Manasek AR: A Location-Based Augmented Reality Application for Hajj and Umrah

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Abstract. In this paper a location-based augmented reality application is presented. It is a mobile application whose goal is to facilitate the journey of millions of pilgrims when performing Hajj and Umrah and overcome the difficulties they face. Using the Augmented Reality, the application displays different types of information about the pilgrims surroundings in a mobile camera view. The usability testing of the proposed application ended successfully with a very high rate of positive feedback from users.

Keywords: Location-based Augmented Reality, GPS, compass, accelometer.

1 Introduction

Millions of pilgrims come every year to Mecca[1] to perform Hajj[2] during the days of Hajj or to perform Umrah[3] at any time during the year. Statistics about the number of pilgrims who came to perform Hajj in the last five years are given in table1 [1]. Pilgrims need all the necessary information to accomplish their spiritual journey such as what rituals they must do, what places they must visit, where these places are located and how far are these places. They can get this information from several sources such as: their campaign, ask volunteers, use conventional maps or following the signs. But there are problems when using these sources; some of them are not available all the time like the lack of volunteer, also joining a campaign force the pilgrim to stay all the time with them which prevent him from moving freely. Some of sources do not give the pilgrim accurate and adequate information such as street signs, so they are not enough to guide him. Also, it is not practical to carry manuals all the time, also manuals are not trusted because any one can print and publish them. Some of pilgrims cannot read maps. In addition, many foreign pilgrims are visiting Mecca once in their lifetime and during their presence in the country they would like to learn more about these holy places.

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[1] The holy city in kingdom of Saudi Arabia and it contains the holy places of Islam.
[2] Means literally "to set out for a place". For a Muslim, that place is the Holy City of Mecca.
[3] Visit of the holy places and perform Tawaf around the Kaaba and Sa'i between Al-Safa and Al-Marwah, after assuming Ihram (a sacred state).

Table 1. Distribution of Pilgrims per year

Year	Total number of Pilgrims
2009	2,313,278
2010	2,789,399
2011	2,927,717
2012	3,161,573
2013	1,980,249

To address this issue, this paper presents a mobile application based on Augmented Reality (AR) which aims to facilitate Hajj and Umrah journey for pilgrims through the use of their mobile phones. The proposed application, called Manasek AR, displays all the needed information about the pilgrim's surroundings in a mobile camera view.

The rest of the paper is organized as follows. In section 2, a brief overview of related work is given, followed by the description of the proposed software application in section 3. In section 4, results of the usability testing are discussed. Finally, the section 5 concludes the paper.

2   Related Work

Augmented reality (AR) is considered as variation of Virtual reality (VR). In AR, the user can see the real world, with virtual objects superimposed upon or composited with the real world [2]. In other words, a typical AR environment has digital information transposed onto a real-world view. While in VR, the user is totally immersed in a virtual or synthetic world. Therefore, AR supplements reality, rather than completely replacing it. In [3], an AR system is defined as the user interaction with the real world through supplementing the real world with 3D virtual objects.

Several papers have been written on augmented reality [2], [3],[4] and many application areas use this technology, such as in medical [5] [6] [7] [8], military [9], manufacturing [10] [11], entertainment [12].

Augmented Reality is now emerging as an important technology for many commercial applications in different fields. In tourism, for example, many AR phone applications have been developed such as Wikitude [13], in 2008, and Layar [14].

3   Methodology

Manasek AR utilizes the local-based augmented reality to improve the Hajj and Umrah experience for pilgrims and overcome the difficulties they face. It provides a complete guidance for pilgrims by giving them all the needed information about Hajj and Umrah places in a completely different way that engage them with their immediate surroundings.

