A Design of Concept-based Augmented Reality Environment

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Abstract: Recently, augmented reality technology has been so advanced that familiar AR application has been increasing, especially for the smart phone applications. However, almost of them put stress on entertainment or commercial advertisement. Flexible framework and intuitive user interface technique is necessary to construct more familiar AR environment. So we consider real world interface, such as voice recognition, gesture recognition and so on. In this paper, we introduce a framework for AR application, that is concept-based AR to achieve distributed environment and real-world interface. This framework has features that user can get various information from real world objects easily.

Keywords: Augmented Reality, Real-World Interface.

1. Introduction

Recently, augmented reality (AR) technology has infiltrate widely and it is applied for various domain, such as medical treatment, manufacturing, and amusement. AR technology overlays some additional information on users' view on their mobile device such as a head mounted display (HMD) and a smart phone. It can reinforce and enhance humans' behavior and idea in the real world[1], [2], [3], [4], [5]. However, current many AR applications put stress on generating impressive AR view so that many developers supply these applications to show information, especially commercial information, effectively. So supplying information with these applications have become one-way traffic. AR application is strongly required that can support communication in the daily life.

Our goal is to construct more familiar AR environment for various users. In the environment, users can easily select information in AR environment whenever and wherever they like. And data update should be easier to operate. Furthermore, to construct familiar environment, intuitive user interface technique is necessary. So we consider about real world interface, such as voice recognition, gesture recognition and so on.

We plan to extend this AR application to communication tool for small office or laboratory and we have to consider about real world interface more. In this paper, we introduce a framework for AR application, that is concept-based AR to achieve distributed environment and real world interface. Each user can build data element with their environment. This framework has features that users can easily get various information from real world objects. So, they "click" some objects to reach various information about the object. Figure 1 shows a concept for AR tag for our daily life.

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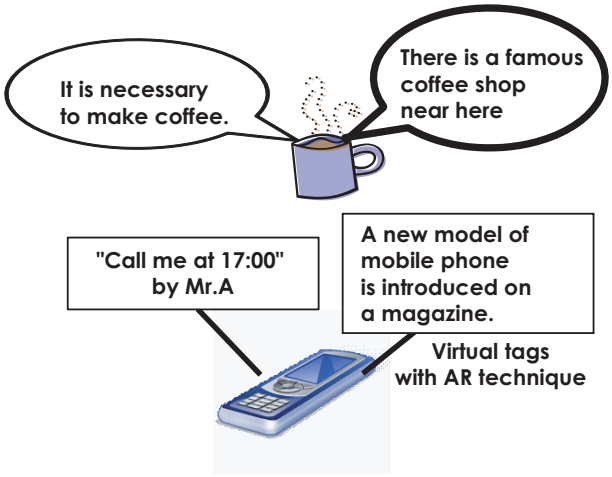

Fig. 1 An abstract of concept-based AR application. When users have cellular phone, some kinds of information about cellular phone is shown on the display.

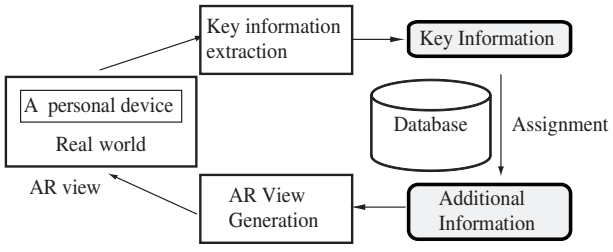

Fig. 2 Ordinary AR environment. First, some key information are extracted and corresponding information are found in the database. After that, these information are shown on the real world view.

2. AR environment

Figure 2 shows an abstract of ordinary AR environment. They have a database for correspondence between key information and showing data. After the keys are extracted or recognized, they show the corresponding data on the keys. In these AR environment, there are two types of key information such as vision-based and location-based ones as shown in figur 3.

