Browsing Reality: Dynamic Contextualization in Human Scale Smart Spaces

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Abstract
Augmented Reality (AR) systems can provide a method for browsing information that is situated in the real-world. We have developed a system that enable the user to browse the objects in the real-world with the help of AR. Our system is an AR application that incorporates information obtained by a Radio Frequency Identification (RFID) system. Our application runs on a smartphone or a tablet and its target space is a shelf. By aiming a mobile phone or tablet camera at a collection of items present on a shelf, a user can browse and interact with the items through the smartphone or tablet.The shelf is termed as smart shelf and it is equipped with the RFID system that makes it a smart space. All the items present on a shelf are RFID-tagged, so they can be inventoried and their locations are calculated with the help of the RFID system. The project is focused on enhancing and enriching the user experience in browsing physical reality.

Author Keywords
Mobile Augmented Reality, Browsing Realty, Contextualization, RFID, Ubiquitous Computing.

ACM Classification Keywords
H.5.m [Human-centered computing (HCC)]: Ubiquitous and mobile computing.

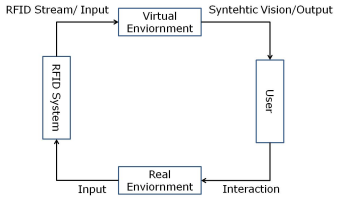

Figure 1: Conceptualization of the project.

Introduction

Over the last few years, browsing physical reality [3, 4] has become an active area of research due to the wide range of human-centric applications including context-aware, physical living environment, education, e-commerce, and other facilities. Many researchers [2, 5] are trying to achieve the goal of Browsing Reality although no concrete and exact solution has been found yet. The technology that leads browsing physical reality is AR.

We have developed a system to browse physical reality, in which the user is able to acquire information from the environment and surroundings. In this research project, we have utilized RFID for inventoring the objects and calculating location in smart spaces. Being focused on the scope of this project, we are enabling browsing physical reality by dynamic contextualization of items located on a shelf. We developed a smart shelf that is based on RFID. It has the capability of a smart space and the items located on the shelf are location aware. The user is able to browse and interact with items located on the shelf in a seamless manner. Our system is an AR application and it is developed using Metaio SDK [1] for the Android Platform. We used fiducial tracking over feature tracking because in combination with RFID it produced more cost effective results.

The services allow the user to interact with these items through a smartphone or a table. The desired contextual information about the particular item is projected at smart devices along an interactive graphical user interface. The user interaction with the items is also possible through a voice interface.

This project contributes to the bridging of online and offline worlds. The user is able to switch quickly and flawlessly from the offline world to online and vice versa. User can select, switch and browse the items in the same way as online browsing, in this way we can give more sense of control and immediate satisfaction by browsing in physical spaces. The core conceptualization of the browsing reality in the framework of this project is shown in Figure 1.

Methods and Procedures

We need to define how the system should sense information from the physical surroundings and how the resultant information should be presented. The different components of system should work in coordination and seamless way with each other fulfilling the requirement of ubiquitous computing. The interaction between the different components of the system is shown in Figure 2. We can divide the system into input methods and output methods.

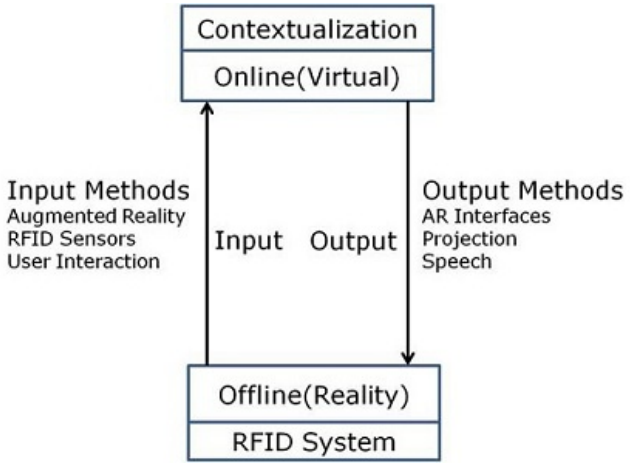

Figure 2: Interaction of different components of system.

User Input and Output

AR is considered as one of the latest technologies for interaction and displaying information. In the developed research project, we are overlaying the physical items

information and providing the context of a particular item as augmented reality. In this project AR is used for both inputs and outputs. Additionally, interaction through speech is also possible. The AR interface is developed with the help of Metaio for Android platform. The developed application is based on Android platform and Postgres DBMS is used for the management of data.