Manasek AR locates the place on the mobile screen tracked by the mobile camera of the pilgrim. The position of the place is calculated using the pilgrim's position with GPS, the direction of the device is calculated using the compass and accelerometer. When the object is located, the augmented reality takes place by giving description about the object on the mobile screen. Internet connection is not required for this service because when a place is located, their related information are retrieved from a database, these database contains all the information about the saved places. The architecture of application is given in figure 1.
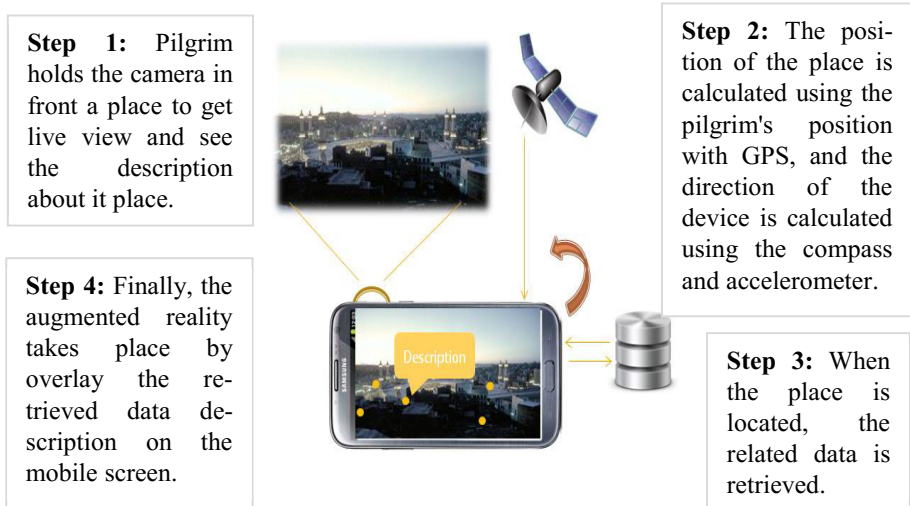
Step 1: Pilgrim holds the camera in front a place to get live view and see the description about it place.

Step 2: The position of the place is calculated using the pilgrim's position with GPS, and the direction of the device is calculated using the compass and accelerometer.

Step 4: Finally, the augmented reality takes place by overlay the retrieved data description on the mobile screen.

Step 3: When the place is located, the related data is retrieved.

Fig. 1. Manasek AR Architecture

The application allows pilgrims to choose the type of information; either locations of Hajj and Umrah places (how far are they from those places), historical information about the places or guidance information of how to perform rituals related to a particular place (Manasek information). Also allows pilgrims to add their campaign place, view maps, and get the recent news of Hajj circumstances through the official account of the Ministry of Hajj and Umrah on twitter.

3.1   Application Features

The features or functions provided by the proposed application are presented and explained in the following.

AR Function and Information Types. This function allows pilgrims to choose the type of information; either locations of Hajj and Umrah places, historical information about these places or guidance information of how to perform rituals related to a particular place (Manasek information). In figure 2, location information about King Abdulaziz gate are displayed. The location information are the distance between the

