



A SURVEY OF PEDESTRIAN NAVIGATION SYSTEMS: PUBLIC DISPLAYS AND HANDHELD DEVICES

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ABSTRACT

Pedestrian navigation systems help us make a series of decisions that lead us to a destination. Nowadays, public displays spread in public spaces and have become available and useful in many purposes for people's life activities, where pedestrians might be utilizing them to find their location and orientation in unfamiliar environments. Furthermore, mobile devices also provide support in these settings. While many of these solutions work well on an individual level, they are less well suited for very crowded situations, e.g. sports matches, festivals and fairs, or religious events such as pilgrimages. However, the people who use these systems in their navigation face many issues, e.g. a key disadvantage of public signage is that it does not provide personalised navigation support. In this paper, we provide a complete analysis and comparison of those systems and describe the issues of every single system.

Keywords: Dynamic signage, crowds interfaces, cross-cultural interface, public displays, user studies.

الملخص

تساعدنا أنظمة ملاحاة المشاة على اتخاذ سلسلة من القرارات التي تقودنا إلى وجهة. في الوقت الحاضر ، تنتشر العروض العامة في الأماكن العامة وأصبحت متاحة ومفيدة في العديد من الأغراض لأنشطة حياة الناس ، حيث قد يستخدمها المشاة للعثور على مواقعهم واتجاههم في بيئات غير مألوفة. علاوة على ذلك ، توفر الأجهزة المحمولة أيضاً الدعم في هذه الإعدادات. في حين أن العديد من هذه الحلول تعمل بشكل جيد على المستوى الفردي ، إلا أنها أقل ملاءمة للمواقف شديدة الازدحام ، على سبيل المثال. المباريات الرياضية والمهرجانات والمعارض أو المناسبات الدينية مثل الحج. ومع ذلك ، يواجه الأشخاص الذين يستخدمون هذه الأنظمة في التنقل العديد من المشكلات ، على سبيل المثال من العيوب الرئيسية للافتات العامة أنها لا توفر دعماً مخصصاً للملاحاة. في هذه الورقة ، نقدم تحليلاً ومقارنة كاملين لتلك الأنظمة ووصف المشكلات الخاصة بكل نظام على حدة.

الكلمات المفتاحية : اللافتات الديناميكية ، واجهات الدفع ، الواجهة عبرالثقافات ، شاشات العرض العامة ، دراسات المستخدم.

1. INTRODUCTION

Recently, researchers and interesting designers started hard work to solve the pedestrian navigation drawbacks. They attempt to design appropriate systems that might be assisted pedestrians to navigate from place to another in unfamiliar environment. We categorized the systems have been done in this context into four types as the following:-

1.1 Social Navigation

Social navigation is one of the wayfinding ways, where many people are using it in their navigation even nowadays. It could be represented in enquires, where pedestrians can ask any local person to obtain some information about their locations and destinations. The social navigation has improved, where in some places, pedestrians can find offices or agencies are working to provide information for people who need aid to know some information about their places especially in tourism places. The technique use in these agencies is human guide. The human guide is a person who has experience in the wayfinding field. Usually expert guide use some tools which using them to explain and illustrate to visitor about specific area. The tools could be maps, photographs, guidebook, etc. In addition, the human guides could categorised such as desert guide (the persons who have experience about Sahara routes, paths, and places). Also at Mecca (Hajj) there is human guide called guide (the person who guide people to visit places where he has experience about routes and places). Actually, until now there is no any technology system used to guide people at Mecca. The people who navigate there are still using human guide to guide them and show them the places. There are many static signs are distributed in each street and inside corridors Mecca's Haram. However, the majority of visitors are facing problems to deal with them. Moreover, in Egypt (Pyramids), visitors are using the same way in their navigation to visit the Pyramids. However, the visitors facing many problems when they using this way of navigation (human guide) such as:

- Restriction (user needs to be free to go where he/she wants to go).
- Limited information (the human guide takes the visitor to certain place rely on user demand)
- Cost.

1.2 Navigation Supported By Public Displays (Signs)

Public displays divided into two types:-

1.2.1 Static Signage:

Static signs are very important for pedestrians to find their destinations even nowadays. Numerous of people find many benefits from static signs such as to identify the roads directions, complex buildings names, hospitals wards numbers, streets names, flats numbers, and inside complex buildings: emergency signs e.g. exit, fire exit, etc. However, there are many issues facing pedestrians when they interact with static signs. Based on previous studies [15], they are concluded that the people have trouble with static signs, the following some those issues:

• Illegibility:

A pedestrian finds some difficulties to interact with stationary signs for example, he/she finds sign nevertheless it is hard to read. (i.e. the lettering is too small, the contrast with the background, although a message might to be quite clear to the person who originally put the sign up, it may be wholly unclear to the observer), If someone has visually impaired or blind, and it could not suitable for elderly persons[15].

