mARGraphy: Mobile AR-based Dynamic Information Visualization

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***Abstract*— We propose a mARGraphy, which visualizes information based on augmented reality (AR) technology. It provides the intuitive and interactive way to make users to understand dynamic 3D information in situ with highly relevant to the target. To show the effectiveness of our work, we introduce a traditional map viewer application. It recognizes region of a traditional map with object recognition and tracking method on a mobile platform. Then, it aggregates dynamic information obtained from database such as geographical features with temporal changes, and situational contexts. For the verification of this work, we observed how our system improves users' understanding information with mARGraphy through preliminary user study.**

Keywords-component; Information visualization, mobile, augmented reality

I. INTRODUCTION

Recently, many researchers have studied information graphics, so called infography [1][2]. Wikicity is a project for visualizing urban dynamics on the web with aggregated data from phones, and buses in real city [1]. Several companies have released toolkits to monitor and visualize sensory information in real time [2]. However, visualization of their works focused on visual analytics on the web or virtual space. Thus novice users were less-readily reached.

To increase interactivity of users and their understanding on visual analytics, mobile AR technology has been introduced [3][4]. Magic lens is a kind of interactive visual interface based on AR technology which overlay up-to-date information on the personal viewfinder [5]. Ann Morrison and his colleagues introduced MapLens, a mobile AR map, which facilitated understanding around objects and places as well as collaborating in a team play [6]. In addition, Ismail Haritaoglu proposed infoScope linking from real space to digital information space [7]. The system captured an image from a camera in real world, recognized a sign or a text in an image, and then overlaid the information on video. These technologies enabled users to understand dynamic environmental changes in real time.

Previous works focused on visualizing 2D information related to recognized objects because of low visibility of a small screen. However, especially in a map viewer application, it is required to provide 3D information such as altitude as well as topography, geographical features of an area to improve spatial awareness of users. In addition, topography changes over time also can be displayed for better readability of temporal information. Therefore it is an important next step to extend user's experience to 3D dynamic infographics to improve understanding of up-to-date information. To address these issues, we propose mARGraphy which provides an intuitive way to make users understand dynamic 3D information as shown in Figure 1.

(a)

(b)

Figure 1. Examples of mARGraphy (a) Map viewer (b) Dish viewer

II. RELATED WORK

With the advent of augmented reality technology on mobile platform, researchers have been studying the way to overlay information user-friendly in real world. To make this information user-friendly, V. Christian et al proposed the

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IV. Implementation and Initial Observations

We implemented a traditional map viewer application on mobile platform: TG01 smart phone (OS: WM 6.5, CPU: 1 GHz, Display: 480 x 800 resolution). In order to test our approach, we used several animated 3D contents such as butterfly and Korea traditional animation character, Hong-kil dong less than 2000 polygons with ES3D library.

Previously we tested recognition rate of paintings. This application covers 50 pictures while keeping the less then 10ms to recognize objects with 99% accuracy. The tested map is highly complex to observe and to see, however, this application can support this easily and not complicated. After recognizing the pictures, we tracked the planner object. This method supports real-time and fast tracking the performance is about 20~25 fps depends on test sequence. To visualize the information, we implemented the UI which enables the users explore the mobile AR tour guide system. In this step, this system visualized population and its changes over time by increasing number of 3d contents, color, shape, and movement of 3D contents. Large values are mapped to number of contents, active movement, size of augmented contents and color. In addition, transportation changes are represented by number of flying gestures, and speed of visualized contents.

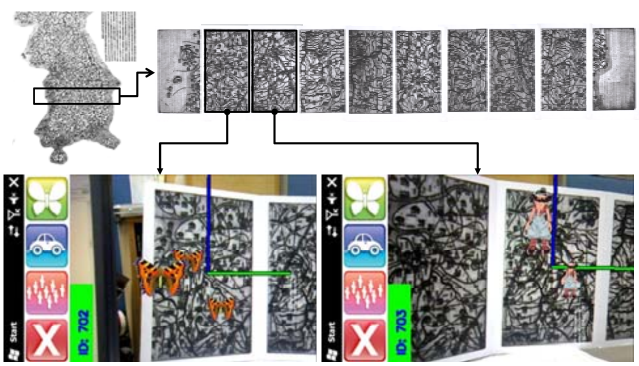

Figure 3. Augmented 3d contents indicating religion specialties of different region

In order to evaluate the effectiveness of our work, we observed users how the system improves their understanding on a specific task. As a task, we asked simple quizzes related to visualized contents (e.g. can you guess how many people lived at Gwangju area in 1200's).

