Employee Location Tracking in Retail Stores

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Abstract. Indoor Positioning System generally uses radio signals, visual data or other types of sensor data to determine where assets such as people and objects are located. There are many different indoor solutions and products used in different application areas from smart transportation in smart cities to contact tracking, location-based games to retail. The offered solutions and/or systems by companies for indoor localization, indoor navigation with context-aware provide different accuracy, reliability, installation and maintenance costs according to the techniques and technologies chosen for the purpose. In this study, an innovative hybrid solution is proposed that will bring a different approach to personnel monitoring in a store that will increase productivity in the retail industry. Within the scope of the study, the indoor location determination process will be carried out by using radio frequency and image data together. Map and/or trajectory fusion will be used to integrate different types of results from different sensors. Spatial decision support approach will be used in directing the salesperson to the busy areas in the store.

Keywords. Indoor Positioning, Indoor Tracking, Wireless Radio Technologies, Vision-Based Technologies, Retail Store Efficiency

1. Introduction

The retail industry pays attention to every detail regarding its customers in order to increase its profitability rates. Many technological approaches are used effectively in the retail marketing, such as store cards, customer phone numbers, customer's smartphones, social media, discount campaigns, and data science analysis of which product and how much customers consume. However, it is seen that new technological applications that have become

widespread in the retail sector generally focus on the customer and the product. In the scope of this study, innovative solutions for store employee, which is another pillar of the sector, are included. By using the proposed innovative hybrid solution, it is targeted that the store sales team will work more efficiently and effectively, thus improving the loyalty of the customers to the store and their shopping continuity, and ultimately improving the productivity of the store.

To determine whether the customers visiting the store receive the attention they expect regarding the products they are interested in, quickly and appropriately from the store employees a long with to increase the satisfaction of the customers regarding the services they receive from the store employees, a Virtual Merchandisor (vMerch)-Team" has been developing.

The vMerch-Team solution provides real-time tracking of store employees with indoor positioning technologies. Thus, the behaviors and activities of employees, both individually and as a team, can be monitored in the store. The performances of store employees are evaluated with data sets obtained as a result of monitoring over business intelligence approaches.

In summary, vMerch-Team is a solution that automatically performs the tasks of tracking store employees based on location and time. These include finding/capturing store employees, identifying and tracking employees, taking action based on customer density in store, and creating analytics such as location analytics, behavior analytics.

2.   Indoor Ecosystem in Retail

Indoor Positioning System generally includes technologies and positioning methods used to determine the location of a receiver in an indoor environment. Today, however, the concept of the indoor ecosystem has expanded substantially and has evolved from indoor location determination to indoor navigation, location-based services, context-aware services and reasoning.

In indoor positioning systems and Location-Based Service applications, roughly, the location of a user is determined using generally wireless radio technology and path planning is executed for the user to reach the place of interest. In the retail sector, however, it is generally desired to follow the customer density or product in the store through indoor localization applications. Proximity Marketing can be given as an example of the prominent indoor application in the retail industry. While employee tracking is carried out with GNSS receivers in the open area, electronic personnel cards are used in enclosed environments. Such an approach through the cards produces only general information in accordance with the Personnel Attendance Control System requirements, such as the hours in which the employee is in the store and the entry-exit hours.

Although there is a wide variety of approaches using different technologies and methods in IPS domain, Radio Frequency (RF) based technology seems to be more common in practice than others. On the other hand, the rapid development of computer vision, video processing, and deep learning makes image-based localization one of the fastest-growing indoor positioning and tracking techniques.

3.   The Proposed Solution: "vMerch"

In this study, Indoor Positioning was designed as a hybrid solution. Firstly, the positioning technique with wireless radio waves, in which the user interacts with the wireless sensor network via wearable devices, and secondly, the image-based positioning technique, in which the user does not interact with the system, was developed separately. Although the first technique using radio signal power and the second technique using optical image are different from each other, they are used together to produce location information. The reason why an approach in which data sets obtained from different sources in different structures is used together is preferred within the scope of the study is that both techniques have pros and cons. Thus, the solution, in which two different techniques are used in a way that supports each other, will ensure that the system works continuously with high performance and will produce reliable outputs for other systems and analyzes to be made.

Stores are cluttered and crowded environments. Additionally, crowded customers around the products may prevent the store employee from being viewed by the camera or performing the correct face recognition from the image. In these and similar cases, information about where and how long the store employee has been can be produced by wireless radio technology. On the contrary, the store employee can give his radio signal tag to another employee. In this case, this employee will be followed by being matched with a different identity. Such situations can also be avoided by using image-based systems.

The main problem to be solved in the hybrid approach proposed in the study is how to use two different techniques with different structures in an integrated manner.

Positioning approach with RF techniques is performed by signal strength and is based on RSSI value. By applying classification algorithms to RSSI values, the location information is given generally on the fingerprint map (RF-map).

In image-based technique, stereo image and depth map can be produced from RGB-D source images or using more than one camera. If a single camera is used, location information can be produced by the help of the grids pre-generated on the image.

Apart from these two spatial representations, there is also a basic map (indoor map, metric map) that reflects the geometric representation of the environment.

In this case, the solution of the problem evolves from sensor fusion to map fusion (map matching). The map fusion problem can be solved by transformation. The coordinate system from which the base map was produced should be taken as the base coordinate system and other spatial representations such as fingerprint maps should be integrated in the base coordinate system. Thus, the locations and traces of movements of employees can be visualized on the base map.

Thematic maps like heat maps produced on the subjects, such as what products the customers are particularly interested in in the store, how long the customers stay in which part of the store, or how much time they spend in which product group, were also included in the map fusion.

In summary, the map engine being developed within the scope of vMerch-Team can spatially integrate the base map with topological features and other maps such as fingerprint, grid display and thematic maps. The interface being developed also visualizes the map and map information according to the roles and rights of the user.

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