• Ambiguity:

Although a message might to be quite clear to the person who originally put the sign up, it may be wholly unclear to the observer.

• Conflict:

Bits of conflicting information in a sign (or in two signs close together) create difficulties. This happens particularly when new signs installed and the old ones not removed, or it may be the result of two signs that complemented each other at one time, but that conflict in new circumstances.

• Inaccuracy:

It is essential to provide all the information that people need, when they need it. However, it must be the right information –up-to-date, and accurate.

- **Unreliability:**

Most people are prepared to depend on signs in an unfamiliar setting, but only for as long as they are dependable and do not, for any apparent reason, suddenly let them down.

1.2.2 Dynamic Display

Nowadays, dynamic display became available and very important in the most of all people activities, where people can benefit from dynamic display to perform several services. It could be more facilities than static signs guide and mobile devices such as sufficient screen size, information up to date. For instance, in the airports travellers able to get up dating information about their trip, in hospitals people could be obtained information about an appointment time, doctor name by dynamic touch screen, etc. addition, it may use dynamic display in navigation system to help people reach their target such as GAUDI system[03].

1.3 Navigation Support By Personal Tools

Pedestrian navigation supported with personal tools could be dividing into two sections such as Analog tools and digital tools.

1.3.1 Analog Tools

Most people when they intend to visit unfamiliar environment normally they should be use tools which provide them the information about that area. These tools, which they are carrying, could be guidebook, hardcopy map, hardcopy list of instructions, and so on. Actually, these tools are considerably useful in this situation where pedestrians via these tools might be able to get their destinations successfully. This is not always true, because many issues could be facing pedestrian when he/she attempt to use carried tools, it might be not enough clear, difficult to follow the map, instructions, and guidebook. Some people should do other tasks and they have not time to see the tools, which they were carry, also some people are carrying luggage consequently their hands full of activity.

1.3.2 Digital Tools

Recent mobile computing solutions such as PDAs, GPS, and mapping software are easier to update. In addition, the users receive directional information from web server or central services via their personal device. This information which pedestrians received could be as visual such as map, textual (a set of instructions), photographs, mixture or auditory for instance, sound / voice, video, music, or hybrid. Another possibility would be to store the necessary data on the mobile device, but two disadvantages are connected to this solution [01]. On the one hand, there is the limited memory capacity of mobile devices and on the other hand the lack of up-to datedness of the stored data. Hybrid approaches are also good possibility, some data store on a server and some on the mobile[06]. However, all these information shown on the personal devices screen. As a result, a user sometimes could not read or recognize it, because the PDA screen size is small, also at times there is no accuracy guidance (i.e. the user must stay seated or stand in right direction during receiving the information). Otherwise the guidance will be unsuccessful) [02]. On the other hand, we cannot always expect that users in complex environments (railway stations, airports, hospitals) will be able to use a mobile phone or PDA with their hands. They might be carrying luggage, which would prevent them from using a mobile phone without a hands-free set; they might not want to attract the attention of other people; or they might need their hands to use a device such as crutches. That means in certain application areas, the user group will be restricted to persons owning a hands-free set or comparable product and to those who are willing to use it in a certain environment [02].

1.4 Navigation Supported By Public Display And Mobile Devices

Public displays could be static signs or dynamic signage, both of them is very important in wayfinding field, where pedestrians might be exploring unfamiliar area through them. In this situation there are some researches talking about how utilize the public displays to support people who travelling from place to another, in addition the mobile devices are improved and become including high technologies and many facilities. As a result, the researchers could use these technologies to improve the wayfinding field such as combine public displays and mobile devices. In related work section we introduced some systems were done in the wayfinding used public displays and handheld devices.

2. RELATED WORK

There are several systems were done in this field. Where, a person able to interacts via public displays to obtain information about her location and target. C. Kray, et al [03] they describe a public navigation system, which uses adaptive displays as directional signs. In addition, they identify novel approach called GAUDI System. The components of this system are a number of displays (dynamic signage) wireless connected with server. Every sign autonomous, the displays are distributed through the building corridors in explicit places where user able to deal with them and get directions information. There are several advantages in this system such as easy to setting up, it possible to add or remove a client into this system. A user can interact with displays by several ways such as manual procedure via administrator, by sensors, or by touch screen [7,8]. In addition, he/she can obtain full information about the paths of that building, the information could be arrows appear on the display with brief description, or photographs which shown on the large screen, user can touch on photograph of person who wants to see, then all the situated displays in the building will display arrows. These arrows all point towards the target office[11]. However, this system interacts with single user, the authors argued that in the future they would complete this prototype to enable multi-user to interact with this system. In addition, there are many information points distributed in certain area to provide people information about their locations and destinations; i.e. it can shows maps, textual, or photographs to illustrate the user directions and destinations. User can interact with display by touch screen.