pilgrim and the gate (130m) and also the position of the gate in the holy mosque. Ma-nasek information about Kaaba[4] are given in figure 3, the information are the rituals that should be performed in this place. And in figure 4, historical information about Kaaba are displayed. User can swap the top bar to select a specific information type.
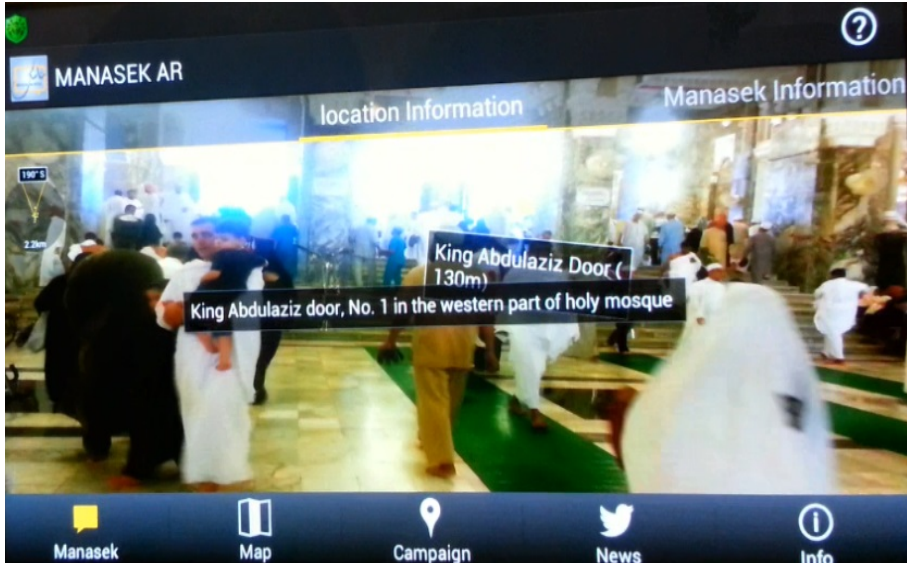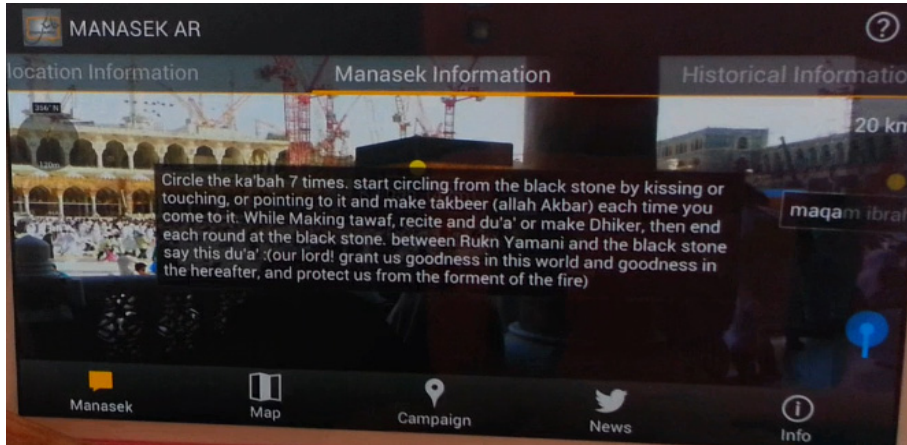

Fig. 2. Location Information

Fig. 3. Manasek Information
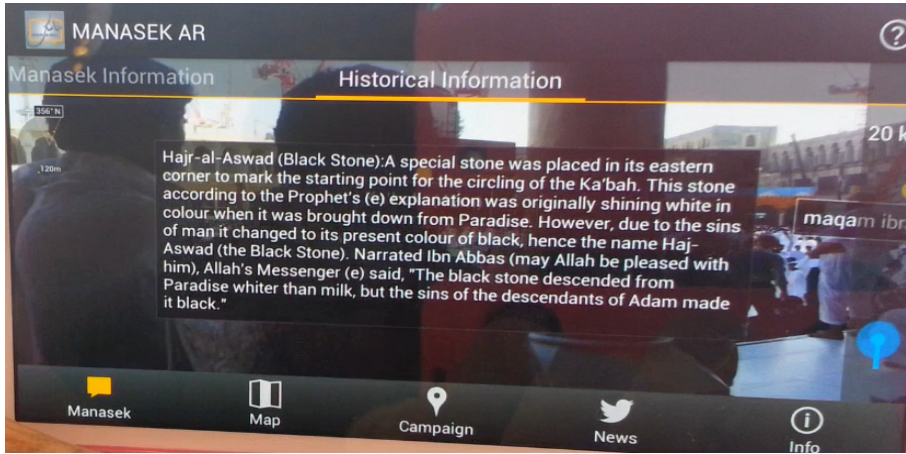
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[4]   Cuboid building at the centre of the holy Mosque in Mecca.

