# Demo: Assisting System for Creating Ceiling Plan Using a Video from a Smatrphone


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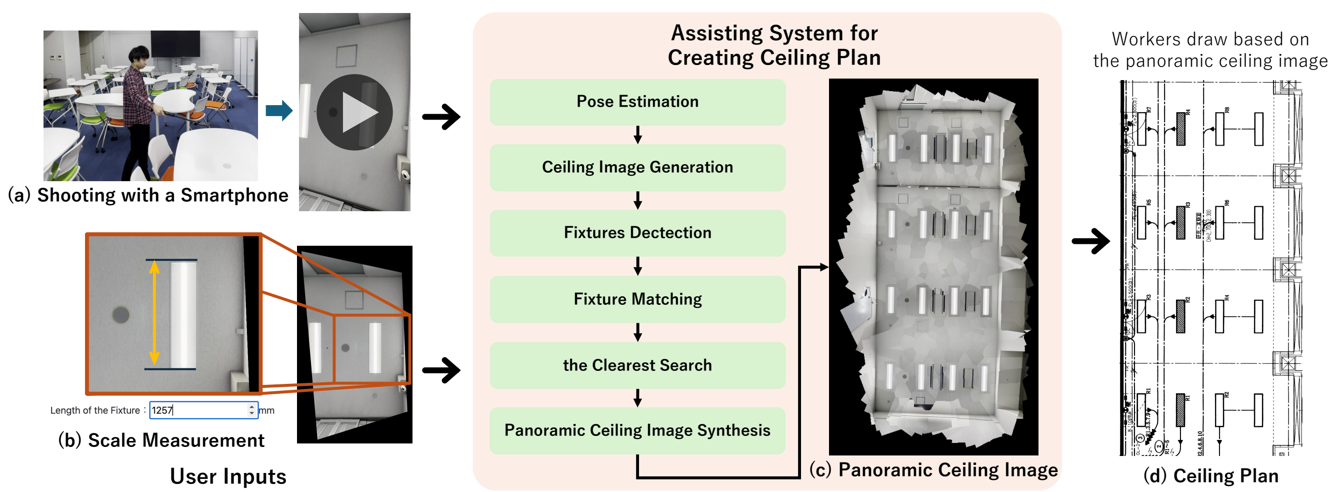


**Figure 1: Assistance Method for Creating Ceiling Plan Using a Video from a Smatrphone. The system synthesize (c) a panoramic ceiling image from 2 inputs of a user: (a) a video shot by a smartphone and (b) a scale measurement on the provided image. Users can draw (d) a ceiling plan accurately and quickly based on the synthesized image.**


## ABSTRACT

We present an assisting system for creating a ceiling plan. Conventional methods of creating a ceiling plan are time-consuming and high-cost. Our system requires only two inputs from a user and outputs the panoramic ceiling image that shows the whole ceiling surface. The system detects the ceiling fixtures and depicts them seamlessly for a reliable resulting image. We confirmed the possibility of assisting in creating a ceiling plan with our system through the experiment.



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*MOBISYS '24, June 3–7, 2024, Minato-ku, Tokyo, Japan*



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ACM ISBN 979-8-4007-0581-6/24/06
https://doi.org/10.1145/3643832.3661847



## CCS CONCEPTS

• **Computing methodologies → Computer vision**; • **Human-centered computing → Smartphones**.

## KEYWORDS

Ceiling Plan, Smatrphone, Image Synthesis, Visual SLAM

**ACM Reference Format:**

Daiki Kohama, Yoshiteru Nagata, Kazushige Yasutake, Shin Katayama, Kenta Urano, Takuro Yonezawa, and Nobuo Kawaguchi. 2024. Demo: Assisting System for Creating Ceiling Plan Using a Video from a Smatrphone. In *The*

*22nd Annual International Conference on Mobile Systems, Applications and Services (MOBISYS '24), June 3–7, 2024, Minato-ku, Tokyo, Japan.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3643832.3661847

YouTube link: https://youtu.be/YX6X7gFROps

# 1 INTRODUCTION

A ceiling plan is a blueprint that includes ceiling-mounted fixtures such as light fixtures, air conditioners, and ceiling access panels. In many renovation projects of facilities, workers create a ceiling plan before construction because of the absence of the current ceiling plan. Conventional methods of creating a ceiling plan are as follows:

- Manual Method: Workers check ceiling fixtures visually and draw a ceiling plan. It is difficult for workers to draw ceiling plans accurately and to create them in a short time with this method.
- Laser Scanner Method: Workers measure the ceiling surfaces using a 3D laser scanner and then draw a ceiling plan based on the measurement result. A 3D laser scanner can measure accurately, however it is used in limited renovation projects because of the high device cost and the requirement of special knowledge.