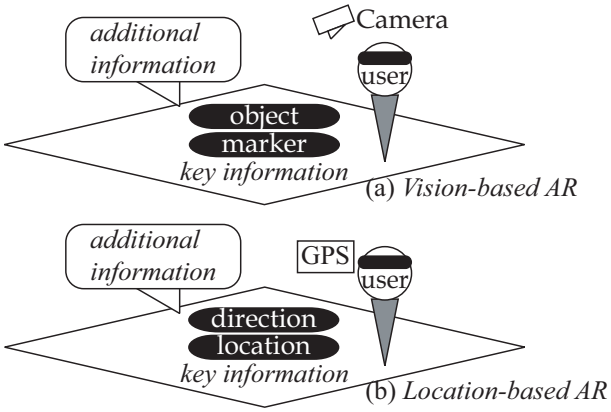

Fig. 3 AR environments:(a) Vision-based AR environment and (b) Location-based AR environment. Users utilize the camera and HMD or hand-held devices on vision-based environment. GPS and sensors are utilized in location-based AR environment.

- Vision-based AR environment: Image data captured as key information in the real world, such as markers are assigned to some special data or information. Computer vision technique is applied to fin keys.
- Location-based AR environment: GPS and compass sensors are utilized to fin the key information, such as location and direction of users. It provides information depending on the location.

2.1 Problems

In the AR environment, additional information is easy to associate to the object in the real world and it can enhance the presence of the information. However, there are some problems.

- Assignment limitation
  Users can get the information only from the same object or place. So the object or marker assigned to the information is limited, users must fin them to have the information. Location-based AR is similar, so users must be the place to obtain some special information. AR contents supplier should assign the object or place discretely.
- Excessive viewing
  The additional information are projected in the AR view, so these information might overfl w in the view if each user can freely update tag and additional information. They often get too much information through AR environment. It is not easy to select the available information in the database when they are sharing information. Furthermore, all information have the similar properties, some structuring are required.
- Unstable sensors
  Image recognition costs processing capability because of light condition, colors, camera motion, and so on, in the view-based AR. Moreover, they cause unstable status and lose the reality of viewing information. Location-based AR is similar that GPS and digital compasses are not always accurate. Furthermore, GPS can be available only in outdoor environment.

These problems cause difficulty of utilizing AR application and interfere prevalence of AR. However, they are sensible so individual variation affect so much for AR application usability. Customizable AR environment may narrow the individual differences and relieve these problems. Real world interface can also have a great affect for these problems because it is necessary for users to handle additional information projected on the real world view.

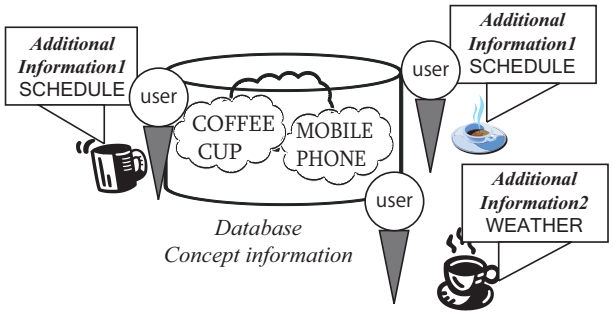

Fig. 4 A framework of concept-based AR. Users can share information through the key concept. Each user is not required to know other's object in the AR view.

2.2 Real-World Interface

Real-world interface (RWI) constructs an intuitive interaction between various data space and the real world. It supports human activity with the computers to provide a natural and intuitive interface more than the operation with mice and keyboards. RWI has to contribute to users' behavior recognition and transform them to the computer operations with taking their intention into consideration. For example, if voice are available for input modality for text, such as mail or chatting, it is very simple and natural interface for human activity. If users browse with real world objects like internet browser, they can obtain necessary information more effectively. RWI has become popular because of motion capture technology improvement. Recently, many easy-to-operate devices have developed and come out[6], [7], [8], [9].

3. Concept-based AR environment

3.1 Concept-based AR environment

We propose a framework for concept-based AR to achieve distributed environment and real world interface as shown in figur 4. This framework has features that users can get some information from real world objects as "instances" and these information have tags called "concepts". Users can share information name as concepts for their AR environment and personally assign their unique key information as instance. These concepts and instances are define as follows to construct concept-based AR environment.

Concept is the name of tag in the database. Each concept is not always unique in the database. Users' required information is so various that many concepts are prepared for them. So concept space is define and configure with many users define concepts. Figure 5 shows concept space. More abstract name such as SCHEDULE, WEATHER, TASKS, and so on, can be utilized to extend concepts.

