager to better understand the planning and renovation of the existing urban system, improve the quality of real city life, and develop new integrated application and service to enhance the urban interaction experience between the people and intelligent city system.

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