We present an assisting system for creating a ceiling plan using a video shot of the ceiling with a smartphone as shown in Fig.1. This system provides a panoramic ceiling image that shows the whole ceiling surface above the shot route. Workers can obtain the panoramic ceiling image by inputting the video and doing the scale measurement on the provided image. Then, they can draw a ceiling plan accurately and easily based on the panoramic ceiling image.

# 2 SYSTEM METHODOLOGY

Our system is designed based on our previous work with an omnidirectional camera[3]. In addition, we have improved some processes to fit the input of the perspective video from a smartphone. We introduce the system overview and smartphone settings below.

## 2.1 System Overview

The system first estimates the pose (position and orientation) of the input video frames using Visual Simultaneous Localization and Mapping (SLAM)[4]. We input the video and camera parameters into the Visual SLAM. The system corrects the coordinate system of the Visual SLAM's outputs to be horizontal based on the ceiling surface. The ceiling surface is estimated from the point cloud generated by the Visual SLAM. Then, the system determines and corrects the room's direction using the results of line estimation by the Line Segment Detector[5] in the first frame's projective transformed image, following the principle of hough transform. We determine the scale of the estimated results by measuring the ceiling fixture in the image provided by the system. The system generates zenith-toward images called "ceiling images" with projective transforming based on the estimated pose. Then, it detects the ceiling fixtures based on the difference in luminance between the fixtures and the ceiling surface using OpenCV[2]. Detected fixtures are matched between ceiling images and searched for the clearest one to depict the fixtures seamlessly in the resulting image. Finally, the system synthesizes the panoramic ceiling image from the ceiling images based on their shot positions. However, each detected ceiling fixture is referenced from a single ceiling image to avoid seams on the fixtures.

## 2.2 Smartphone Settings

We tried to shoot and execute the Visual SLAM with some smartphones and their lenses. We found two tendencies where Visual SLAM tends to lost track, 1) the camera's field of view (FoV) is narrow (less overlap between frame images), 2) the frame images are unclear (fewer image feature points). Therefore, we decided to use the iPhone 15 Pro[1] with a 13mm focal length lens because of its ultra-wide FoV and clear frame images. In addition, we have considered that the impact of image distortion due to a wide-angle lens on Visual SLAM is minimal. This is because, even with a wide FoV, Visual SLAM is provided with those camera parameters.

# 3 EXPERIMENT AND DISCUSSION

We experimented to verify how easily and accurately our proposed system can generate a panoramic ceiling image. We shot a video in a room of 96 $m^2$ as shown in Fig.1(a), and then input it into the system. We measured the length of the fixture as shown in Fig.1(b). The system automatically generated the panoramic ceiling image as shown in Fig.1(c). We obtained an accurate and photorealistic resulting image, and workers will be able to draw a ceiling plan based on the image.

We have confirmed the possibility of synthesizing a panoramic ceiling image using a smartphone. However, shooting a video with a smartphone for the system requires a bit of a knack because the Visual SLAM tends to fail when the field FoV is narrow, so it is not practical for users without the knack now. To make it usable by anyone, we are considering the use of multi-source fusion SLAM that utilizes sensors other than the smartphone camera, such as LiDAR, infrared sensors, and accelerometers. Furthermore, we are considering to use of wide-angle lenses to widen the camera's FoV.

# ACKNOWLEDGEMENTS

This research is partially supported by JST, CREST Grant Number JPMJCR22M4, commissioned research (No.22609) by National Institute of Information and Communications Technology (NICT), JSPS KAKENHI Grant Number JP22K18422 and a project, JPNP23003 and JPNP23025, commissioned by the New Energy and Industrial Technology Development Organization (NEDO) in Japan.

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