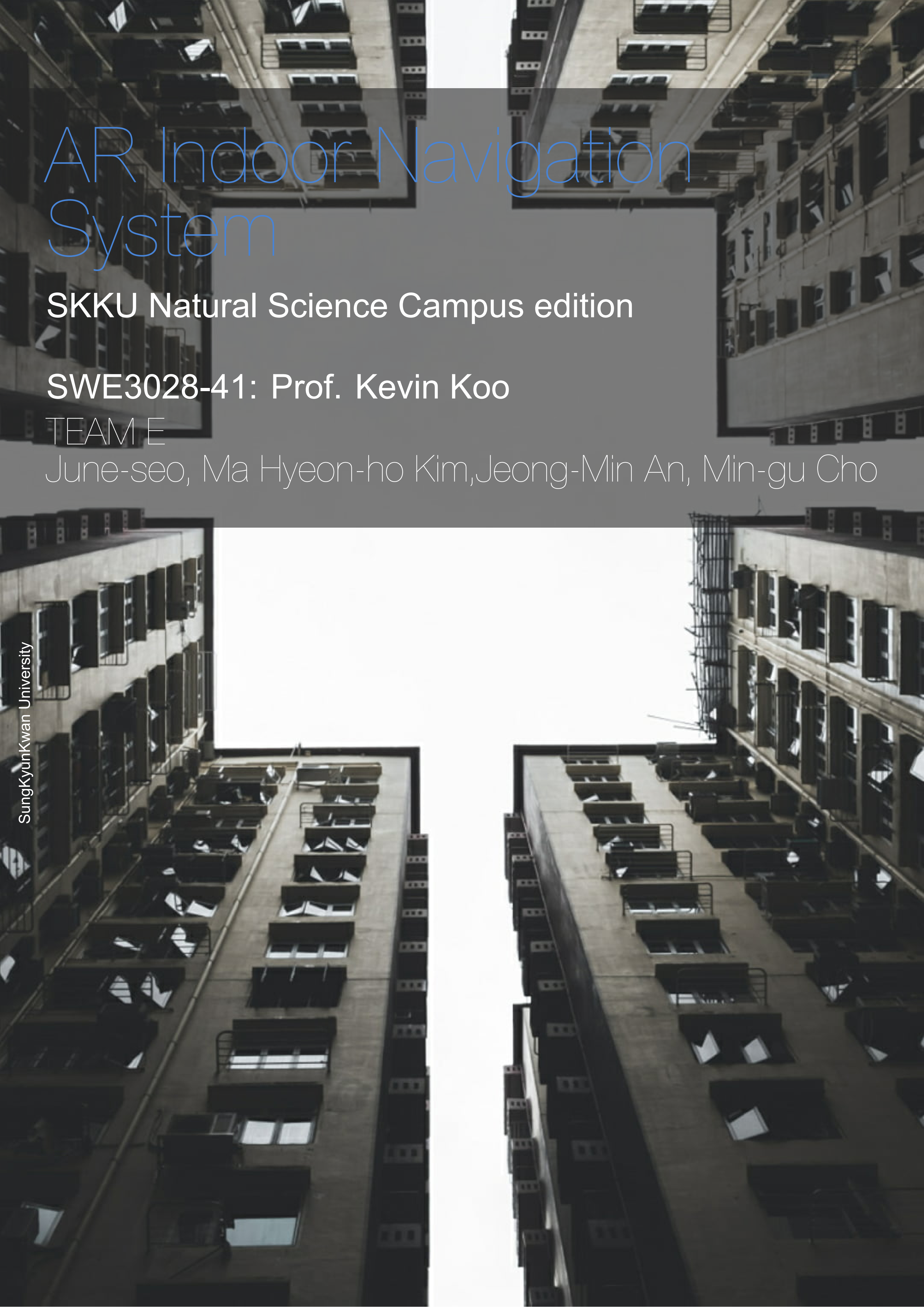

AR Indoor Navigation System

SKKU Natural Science Campus edition

SWE3028-41: Prof. Kevin Koo

TEAM E

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AR Indoor Navigation for SKKU Natural Science Campus Benzene-ring Building*

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Abstract. As indoor spaces become larger and more complex due to the development of technology, solutions for efficient road guidance are needed indoors. However, traditional navigation using GPS is not suitable for indoor use. AR navigation enables intuitive navigates and is useful to specify the user's indoor location with information obtained through the camera. The subject of this paper is the completion of practical AR indoor navigation available on campus.