Fig. 4. Historical Information

Help Function. To explain to the user how to use the application properly, developers come up with a new idea that explains the whole interfaces and   the functions to the users in an easy and stunning way that fit and suit the nature of smart phones. The following steps show how to use this function:

1. The user has to touch the help button (question mark button according to Android list of legal button) in the top right of each interface screen, as shown in figure 5.
2. A semi-transparent panel will be displayed above the original interface, it includes arrows and brief descriptions of how to deal with the interface component.
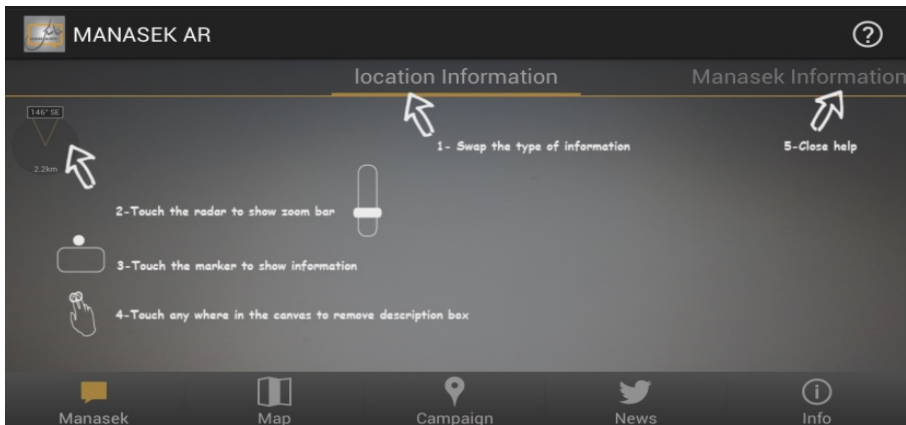3. To remove the instruction panel, the user has to touch the help button again.

Fig. 5. Help Function

Radar View Function. The radar is used to display the icons for objects outside the user's field of view by some range. It also acts like compass as it illustrates the coordination to the user whenever he/she moves its device. The objects on the radar indicating the existence of places around the user will be moved in and out of the view as the user moves and rotates. The radar view is shown at the top left corner in the tab "Manasek" as illustrated in figure 6.
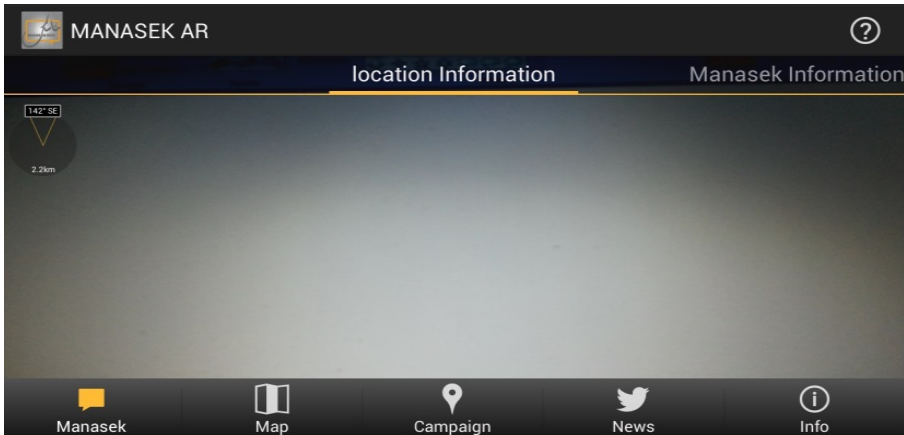

Fig. 6. Radar View Function

Zoom Bar Function. As mentioned previously, the radar view uses some range to display objects around the user and to allow the user to gain control of this range as he/she want. Developers give the user the possibility to set the radius of data collection from 0m to 20,000m (20 km). To display the zoom bar to the user, he/she has to touch the radar view in the tab "Manasek", and the zoom bar will be immediately displayed in the right side of the screen.
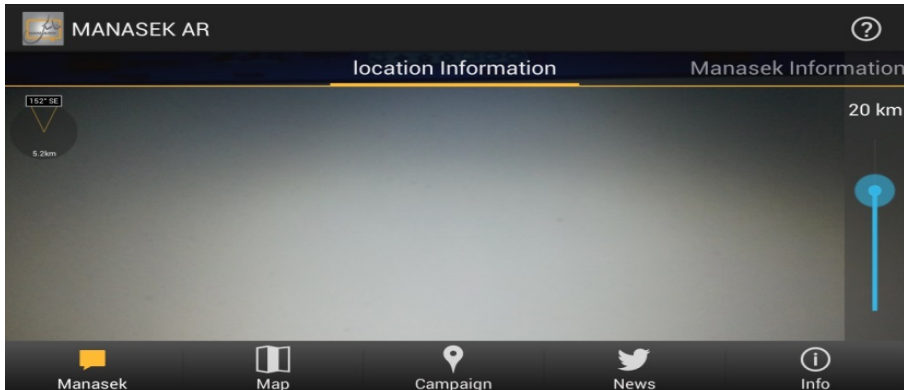

