Meet AR-bot: Meeting Anywhere, Anytime with Movable Spatial AR Robot

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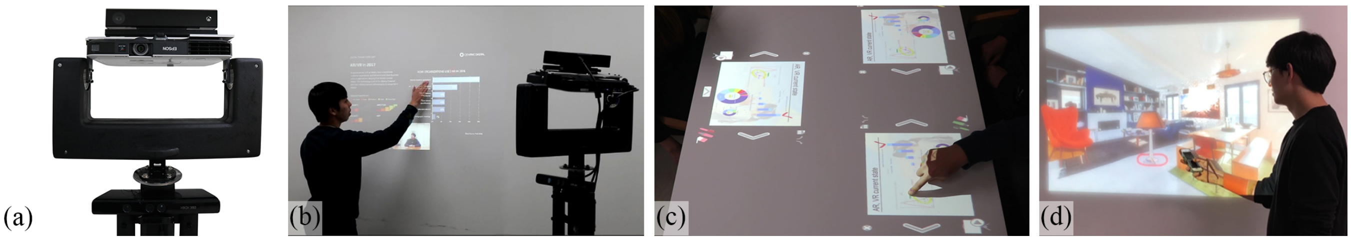

Figure 1: Meet AR-bot system (a) Hardware configuration of Meet AR-bot. (b) Main Presentation system. (c) Multi-user write down using spatial touch interaction. (d) Virtual object maniplation using mobile device interaction.

ABSTRACT

Many kinds of preparations are needed when meeting. For example, projector, laptop, cables and ETC. As such, this video have constructed Meet AR-bot, which helps users to keep meeting going smoothly, based on the projection of Augmented Reality(AR). Our system can easily provide meeting room environment through the movable setting via wheel-based stand. Users do not need to carry a personal laptop and connect them to the projector. Robot reconstructs the 3D geometry information through pan-tilt system and compute projection areas to project information in the space. Users can also control through mobile devices. We offer presentation, table interaction, file sharing and virtual object registration by mobile device.

CCS CONCEPTS

• **Human-centered computing → Mixed / augmented reality**; **Interactive systems and tools**; **Collaborative and social computing**;

KEYWORDS

Spatial Augmented Reality; Interaction; Meeting room

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1 INTRODUCTION

Projectors are actively used in meeting rooms thanks to their ability to provide information to multiple users simultaneously. However, various types of information sharing as well as visual sharing of simple meeting materials should be done in meeting room environments. Therefore, there is some equipment that is prepared by individuals such as physical meeting materials, notebooks, pointer, writing tools, etc. Projectors used in typical meeting room environments are fixed on the ceiling. This leads to space limitation because only one wall surface is used. In addition, we have had limited and unnatural interactions with a projection system using keyboard, mouse, tablet pen, etc., for transferring additional information. In order to solve these problems, studies on projection-based AR technology that enables high information transfer and natural interactions have been underway.

Projection-based AR technology is effective in transferring information since it can realistically provide additional information reflecting real environments using camera images and a projector screen. Studies applying projection-based AR technology to meeting environments are mainly divided into fixed- or moving-type system, depending on their types. First, the fixed-type system is mainly fixed on the ceiling or on the front of the wall and allows us to share meeting data and to interact with the system[1]. The system in these studies can be operated only in pre-built environments. Since one projection system can project only one direction, this type can provide a fixed AR environment. However, there is a drawback that multiple projection systems must be installed to build the entire space of a meeting room as an AR environment. Second, the moving-type system can be easily installed on the table or floor so that information sharing can be intuitively done. However, because it is specialized for table-top environments, we can only perform limited scenarios confined to the table-top[2].

In this demonstration, we propose a movable pan-tilt projection system to overcome the space constraints of the fixed-type system and address the limited scenarios of the moving-typed system. For this, we built a projector with 360-degree control and a camera-based pan-tilt system. We add mobility to the system through a wheel-mounted stand and can perform scenarios in various spaces. We build a 3D point cloud map of the 360 degree view for the new environment and automatically detect the planes that can be outputted using this map.

2 MEET AR-BOT SYSTEM

The proposed system aims to build an AR environment where information can be actively shared in the entire space of a meeting room, escaping from existing meeting environments where information is limitedly provided at the fixed location. Through this study, we can augment information in the space that participants want and they can share information through intuitive interactions. Like this, we built a more efficient and advanced projection-based AR meeting environment compared to the existing static meeting environment. To this end, we constructed a projector with 360 degree control and a camera-based hardware system as shown in Figure. The 360 degree controllable projection system is equipped with a projector and a depth sensing camera in a pan-tilt system with two servo motors, and a depth camera for interaction is additionally installed. Two servo motors are controlled by attaching the arduino to run the pan-tilt system. Mobility is given for easy movement by finally installing it on a movable stand.