Keywords: Artificial Reality · Indoor · Navigation

1 Introduction

With the advancement in technology, not only are the buildings becoming bigger, but they are becoming more complex. This had lead the users of the building confused and losing their bearing in the building. Such results are either one or both fruition of bad architectural design category; over-complexity and over-similarity. Therefore, the need for indoor navigation is increasing, but existing GPS cannot be used indoors.

The latter category of over-similarity architectural design is the infamous "Benzene-ring" buildings, that named because several buildings are connected in the form of benzene rings, situated in SungKyunKwan Natural Science Campus(Fig: 1). These buildings have a structure that rotates and repeats, making it difficult for users to find directions indoors. We would like to create an indoor AR navigation system that can be used practically on these buildings.

2 Objective and Motivation

AR navigation is an area that large companies such as Apple/Google/Naver are continuously researching because it can provide intuitive guidance and apply various source technologies such as AR and AI. But so far, the 'core and huge' space is a priority because it takes a lot of resources to map indoor spaces

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Fig. 1. Benzene-ring Building

accurately and process data obtained through sensors. Google's service is difficult to introduce in Korea due to security reasons, and Naver's service is also in the process of testing in a space with a large floating population such as COEX department store(Fig: 2). For this reason, it is impossible to expect corporate

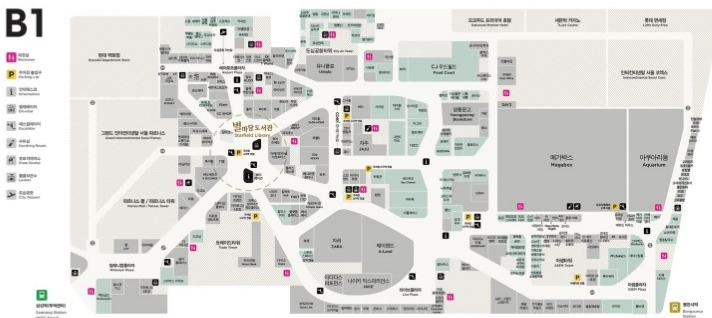

Fig. 2. COEX Building Indoor Map

services for campus in the near future. However, there are many buildings on campus that are prone to get lost due to repetitive structures, and due to the nature of the space called the school, there are new students and visitors every year who encounter the building for the first time.

Therefore, in this project, we aim to analyze existing indoor navigation-related technologies and provide a compact and practical "Artificial Reality(AR) Navigation" service suitable for SungKyunKwan Natural Science campus.

3 Background and Related Work

The keys to indoor navigation are mapping real space and specify the user's location. Traditional navigation uses the Global Positioning System (GPS). However, it is difficult to use GPS indoors because the satellite's signal is not reached by the wall, so various attempts have been made to identify the user's location. The most famous method in this area is Simultane localization and mapping

(SLAM). The SLAM technique, which is actively used in the autonomous robot field, is useful for mapping indoor spaces using vision data obtained through camera sensors. In Korea, Naver attempted to map a large shopping mall and a large metro station in Seoul using SLAM[1].

Fig. 3. Illustration of the proposed NAVER LABS indoor visual localization datasets. Top: Point clouds from LiDAR SLAM (red) and dense reconstruction (color).Bottom: Images showing different challenges; from left to right: textureless areas, changing appearance, crowdedness/occlusions, dynamic environment.[1]

While these SLAM technologies provide a high-accuracy dataset, small-scale indoor navigation tries another way because it requires robots for mapping and need to manage vast amounts of data. Table 1 gives a summary of related indoor location estimation technology and accuracy.

In estimating the user's starting position, a method called AR-marker that recognizes a specific image in which location information is stored through a camera is widely used[3]. As part of vision-based localization, the method of installing anchor based on the feature of the environment and specifying the user's location through triangulation was also discussed[4].