Users can give the relationship between information and real world objects. The users do not have to know other users' instance setting. For example, some user give information "coffee cup" concept. The one does not know properties of others' cup, shape, size and color.

Structuring these information is very easy and intuitive in the

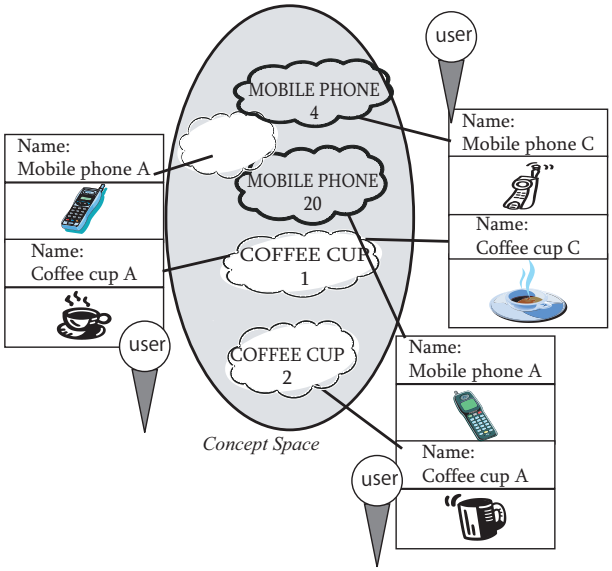

Fig. 5 Concept space. Users can construct relationship to their favorite concept. It depends on users required information.

abstracted concept database. So data handling operation become simpler and easier.

3.2 Database Handling for Concept-based AR Application

Database should be distributed in the concept-based AR environment, because it is effective to share the information and burden the cost to update the database. More abstract information is necessary to operate data. The database should preserve the attribute information that relates to the real world object.

Database structuring and information handling method are required these properties as follows.

(1) Easy to handle information inside database. Especially, update (include to change and to save newly) function should be easy and natural for users.

(2) Simple labeling and structuring methods are required to treat abstracted concept information.

3.2.1 Database Structuring

We prepare local and personal information database are prepared as shown in Figure 6. Local information database store "concepts" as a concept space. Personal information database deal with personal information such as "instance". These database work for only users' personal devices, so users' status is represented in the database.

3.2.2 Information Handling Method

Figure 7 indicates workfl w that users edit the database.

(1) Instance registration

At firs users register the image data captured in real world as an instance for the concept. These image data are utilized for object recognition to refer the concept data for the AR application.

(2) Relationship definitio

Users have to defin relationship between instance data registered and existing concept data.

(3) Concept edition

Users can edit concept name and data. So the similar concept names will occur to be generated.

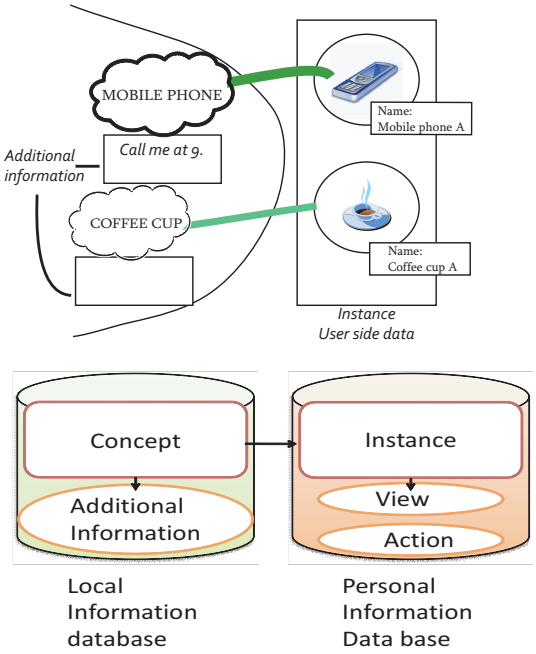

Fig. 6 Data elements in the concept-based AR applications. Right side means Personal Information Database for instance descriptions. Users register the image data for object recognition. Left side is Local Information Database for concept space. Sharing information are described with the concept name as "Additional Information".