Fig. 7. Zoom Bar Function

Add Campaign. When the user clicks on the campaign tab the camera view will show up. The user should be in the same location of the campaign to add the camping marker because the marker depends on the user location. This procedure is illustrated in figure 8.
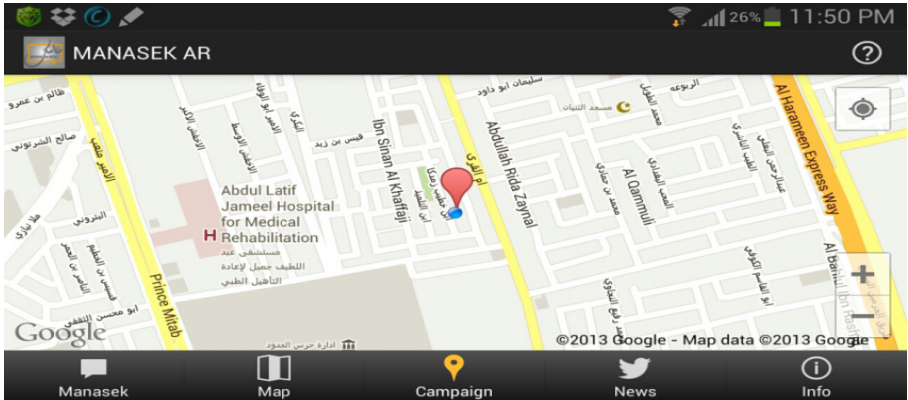

Fig. 8. Add Camping Function

Delete Marker from the Map. When the user add a marker via Add Campaign function, the marker will appear on the map. To delete this marker for any reason, the user should follow these steps:

• Long click on the marker.
• Alter dialog will show up, as shown in figure 9.
• Yes, to delete the marker.
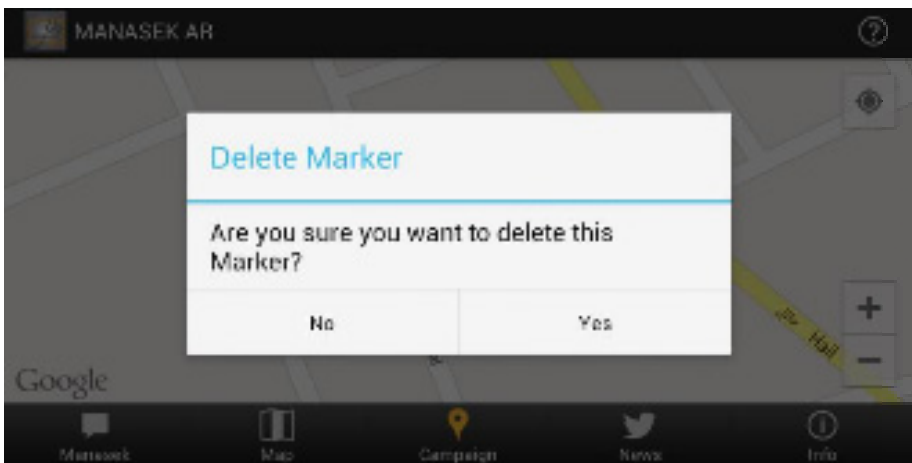• No, to keep the marker and cancel the operation.

