# Shared Database of Annotation Information for Wearable Augmented Reality System

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## ABSTRACT

This paper describes a database of annotation information for augmented reality (AR) on wearable computers. With the advance of computers, AR systems using wearable computers have received a great deal of attention as a new method for displaying location-based information in real-time. To overlay annotations on the real scene image, a user's computer needs to hold annotation information. Up to this time, since a database of annotation information is usually held in advance in the wearable computer, it is difficult for the database of annotation information to be effectively updated or added by providers of information. The purpose of this paper is to construct a networked database system of annotation information for wearable AR systems. The proposed system provides users with annotation information from a server via a wireless network so that the wearable computers do not need to hold it in advance and information providers can easily update and add the database with a web browser. In this study, we have developed a shared database of annotation information and have proven the feasibility of the prototype system with preliminary experiments. In experiments, the orientation and the position of user's viewpoint are measured by integrating several kinds of sensors. The user's position-based annotations have been proven to be shown to the user automatically. Moreover, we have confirmed that the database can be successfully updated and added by information providers with a web browser.

**Keywords:** Wearable Computer, Augmented Reality, Annotation Overlay, Networked Annotation Database, Wireless Network

## 1. INTRODUCTION

Since computers have made a remarkable progress in resent years, a wearable computer can be realized[1]. At the same time, the augmented reality (AR) technique which merges the real and virtual worlds has received a great deal of attention as a new method for displaying location-based information in the world[2–4]. Therefore, AR systems using wearable computers will open up a new vista to the next generation wearable computing[5,6]. Figure 1 shows an example of annotation-overlay system using a wearable AR system. Since the wearable AR system can intuitively display information to user on the real scene as shown in Figure 1, it can be applied to a number of different fields[5,7–12]. To realize a wearable AR system, the position and orientation of user's viewpoint and annotation information are needed. The position and orientation of user's viewpoint are needed for acquiring the relationship between the real and virtual coordinate systems. Many researchers have proposed methods for measurement of the position and orientation of user's viewpoint with some kinds of sensors[6,7,13–15]. To overlay annotations on the real scene image, a user's computer needs to hold user's location-based information. Up to this time, since a database of annotation information is usually held in the wearable computer in advance, it is difficult for the database of annotation information to be updated or added by information providers (including normal PC users and wearable PC users).

The purpose of the present work is to construct a shared database system of annotation information for wearable AR systems. To realize the system, we install a database server which can be accessed with a wireless network. The database is shared by multiple users of wearable AR systems and information providers. Thereby,

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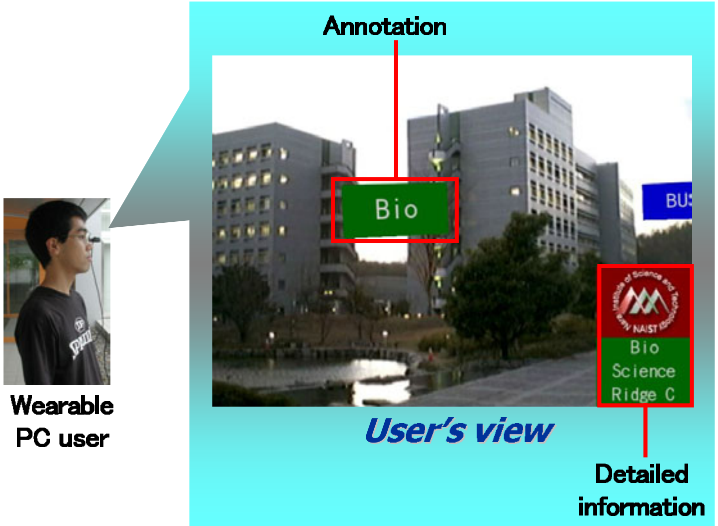


**Figure 1.** An example of annotation overlay system

the information providers can provide users with the newest annotation information by updating the annotation database. On the other hand, users of AR systems can see the newest annotations without holding the annotation information in advance. The information providers can efficiently update and add the database with a web browser. Moreover, a wearable AR user can also edit the database of annotation information easily because the user's position acquired by a positioning sensor is used to determine the user's position on the map.

This paper is structured as follows. Section 2 describes the shared database system for annotation information using a wireless network. In Section 3, experimental results with a prototype system are described. Finally, Section 4 describes summary and future work.

## 2. SHARED DATABASE OF ANNOTATION INFORMATION

Figure 2 shows an outline of shared database system of annotation information. In this study, the database is shared via a wireless network. The database of annotation information is stored in the server and is shared by multiple users of wearable AR systems and information providers. Consequently, users of wearable AR systems can obtain annotation information at anytime via a wireless network and can see the newest annotation overlay images without holding the database of annotation information in advance. On the other hand, information providers can provide efficiently the newest annotation information for users of wearable AR systems by updating and adding the database with a web browser. In Section 2.1, the composition of a database of annotation information is described. Section 2.2 describes the method updating the database with a web browser. Section 2.3 describes how the user obtains annotation information.