2.1 Examples

J. May, et al, [01] they are talking about the quality of information that pedestrians need during their navigation. It should be very important to understand what kind of information pedestrians required. In addition, they argued that there are several important questions should be taking into account. For instance, what information do pedestrians need when they navigate in unfamiliar environment? What terminology is using to describe this information? How important is particular information in enabling key navigation objectives, and to what extent is information redundancy employed in navigation instructions?

A.K. Beeharee, et al [02] they discussed how pedestrians can reach to certain places (such as buildings, parks... etc) supported with photographs already are stored into his handheld device. The authors in this paper want to propose and give an initial study of a guiding system that utilises photographs. These photographs are not explicitly took with the intention of using them subsequently for giving route directions; rather they are extracted from existing geo-tagged photo collections from mobile phones. A user of this system sees a route description as text and a map that refers to a series of photographs. The main contribution of this system is in demonstrating this concept and testing it in an exploratory between-subjects experiment. The experiment shows that presenting the right photographs certainly can help with particular types of routing instruction for users not familiar with an area. In addition, this paper discusses a new opportunity for guiding and routing services based on another facility of mobile devices that is becoming ubiquitous: the ability to take and store photographs. One issue with guiding and routing services is that they still rely mainly on giving their instructions using maps and text. They proposed that a complementary mechanism for explaining routes as a series of references to photographs, where target directions or turning instructions can be gave with a reference to photographs [10]. As a result, the photographs are very important as support references for pedestrian navigation and not as main reference.

M. Eissele, et al [09] they focused on indoor navigation environments. Their system concerned with providing assistance to the user who looking for their location and destination. A user could be using their mobile devices to capture some visible locations: such as posters, door plates or labelled installations and send it to the central server. Actually, the system consist of two main components: A server connected to a database to perform optical character recognition and text matching and a hardware specific client application to perform navigation tasks and access additional information to real world texts. A user after he sent information which he captured it by his PDA, he now waiting for the feedback from the server. As a result, by that feedback he will achieve information about his surrounding area [13,14].

Important point: user's PDA interacts with static sign to get information about his surrounding environment. Which meant the static sign information is one of the important resources in this technique[09]. In the other words, the prototype in this context using the static signs tools as inputs for this system to get information about that unknown location inside building. . Figure 1 shows how this system is working.

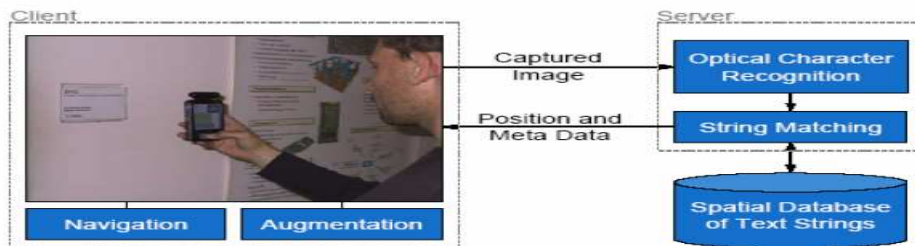


Figure 1 Shows System Overview [09]

E. Rukzio, et al [05] they describe that in current mobile navigation systems users receive the navigational instructions on a visual display or by descriptive audio. They are identified how pedestrian by mobile device and public display able to receive directional information. Furthermore, they introduce the concept of synchronized information displays for navigation. All users have handheld devices and the displays shown four directions arrows, also there is synchronization between the display and user's PDA, the distance between the users and the display should be appropriate to allow users to recognize and understand the information which appear on the display, and the user's place also should be not in crowded. Otherwise the information will be unclear and noisy [05]. When the public display highlights the direction that a person needs to go the personal device of this person will vibrate. The display highlights the directions independent of the people around. We concluded that this system is relevant to my work as in my system we will use public displays and mobile devices, the second point we attempt to let my system working with multi-user as this system work, the third similar point it could use the synchronization Technique.



Figure 2 Illustrates how the system working [05]

In addition, E. Churchill, et al (2004), they argued that the Digital Graffiti system enables traveller users to annotate content displayed on a public screen, which relies on sending data from a mobile device over a network connection to a public display. Users of this system can use a PDA (Personal Digital Assist) to create notes relating to content shown on the public display. Then shown alongside the content on the public screen [16]. Figure 3 shows how this technique work.



Figure 3 illustrates Annotating a public posting using a Personal Device [16].

3. Comparison of systems

The table below shows the systems types, system background, techniques, issues, advantages and disadvantages of every single system.

Depending on the table results, we noted that the dynamic display was the best system compared with the others systems we investigated. There are many facilities could be available in the dynamic signage technique such as information accuracy, reliability and clarity. Furthermore, one of important goals is to make pedestrians feeling comfortable and pleasure when they are interact with it , and they definitely get their destinations by effortless.