Fig. 9. Delete Marker – View Map Function

News. When the user clicks on the " News " tab for the first time, a blank page is displayed. After that, the user pulls the page to get the recent news from twitter. Finally , the news are returned from twitter and presented as a list, as shown in figure 10. The user can pull the page when he/she wants to see the recent news from twitter .
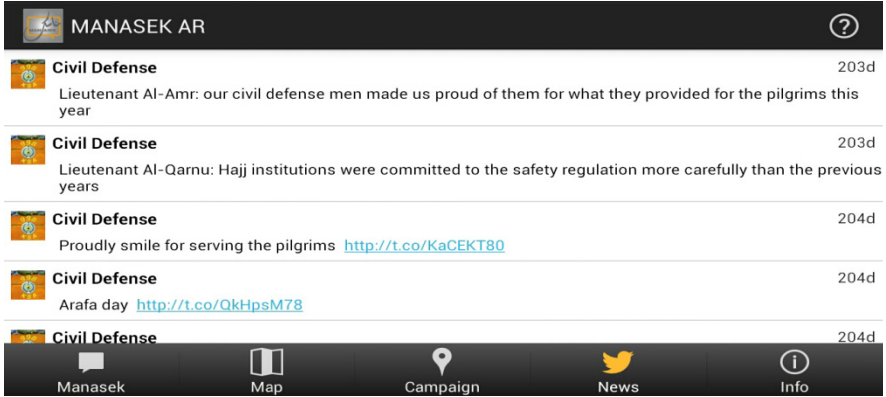

Fig. 10. News Function

The proposed application is similar to the AR software Wikitude [13]. We present in the following the differences between Masasek AR and Wikitude:

- Manasek AR's database content is static and updated under the supervision of developers. Unlike Wikitude, it is mostly user generated.
- Manasek AR is customized only for Hajj and Umrah places and covers them with details. While Wikitude is a world browser.
- Manasek AR provides different types of information for users. It allows pilgrims to choose the type of information; either locations of Hajj and Umrah places, historical information of these places or guidance information of how to perform rituals related to a particular place. Besides, other services are available to help pilgrims in Hajj and Umrah.
- Internet connection is not required for most of the services of Manasek AR. This is because of the static database that contains all the information about the saved places.

4   Usability Testing Results

This testing process involves several users outside developers team , and those who have no idea about the application, and give them a set of tasks that cover all interface functionalities. Tasks are given in the table 2. During usability testing, testers observe the users' attitude. The results of this testing are excellent and most of users perform the tasks without confusion.

Table 2. Usability Testing Results

Task	Comment
View help	Done correctly
Hide help	Done correctly
View map	Done correctly
Show the location information	Done correctly
Show the manasek information	Done correctly
Show historical information	Done correctly
Hide the information box	Done correctly
Show the zoom bar	Done correctly
Hide the zoom bar	Done correctly
Add campaign	Done correctly
Delete campaign	There is some late . Developer solved this problem.
View info	Done correctly
View Twitter timeline	Done correctly

The system testing was performed in the holy Mosque in Mecca. The system recognizes all the places contained in the database, gives the right direction, and displays the correct information according to the selected type of information.

In the usability testing, 35 users outside the developers team were involved. They performed tasks that cover all the interface components. Very good results are obtained and most of users perform the tasks without confusion and give positive feedbacks.

5   Conclusion and Future Work

Manasek AR is classified as a location-based augmented reality application which provides a complete guidance for pilgrims. It displays all the needed information about the pilgrim's surroundings in a mobile camera view. Also it allows pilgrims to add their campaign place, view maps, and get the recent news of Hajj circumstances through the official account of the Ministry of Hajj and Umrah in twitter. Manasek AR's goal is to grasp the opportunity of utilizing AR technologies to improve the Hajj and Umrah experience for pilgrims and overcome the difficulties they face. An evaluation was done to examine its ability to display places' information regarding these places in Mecca correctly. The evaluation ended successfully with a very high rate of positive outcomes. As a future work, the system can be extended to cover different cities and places in Saudi Arabia.

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