### 2.1. Composition of a database of annotation information

The database contains some kinds of location-based contents. Each annotation is constructed of a pair of contents and their location. Components of the annotation information are described in detail in the following.

**Position:** Three-dimensional position of an annotation in the real world. Three parameters (latitude, longitude, height) are stored in the database.

**Name:** A name of the object which is overlaid in the real scene as annotation information.

**Detail:** Detailed information about the object. When user's eyes are fixed on the object, the detail about the object is shown at the lower of the user's screen.

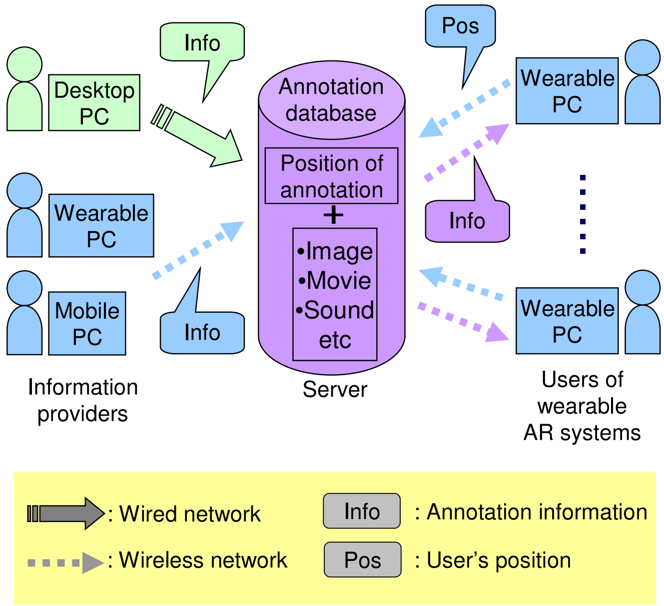


**Figure 2.** Shared database of annotation information

## 2.2. Updating the shared database

The annotation information can be corrected, added and deleted by information providers with a web browser. An interface for information providers to update the database is a web browser as shown in Figure 3. Information providers can easily update the database by accessing a prepared web page and by transmitting the data of annotation information. The annotation updating procedure is described in the following.

1. **Specification of position**

   Information providers can zoom in and out to maps (Figure 3: C, D) using buttons (Figure 3: A) . Besides, the providers can move by clicking any point on the map. In this way, the providers can specify the position of a new annotation to be added. It should be noted that position parameters such as latitude, longitude and height are automatically determined based on the specified position on the map.

2. **Input of name**

   Information providers input the name of an object. The name is sent to the server and a picture of an annotation is automatically generated in the server.

3. **Input of details**

   By the same method as in the input of the name, information providers send details of an object. The providers also can send a picture, a sound file and a movie file as details.

The providers can efficiently send the newest annotation information using a web browser. For that reason, a user of wearable AR systems can also update the database. In this case, the server can show the user a map of his neighborhood according to the user's position acquired by positioning sensors. Since the user is able to update the database, the user can immediately correct the position error of annotations by confirming the overlaid image.