Table 1. Accuracy of user tracking system.[2]

TrackingSystem	**Accuracy**
UWB	1cm-0.3m
Wi-Fi Based Positioning System	1-10m
magnetic Positioning System	1-8m
GPS	1-10m
Bluetooth	0.5-10m
Vision-Based	1mm-1m
PDR	n/a

4 Problem Statement and Proposed Solution

For navigation, a virtual map representing the real space is needed. We will use two methods: creating a virtual model based on floor plans and mapping based on a feature point of a real location.

The software must recognizes the user's initial location. It is expected that most of the time when the system is initialized, the user is trying to either enter the building through the main entrance or exit the class room. By using the door plate placed next to each room as a marker, it is not expected that it will be difficult for the system to recognize the starting point in most cases.

When the starting point is recognized and the user starts moving, the movement is detected and reflected through smartphone's gravity and acceleration sensor. This, however, cannot perfectly detect the user's movement, resulting in constant error. When this error accumulates, of course, a problem occurs in navigation guidance. Due to the nature of AR, which outputs content based on the relative position of the user, an error in navigation guidance would result in AR outputting wrong location content.

To correct this error and synchronize the navigation position with the user's current position. We will be designating and taking scanned images of feature points within the building, and set it up as AR anchor. When the user's phone camera approaches this feature point, the system will adjust the user's current position through triangulation calculation by comparing relative position of phone's place when it recognized the feature point and saved anchor's position in system database.

If mapping of corridors and spots is done well, it can be expressed as points and lines like an image, so it seems that you can set and guide routes based on graph algorithms such as A-star or Dijkstra.

5 Planning in Details

1˜2 Weeks In the 1st and 2nd weeks, since there is still no solution that can be said to be the correct answer for the implementation of AR indoor navigation at campus environment, we is will be collecting and analyzing related previous studies as much as possible to select candidates suitable for the scale we will try, and Implement AR experiences

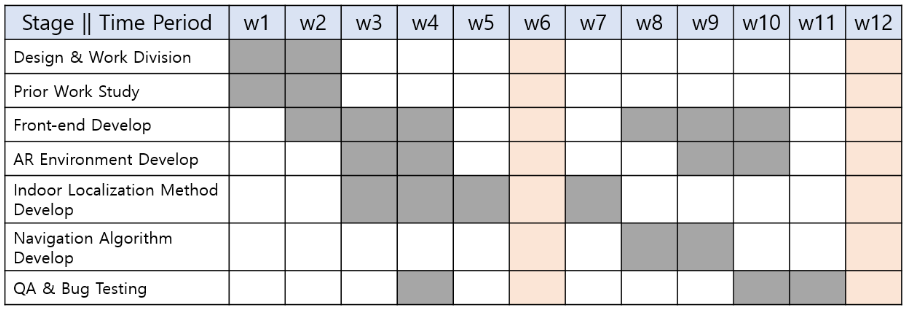

Fig. 4. Team Development schedule

3~4 Weeks In the 3rd and 4th weeks, the selected technologies are implemented so that they can be tested on a small scale of about two corridors. During this week, the mapping and localization technologies that are considered suitable are selected.

5~9 Weeks Between the week of 5th and 9th, the entire system such as mapping, localization, and route setting algorithm is implemented and tested at the building scale. For the mapping, we will be getting school schematics and build it in “Benzene-ring” building. For Localization, we will be taking several photos of the building for feature points and Class room numbers. Though it hasn’t not been finalized, the triangulation algorithm will be implemented.

10~Weeks After the 10th week, the project is integrated and finalized. If there is room in the schedule, the system could correct localization errors through algorithm and improve accuracy. We will conduct further research to improve UI/UX in AR environment, or provide service in a more general environment, expanding service beyond the “Benzene-ring” building.
The division of these works are the following as shown in (Table: 2)

Table 2. Team E work Divisions

Division	Name
AR Development and Mapping, UI/UX	June-seo Ma
AR Marker Recognition	Min-gu Cho, Jeong-Min An
Vision Based localization	Hyeon-ho Kim, Jeong-Min An
Location error Correction	Hyeon-ho Kim
Navigation Algorithm,Data Management	Min-gu Cho

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