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Real time indoor localization system with self-supervised learning

Jaehyun Yoo

Abstract— **Indoor localization systems play a pivotal role in various applications, ranging from asset tracking in industrial settings to personalized navigation assistance in shopping malls. This paper presents a novel real-time indoor localization system designed for quick and easy deployment. The core positioning technology is based on self-supervised learning, which allows people to collect unlabelled data by themselves and then to build own localization system. The algorithm utilizes WiFi signal strength and inertial sensors embedded within smartphones to continuously estimate the user's position in real-time. A web-platform basically shows a thousand of current and past locations of users whose smartphone connected to the server. Also, it has geofencing that alarms users who go across boarder of some designated area such as dangerous zone. Proof of concept has been done from many industrial factories, warehouses, subway stations, offices and malls.**

I. INTRODUCTION

Asset tracking and personnel management are increasingly in demand in industries. One of the traditional approach for indoor localization is hardware-based method. However, the installation of transceivers for radiofrequency devices such as RFID, BLE, and UWB incurs significant costs. Also, the installation process might take long and management of the hardware devices such as battery changes is required.

Our positioning system is based on machine learning technology that uses RSSI (received signal strength indicator) data sets from pre-installed WiFi APs (access points) and inertial measurements from a smartphone. The developed self-supervised learning method [1] gets rid of labelling process so that people collect data by themselves without professional manual and build own positioning model.

II. REAL TIME INDOOR LOCALIZATION SYSTEM WITH MACHINE LEARNING

Entire process from data collection to running mobile application is shown in Fig. 1. First, a user collects data by free-walking with our collection app installed in a smartphone, and the data is sent to the server. After the server creates a positioning model, it is downloaded as a part of the positioning app. Finally, the smartphone calculates it own position with the positioning app. If an user agrees to send the position to the server, the server operates monitoring platform as a frontend.

A. Self-supervised learning for indoor localization

Fig. 2 summarizes a detail of how to learn a positioning model in a self-supervsied way. It uses WiFi RSSI meausrements and inertial measurements as training data. Free walking is allowed for users to collect the data. The inertial

IPIN LABS, Seoul, Korea jaehyun.yoo@ipinlabs.com

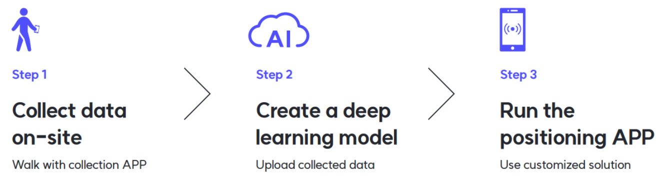

Fig. 1. Service journey from data collection to running mobile application.

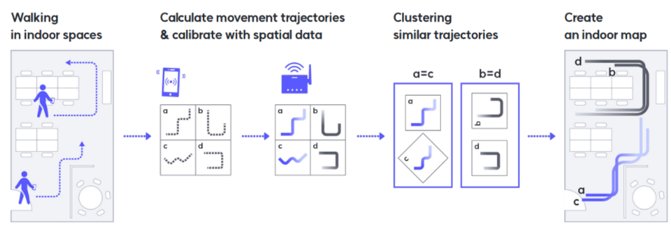

Fig. 2. Description of how to learn a positioning model.

measurements are converted to relative position trajectory [2]. These trajectories are calibrated by WiFi RSSI and then similar trajectories are clustered based on similarity. Finally, the trajectories are matched to a real map. As a result, 2D WiFi SLAM is created.

B. A web-based monitoring platform

Fig. 3 is the web-based monitoring platform. Thousands of objects' locations are presented at a glance, on a single web page. The web-platform is designed for users' convenience without investing time to learn the platform. The UI components are organized that corresponds to natural flow for the eyesight from top-left to bottom-right. On Top left, a user specifies an interested area by selecting in the order of Place, Building, Floor. In center frame, it displays markers for real-time location tracking on a map. On Top right, four features, i.e., map manipulation, visualization, geofencing, and grouping, are positioned. Lastly, in Right bottom, it shows details of the markers such as name, age, phone number, etc. The philosophy behind UX design was to simplify the user's journey with an intuitive interface, but also provide complex features to highlight location information in a well-colored way whereas the rest is in light grayscale. Also, the map area located at the center frame is emphasized by both size and color for clear visibility and simple usability.

III. CONCLUSIONS

IPIN LABS helps companies to improve safety and operational efficiency in their large indoor facilities by providing a

Fig. 3. BPIN: a web-based monitoring platform

web-based asset location monitoring platform. It is a solution that can be deployed in less than 24 hours, and without any extra hardware installation. IPIN LABS has developed a deep learning-based indoor positioning solution that is more affordable and faster to deploy than beacons.

ACKNOWLEDGMENT

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