Table 1 Comparison of systems

Pedestrian Navigation via different Systems	Pedestrian Navigation via Static signage	Pedestrian navigation via Personal Tools		Pedestrian Navigation via Dynamic display	Social Navigation
		Analog Tools	Digital Tools		
System background (definitions)	Static signs are one of the important equipment's of the wayfinding even nowadays. It could be provide extremely aids for pedestrians to find their locations and directions.	All tools which people can carry them to find locations and destinations. e.g. compass, stick, maps, etc.	Digital tools are very important to provide help guidance to people who find themselves in unfamiliar environment, such as mobile devices	In any modern Airport or Railway station, passengers informed of departure and arrival times by digital screens .showing specific content, this known as Digital Signage.	Pedestrian could be use someone who has experience about the environment which pedestrian wants to visit it. He guides him and shows him what he would like to see.
Techniques used	Maps, arrows, descriptions, directions support with maps mixed	guidebook, map, instructions, etc.	Mobile device Visual, audio, Both. i.e. Textual, Maps, Photos, Voice, video, etc.	Visual, audio, Both. i.e. Textual, Maps, Photos, Voice, video, etc.	Usually expert use some tools, he use them to explain and illustrate a bit background about that area to a user. The tools could photographs or map, etc.
System Benefits	<ul style="list-style-type: none"> - Guide people to their destinations in outdoor. -Identify the roads directions, - In complex buildings names, numbers, emergency signs e.g. exit, fire exit. - Hospitals wards - Streets names - Flats numbers, names. 	Provide some help to people to reach his destination	Lead people to achieve their target with several tools such as map, textual, photographs, sound, mixture. Information could be up date when PDA connecting with central server.	It could more effectiveness to provide clear and accuracy information to pedestrian. Where dynamic signage including many advantages such as: sufficient screen size, memory capacity, dynamic information, easy to setup, and easy to use and interaction with it.	It could be useful way to help people especially in tourism places ((tourist guide), desert guide, who has experience about the routs and paths in the desert. Also at Makah: the main guide is people who guide visitors and show them the places and routes.
System Issues	<ul style="list-style-type: none"> • Ambiguity • Conflict • Deficiency • Excess • Illegibility • Inaccuracy • Unreliability 	<ul style="list-style-type: none"> - Not enough clear. - Difficult to follow the information such - Some people have not time to read and recognize the Analog tools. - Some people are carrying 	<ul style="list-style-type: none"> -Limited screen size.(i.e. difficult to recognize and read the information is shown on the screen) -Limited memory capacity (i.e. memory not enough to store a number of images. -Lack of up to date (i.e. if the data were stored into mobile devices). -Inaccuracy guidance. 	<p>M. Czerwinski, et al,(2006) [12] they identified several of the usability issues such as:</p> <ul style="list-style-type: none"> - Losing track of the cursor. As screen size increase, hard to keep track where the cursor is. -Distal access to information. As screen increase, it 	<p>The problems facing the pedestrians as:</p> <ul style="list-style-type: none"> -Restrict (user need to be free to go where he want to go). - Limited information (the guide take the user to certain places rely on user demand). - Cost.

		luggage and some have disabled and use devices such as crutches as a result their hands are busy.		become increasingly more difficult and cursor, distal access to windows and icons, dealing with bezels, window management, and task management.	
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4. RECOMMENDATIONS (FUTURE WORK)

As a future work, we suggest that Dynamic signage system could be useful and providing assist to pedestrians to find their way in unfamiliar places. The idea of our suggestion is concerned with providing assist to pedestrians to find their way in unfamiliar environment by a novel system that supports Pedestrian Navigation via Dynamic Signage and Personal Devices. The system consists of a number of displays as directional signs. The displays distributed in different places in certain environment. It could be wireless connected with the storage database, which provides the information to the signs. All displays operated interdentally from each other. The displays can supply pedestrians with directional information. Pedestrians are able to interact with the signs by several ways such as PDAs, sensors, or touch screen to determine their directions, orientations, and locations through that environment. It is important to take into account that the GPS system is working only in outdoor environment [04]. However, Bluetooth is adequate to swap information between user and signage in both situations indoor and outdoor. With regard to indoor situation such as complexes buildings, airports and hospitals the signage could be mounted on walls via the buildings corridors in highly visible places. That could allow pedestrian to interact with the signage without any effort, where he/she can recognize and understand every things are showing on the signage.

In addition, there are many important considerations should be taken into account for example, the distance between user and display (i.e. user able to recognise and understand the contents are illustrated on the sign), the display size i.e. appropriate screen size which allows user to interact with sign by effortlessly [03].

There are many important points in this idea for instance, it is necessary to understand the information requirements of pedestrians when they are near to signage, and what the information particularly they are looking for and how use it [01].

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