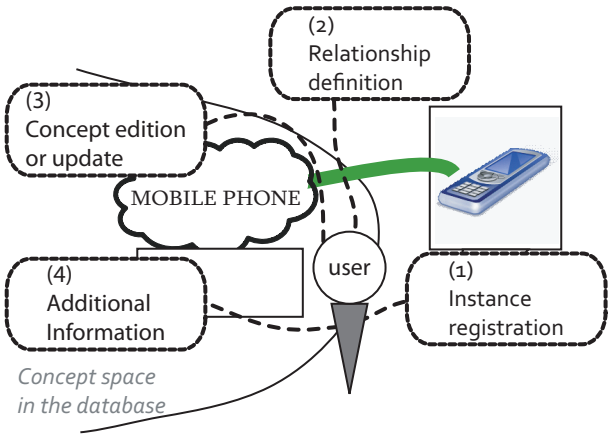

Fig. 7 Users can edit the data. 1. Instance registration, 2. Relationship definition 3. Concept edition and 4. Additional information constructing.

(4) Additional information

Users can give additional information to the local information database so that other users can access when they see the instance object in the AR application.

4. AR Office

4.1 AR Office

We try to apply this concept-based AR to daily works. AR Offic is considered in our research. AR Office have these properties as follows:

- Sharing concepts

  Office workers prefer to communicate directly with their colleagues in an office. Therefore, we try to promote direct communications by presenting specifi information only related for the current work using AR. To support these communication, it is required that members can share and edit

Fig. 8 HMD and camera in our testbed AR tool.

concept information about their works.

- Automatically update
  Relationship information (included in personal information database) is updated depending the user's state. For example, if the user have many tasks, showing information varies with priority.
- Gesture recognition for RWI
  RWI is very important concept in our application to support their communication, Daily operations "grabbing" or "shaking" and so on in the real world are used as the important information for the interface based on RWI. Hands gesture recognition is very important to achieve intuitive RWI. In the application, not only pose of hands, but also motion are captured and recognized. Moreover, context information should be considered. For example, when just grabbing their mobile phone, addresses are shown in the AR view. But when shaking them, the user can view schedule information.
- Device independent and personal view arrangement
  Members have different environments and viewing devices. The status of users are variable with their tasks. So fl xible AR environment is necessary for users. Supplying member independent AR environment, they can customize their marker object and view.

4.2 Implementation

We utilize one of HMD attached CCD camera on the hat shown in figur 8 in our AR application. One of problems is offering the device in daily life without the sense of incompatibility. So it difficul to wear long time and utilize them. It will be necessary to improve HMD + CCD camera in the future.

In the present AR applications, portable terminals, such as smart phones, are utilized. They are so suitable for these AR applications that user can treat very easily. So users can view the AR environment in the favorite viewpoint. Development of smart phones contribute these powerful function that can display 3D computer graphics in real time.

However, when users have hand-held devices like smart phones, both hands are utilized for handling them. They are powerful but not suitable for hands-free environment. Moreover, many AR applications are basically assumed in outdoor use. Hands-free environments are required to construct real world interface. In past AR applications, head mount display (HMD) have been utilized for viewing virtual object in the real world. The old type HMD is a little big and heavy, so it is hard to treat these devices. Antithetically, HMD has become light and easy-to-use device.

5. Conclusion

We introduce a framework for AR application and discuss distributed RWI using this framework. We have implemented a testbed for AR application. We plan to extend this AR application to communication tool for small office or laboratory and We have to consider about real world interface more.

To achieve more natural RWI, hands gesture recognition should speed up and it is necessary to make the process extract more complex motion from users behavior. We must take consideration into the relationship between concept based database and hands gesture recognition. Gesture recognition rule can be described in concept database. For example, if users have cup to drink coffee, information about coffee is fed to users. On the contrary, if users have cup to wash (it can be distinguished by the hand shape) application should display another information. Concept data can fi for the rule-based gesture recognition.

Through the implementation and working test, we have found method to show the retrieved information is also a problem. Now, information displayed on HMD is very small. However, it is easy to consider the huge data size. We have considered a framework for AR user interface, for example, when users slide object with their hands, information might change depending users' slide motion.

Our future work is to implement huge scale concept database. And this framework should be evaluated from more viewpoint, such as interface, VR and mage processing through the practical activities.

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