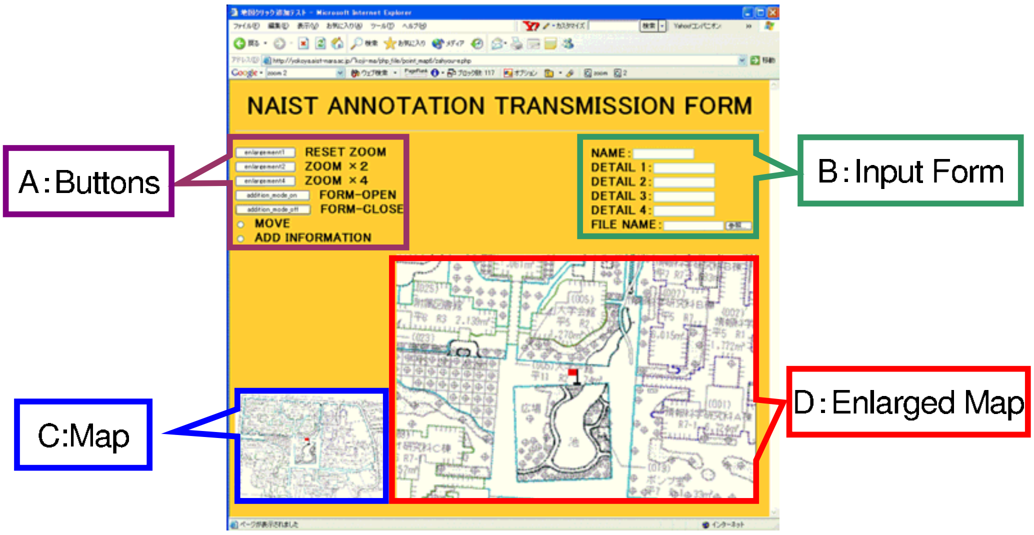


**Figure 3.** Input form of annotation information

### 2.3. Getting annotation information

In this work, a database server is prepared assuming that the user's wearable computer can access the database via a wireless network. Annotations to be presented to the user are determined based on the user's current position. First, the user's position is measured by some sensors (Positioning Infrastructures, GPS, and so on) which are equipped by the user. The user's wearable computer then obtains proper annotation information based on the measured user's position. The server automatically decides which annotation should be provided. Consequently, the user's wearable system can obtain the newest annotation information at anytime. The user's wearable system obtains the newest annotation information periodically when the user moves for a fixed distance or a fixed time is passed.

## 3. EXPERIMENTS

We have carried out some experiments using the proposed database of annotation information. We have developed a shared database of annotation in a server in our campus where users of wearable AR systems can use a wireless local area network. Figure 4 illustrates a hardware configuration of a wearable augmented reality system which is used in these experiments. The user equips some positioning sensors, a notebook PC and a display device. Three sensors can obtain the position and orientation of the user's viewpoint and the real scene image. These data are sent to a notebook PC. The notebook PC obtains annotation information from the database server via a wireless local area network. The notebook PC sends annotation overlay images to a display device attached to the user's headset. The user can see it through the display device. Components of the system are described in more detail in the following.

**Sensors** The user equips the following three sensors. Electric power is supplied from the notebook PC or a 9V battery. The data is transmitted to the computer through USB or serial connection.

- **Inertial sensor** (Intersense: InterTrax[2]) An inertial sensor is attached to the user's headset and measures the orientation of the user's viewpoint. The inertial sensor can obtain data at 256Hz.
- **Camera** (Logicool: Qcam) A camera is attached to the user's headset and captures the real scene image from the user's viewpoint. It can capture a color image of 640 $\times$ 480 pixels at 30fps.
- **Positioning sensor** (Point Research Corporation: Dead Reckoning Module) A positioning sensor can measure the latitude and longitude. It can also measure accelerations in the horizontal direction.

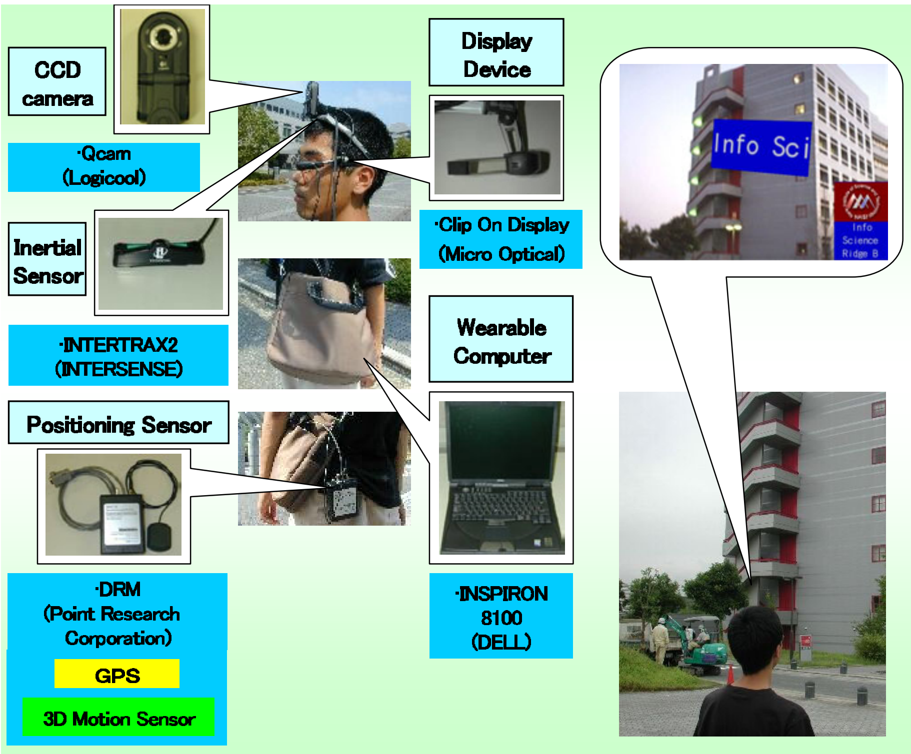


**Figure 4.** Hardware configuration of wearable augmented reality system

**Table 1.** List of sample annotation information

| | Lat, Lon | Name | Details |
|---|---|---|---|
| 1 | 34.7321950457(N) 135.732381307(E) | Office | Administration office reception 9am - 5pm |
| 2 | 34.7322849446(N) 135.733036134(E) | Library | University library 24-hour opening |
| 3 | 34.7321831473(N) 135.733607698(E) | Cafe | today's special spaghetti |
| 4 | 34.7320086376(N) 135.734110109(E) | Info Sci | Information Science Ridge B |
| 5 | 34.7311836828(N) 135.733912531(E) | Mat Sci | Materials Science Ridge F |

**Computer** (DELL: Inspiron8100, PentiumIII 1.2GHz, memory 512Mbytes) A computer is carried in the user's shoulder bag. It can use a wireless local area network with a network card.