Smart Spaces
Our target space is a shelf and it is termed as smart space. It has the capability of providing real time inventory and location of items by using RFID system. The shelf is equipped with the RFID antennas that are connected to the RFID reader through multiplexers and the items present in the shelf are RFID-tagged.

Procedure
First, we place one fiducial marker at the center of the smart shelf. This marker helps us to map the coordinate system of the physical shelf to the Android device screen coordinates. Once the coordinates are mapped, the algorithm automatically applies the scaling factor in real time. In this way, we get the physical item location on the device screen. An interface is developed to browse through the shelf in real time. Once the user taps the item on the screen, the information about that particular item is presented.
Behind the scenes, we developed a database that contains all the information about the items present on the shelf with their locations obtained with the help of RFID system. Once the user taps on the screen we calculate the location of that item and we query the database and then we contextualize the particular item at that location for output.

System Architecture
From the core architecture point of view the whole system is divided into three basic layers. The First layer is for the user interaction on the smart devices, a friendly user interface is designed in which user is able to aim the smart device camera at the smart shelf with live video running on it and tap the specific area of interest. The user area of interest location is passed to the Metaio SDK which then maps the location to smart space. Next, the location segmentation of the particular area of interest is performed. Once we get the specific segment, this information is passed for inferencing inside the middleware. During the dynamic inferencing process, the contextualization of the item is performed and then the output is passed to the third and last layer, that is the output layer. In the output layer an interactive interface allows user to view the particular information in real time and browse items. The whole process is explained in Figure 3.

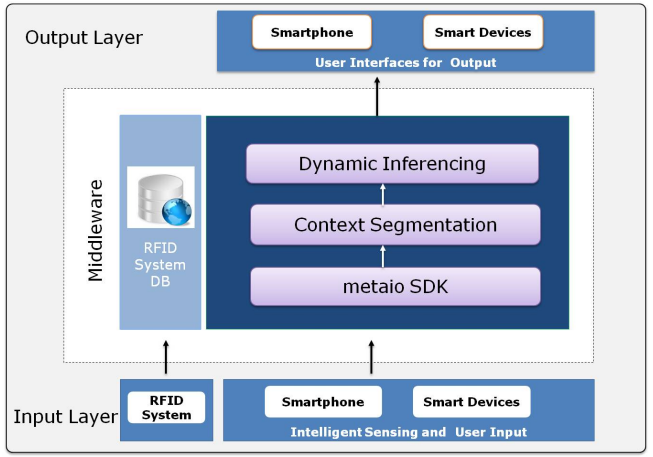

Figure 3: System architecture.

The RFID system dynamically tracks the RFID-tagged items, measures their location with an accuracy of 30cm, and populates the database.

Results and Conclusion

The developed system was tested with a shelf that contains various books at different locations and we were able to locate and browse the books with Android tablet. The results are realistic and have the potential for various scenarios, e.g. in retail, library. Figure 4 shows two screen shots of the AR application.

Figure 4: a)The user is aiming at shelf for information through the tablet. b) Contextualized information of books at user tapped location.

Some examples are discussed below to explain the application of the system in different life scenarios. Wheelchair user are limited to browsing the few items that are within their reach, and cannot examine goods in higher shelves, or those beyond arm's length. So this research project is a step forward towards independent living of handicapped people. The proposed system has the potential to revolutionize current library systems and the way we look for books. With the help of this system time can be saved.

Acknowledgements

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References

[1] metaio. http://www.metaio.com.

[2] Graham, M., Zook, M., and Boulton, A. Augmented reality in urban places: contested content and the duplicity of code. *Transactions of the Institute of British Geographers* (2012).

[3] Lupiana, D., O'Driscoll, C., and Mtenzi, F. Taxonomy for ubiquitous computing environments. In *First International Conference on Networked Digital Technologies, 2009. NDT '09.* (2009), 469–475.

[4] Merrill, D., and Maes, P. Augmenting looking, pointing and reaching gestures to enhance the searching and browsing of physical objects. In *Proceedings of the 5th international conference on Pervasive computing*, PERVASIVE '07, Springer-Verlag (2007), 1–18.

[5] Välkkynen, P., Niemelä, M., and Tuomisto, T. Evaluating touching and pointing with a mobile terminal for physical browsing. In *Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles*, NordiCHI '06, ACM (2006), 28–37.