Figure 4. Preliminary user study

V. Summary and Future Works

We proposed an mARGraphy, which visualizes information based on AR technology. To show effectiveness of this work, we implemented a mobile traditional map viewer application by augmenting adaptive information in ubiquitous reality environments. This application recognized target objects, and displayed appropriate contents based on the objects in a mobile platform. As a future work, we will evaluate the application focusing on effectiveness and intuitiveness of visualized information, e.g. how much this application allows individual users to understand visualized information intuitively.

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guidance arrow by projecting it on the floor or a street considering environmental 3D topography information [8]. However, this type of visualization is only dedicated to navigation application. If we have plenty number of information to augment like tags, intuitive visualization method is an essential issue. To do this, we have to find a way to organize and rank relevant information from the list and to visualize information user-friendly.

Researchers in the field of infography have studied about a way to visualize data in user-friendly manner. Ismail Haritaoglu proposed infoScope linking from real space to digital information space [7]. This system captured an image from a camera in real world, recognized a sign or a text in an image, and then overlaid the information on the video image. These technologies enable users to understand dynamic environmental changes in real time. However, although this technology enables users to understand dynamic environmental changes in real time, provided information is not directly linked to real object because it represents on the web.

In addition, mobile platform accelerates the usage of contextual information from internal phone sensor, environmental changes for visualization. Many researchers have been studied on visualizing contextual information to enhance awareness of environments as well as users. CenceMe system used sensor data gathered using mobile consumer devices (e.g., cell phones) to learn about the everyday activities of the general population [9].

In historic tour guide application, 2D Map viewers with AR technology on mobile platform have been developed [5][6]. Traditionally map viewer application provides guiding information from tag distributed by the public or static information such as region information, historical features with graphs and figures. In this field, visualized information is limited to 1D graph and 2D contents. Novice users usually are hard to understand this graphical information such as topography, geographical features, spread of population changes over time, ecosystem changes over time, transportation and regional specialties. To address this issues, we proposed ARGraphy which provides the intuitive and interactive way to make users to understand the visualized dynamic 3d information (not limited to 2d) in situ with highly relevant to the target.

III. PROPOSED METHOD

Here, we propose a mARGraphy, which visualizes information based on AR technology. This method includes 2d planner object recognition step, tracking a 2D object step, and adaptive rendering step. For visualizing dynamic information, this method enables systems to recognize dynamic changes of environments and users in real-time, and to display appropriate contents according to these recognized information on a mobile phone.

A. Overall Procedure

An overall procedure of our proposed method is illustrated in Figure 2. First, captured images are passed to the planar object recognition module. To recognize different kinds of objects, we apply local binary pattern matching method which has benefit to replicable textures, low number of features, and changes of lights. In this step, object ID and initial pose information is obtained. Then, the tracking module is activated and keeps sending updated pose information of recognized objects. For tracking, we use ESM-blur method.

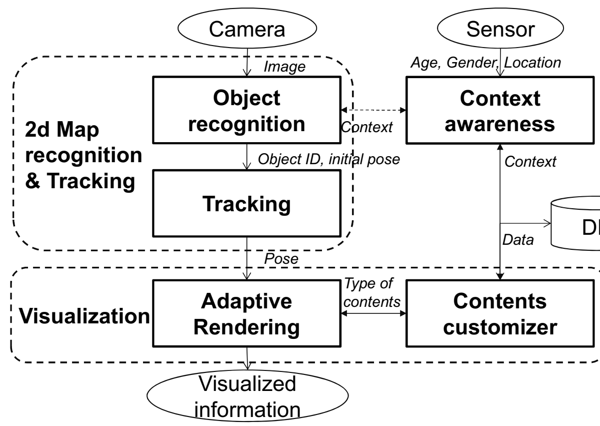

Figure 2. Overall procedure

Finally adaptive rendering module decides model type, color of model, animation time, movement of model, and direction of movement for visualization. It collects all the changes of contextual information from sensors, and basic information to represent from DB. In this work, we especially visualize population and its changes over time by increasing number of 3D contents of different regions while changing color, shape, and movement of 3D contents. Large values are mapped to number of contents, active movement, size of augmented contents and color.

B. 3D dynamic inforamtion visualization

Autonomic visualization step collected all the changes of contextual information from sensors, basic knowledge to represent and annotate. Then it mapped contextual information and action according to following formulation. To recognize dynamic change of environment, and users, and other tagged contents distributed in environment. We collected the information from the UCAM framework. The features from camera and contextual information such as lighting, accelerometer, and user interest are analyzed by UCAM module [10]. This information is used for selecting appropriate color, shape, movement of 3d contents based on data set.