**Display device** (MicroOptical: Clip On Display) A display device is a video see-through device. It is attached to user's headset. It can present a 640 × 480 color image to the user.

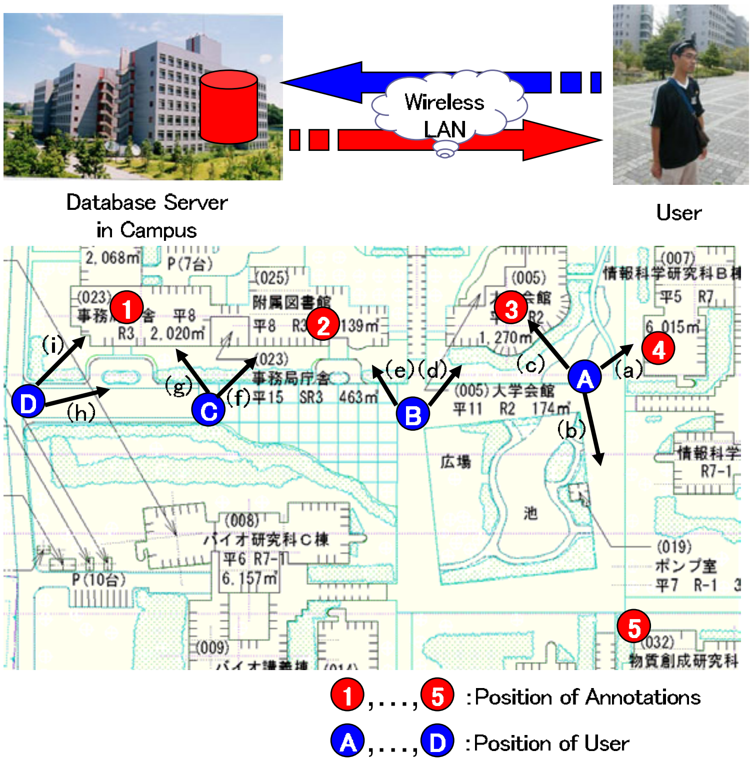


**Figure 5.** Environment of the outdoor experiment

In this experiment, we have developed a database of annotation information in the server (CPU Pentium4 2.0GHz, memory 512Mbytes) in our laboratory. Table 1 shows the list of sample annotation information. Figure 5 illustrates the experimental environment. In Figure 5, the points ①,...,⑤ mean the positions where the annotations exist. The user obtained the annotation information and looks round at the points A,...,D. A criterion concerning which annotations should be obtained is based on the distance between each annotation and the user's position. In this experiment, we set empirically the criterion at 70 meters. Besides, in order to check that the database is correctly updated, the user moving in our campus updated the annotation information about "cafeteria" with a web browser.

Figure 6 and Figure 7 show the annotation overlay images. Figure 6 shows the annotation overlay images when the user was at the points A,...,D in Figure 5 and the user's orientation was along the arrows (a),...,(i) in Figure 5, respectively. As shown in Figure 6 (a), the annotation of "information science" is overlaid on a front of building, so that the user can recognize the annotation information intuitively. The same conclusion is obtained from Figure 6 (b),...,(i). Thereby, we have confirmed that the user can obtained and perceive the shared annotation information intuitively. Figure 7 shows the annotation overlay images before and after updating the annotation information. The annotation information in Figure 7 (a) was changed to the new one in Figure 7 (b) automatically when a fixed time is passed. We have confirmed that the annotation information can be updated by editing the shared database of annotation information.

Through experiments, the user has successfully obtained the location-based annotation information according to the user's position. Simultaneously, the shared database can be easily and efficiently updated and can provide the user with the newest annotation information in real-time.

## 4. SUMMARY

This paper has described a database of annotation information for a wearable augmented reality system which is shared by multiple users via network and is efficiently updated with a web browser. In other words, proposed is a networked wearable augmented reality system. We have shown the feasibility of the proposed database through the demonstration with experiments in our campus. In the future, we should conduct experiments in a wider area and use other kinds of detailed location-based contents (movie, sound, and so on).

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**Figure 6.** Overlay images at the points A, B, C, and D


(a) before updating

(b) after updating

**Figure 7.** Example of updating annotation information