2.1 3D map reconstruction and plane detection

3D map reconstruction is conducted to provide projection augmented reality information in meeting environments. The environment for this system is constructed by using a depth sensing camera attached to the projector. Methods for constructing 3D point cloud-based map using depth images are divided into Iterative Closest Point(ICP) and feature point-based methods[3]. The ICP method has limitations in constructing the map in real-time because it does many repetitive pose calculations. This study used a feature matching method to obtain poses after extracting features from input images and by comparing them with the features of the previous frame. Feature points are detected using a feature point detection algorithm with images obtained while rotating the angle of the pan-tilt by 10 degrees in one direction. After this, descriptors for feature points are generated and matched using a descriptor algorithm. We obtained the pose of the current frame using the RANdom SAmple Consensus(RANSAC)[4] algorithm through the matched 3D world coordinate point values of the previous frame and the matched 2D points of the current frame. Rotate and translate the point cloud information of the current frame based on 3D world coordinates. Depth segmentation is performed using the depth information of the constructed 3D map. After this, plane areas are detected by performing the Randomized Hough Transform algorithm[5] based on the segmented areas. Then, the maximum projection area is detected in the detected planes and the final projection position is selected by reducing the projection distortion using the normal vector of the plane area. The projection area is determined using the camera-projection calibration matrix information that is calculated in advance.

2.2 Mobile interaction

Mobile interactions are made through a separate mobile device application. The constructed 3D point cloud map and the detected planes can be browsed on the screen of mobile devices. The location of the detected planes can be selected, modified and added through mobile devices. In order to provide a smooth meeting environment, information and functions necessary for a meeting can be set on the detected plane by a mobile application, and files in mobile devices can be shared. In addition, it is possible to manipulate the augmented reality contents in the projection by using the sensors of mobile devices, thus it can be utilized in collaboration situations.

2.3 Touch interaction

In order to use the interface in the projection space where there is no separate touch sensor, touch interaction using a depth recognition camera is implemented. We applied Wilson's et al.[6] method to detect the touch of a user and a projection area. For this, the depth data of the projection area is stored and it is recognized as touch when users touch the area within the set threshold. Multiple interactions can be made in the area projected through this touch interface.

3 MEET AR-BOT SYSTEM DEMO SCENARIO

The meeting room system is divided into three scenarios. The first scenario allows presenters to control the presentation screen by using gestures during their presentations and to write down on the presentation screen. The second table interaction scenario allows multiple users to sit at the table. This scenario allows users to share their handwritten contents on their notes at the table and to share data on their mobile devices through the gesture interface. The last scenario is a collaborative work with multiple users. Multiple users can manipulate and register augmented virtual objects by using their mobile devices. For example, they can conduct a collaborative work by rotating their mobile devices, manipulating virtual furniture and registering them in the desired space.

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REFERENCES

[1] Andreas Rene Fender, Hrvoje Benko, and Andy Wilson. Meetalive: Room-scale omni-directional display system for multi-user content and control sharing. In *Proceedings of the 2017 ACM International Conference on Interactive Surfaces and Spaces*, pages 106–115. ACM, 2017.

[2] Jeongyun Kim, Jonghoon Seo, and Tack-Don Han. Ar lamp: interactions on projection-based augmented reality for interactive learning. In *Proceedings of the 19th international conference on Intelligent User Interfaces*, pages 353–358. ACM, 2014.

[3] Thomas Whelan, Michael Kaess, Hordur Johannsson, Maurice Fallon, John J Leonard, and John McDonald. Real-time large-scale dense rgb-d slam with volumetric fusion. *The International Journal of Robotics Research*, 34(4-5):598–626, 2015.

[4] Martin A Fischler and Robert C Bolles. Random sample consensus: a paradigm for model fitting with applications to image analysis and automated cartography. *Communications of the ACM*, 24(6):381–395, 1981.

[5] Lei Xu, Erkki Oja, and Pekka Kultanen. A new curve detection method: randomized hough transform (rht). *Pattern recognition letters*, 11(5):331–338, 1990.

[6] Andrew D Wilson. Using a depth camera as a touch sensor. In *ACM international conference on interactive tabletops and surfaces*, pages 69–72. ACM, 2010.