SELECTIVITY OF MULTIMPLE INDOOR POSITIONING SENSORS

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Abstract:

Recently, seamless positioning techniques in indoor and outdoor environment are required for the purpose of self-location acquisition for construction field and plant maintenance. Though we can acquire our own locations with outdoor positioning systems such as a Global Navigation Satellite Systems (GNSS) in outdoor environment, they're unavailable in indoor environment because the radio wave from GNSS satellites can't reach into indoor and underground. Moreover, each indoor positioning system such as wireless LAN, indoor messaging systems (IMES), radio frequency identification (RFID) tags, infrared tags and visible light communication system is severally developed and partially short of efficiency such as accuracy, stability and integrity in indoor environment. Therefore, sensor data selectivity and integration are required for crowded navigation systems consisted of existing and the latest, multiple sensor systems that have disparate kind of data format and property to achieve high efficiency positioning system. Thus, we firstly focus on selectivity of multiple indoor sensor data, and have proposed a reliable sensor data selection approach to achieve more accurate and stable positioning using the multiple indoor positioning sensor data. We then conducted indoor positioning experiments under a combination of multiple systems and sensors with 254 verification points. Two patterns were tested in this experiment. To produce the first pattern, the experimenter walked while holding the mobile PC to simulate navigation for pedestrians. Another pattern involved smooth movements by a truck to simulate navigation for autonomous robots. Moreover, we have set indices to each synchronized data received from IMES, RFID and Infrared Tags from the point of view of accuracy, integrity and continuity based on "Standards and Recommended Practices" (SARPs). Finally, we summarize this study with some parameters for indoor positioning data selections.

1. INTRODUCTION

Recently, seamless positioning and navigation techniques throughout indoor and outdoor environment are required for acquisition of location data in various situations such as construction field, pedestrian and autonomous robot navigation and spacial infrastructure management. Actually, for example, we can acquire our own location with outdoor positioning techniques such as GNSS in outdoor environment. However, GNSS receiver cannot receive signal from GNSS satellites in indoor and underground environments. Moreover, each existing indoor positioning system such as wireless LAN, IMES, RFID tags, infrared tags and visible light communication system is separately developed, utilized and partially short of efficiency such as accuracy, integrity, continuity and availability. Nevertheless, it is considered that even more new multiple positioning systems will be developed and used combinedly in the future. Therefore, in this study, we focused on data acquisition of high efficiency location data using multiple positioning systems simultaneously.

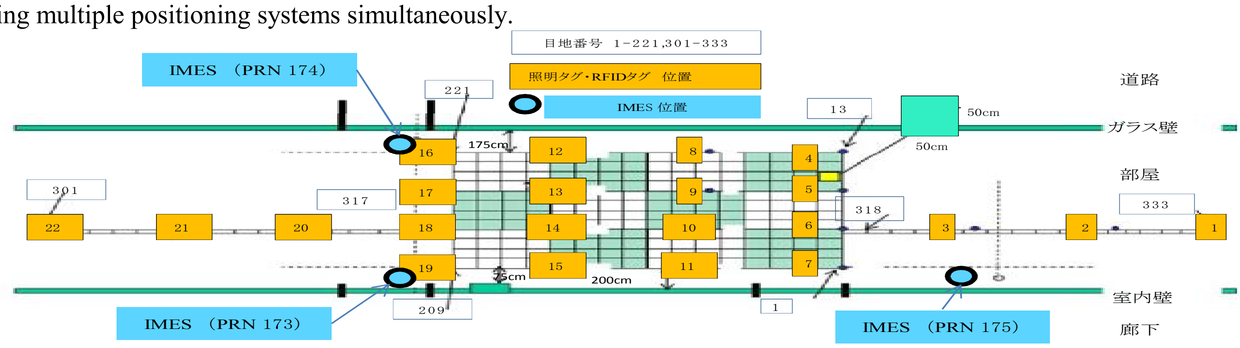

Figure 1: Sensor distribution map for the indoor study area

2. METHODOLOGY

Our purpose methodology is described as follows. Firstly, we set the indices on the data from multiple positioning systems from the point of view of accuracy, integrity and continuity based on Standards and Recommended Practices (SARPs). Next, weight parameters are set using the indices. Then, position data are optimized using multiple sensor data.to estimate more accurate and reliable position values. These procedures are shown in Figure 2.

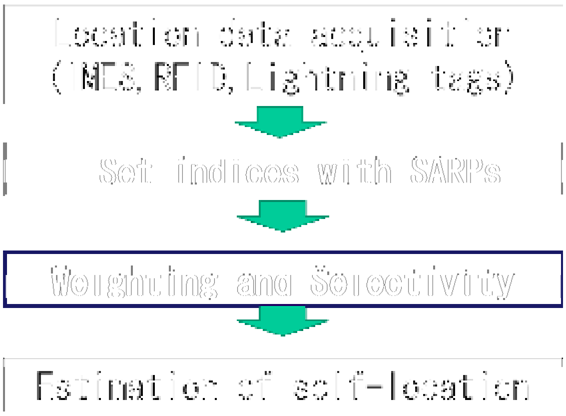

Figure 2: The processing flow

2.1 SARPs

SARPs is the format of standard and recommendation with high safety standards; accuracy, integrity, and continuity necessary to utilize GNSS for a navigation defined as following. Accuracy is the value the rate of the number of that is over 95%. And integrity is the reliability of the result value. In this study, after an accuracy verification experiment of lightning tags, we calculated the data service range and data acquisition rate in the area., and calculated IMES data acquisition rate about all points. Continuity is the probability that the system doesn't suspend the service within a given time and judged about 2 situation, stability and moving. For example, continuity is judged with the number of points with empty data about IMES, and with the number of point that receive data with more than 1Hz sampling rate. availability is frequency that the system is available and not considered in this study. With these indeces, we conducted an experiment.

3. EXPERIMENTS AND RESULTS

We conducted an experiment on 7 July, 2011 in our campus. In this case, the following positioning systems are used as showed in **Figure 4**, IMES, RFID tags and lightning tags.
Firstly, the experiment was conducted and the temporally synchronized data from each positioning system, IMES, passive type RFID tags and lightning tags distributed as showed in Figure 1. Secondly, we set indices to data from each system from the point of view of accuracy, integrity, and continuity based on "Standards and Recommended Practices" (SARPs). Thirdly, we arranged weighting the data indexed with SARPs and select one that have the highest efficiency or sum up them, and estimate more accurate and reliable position values.

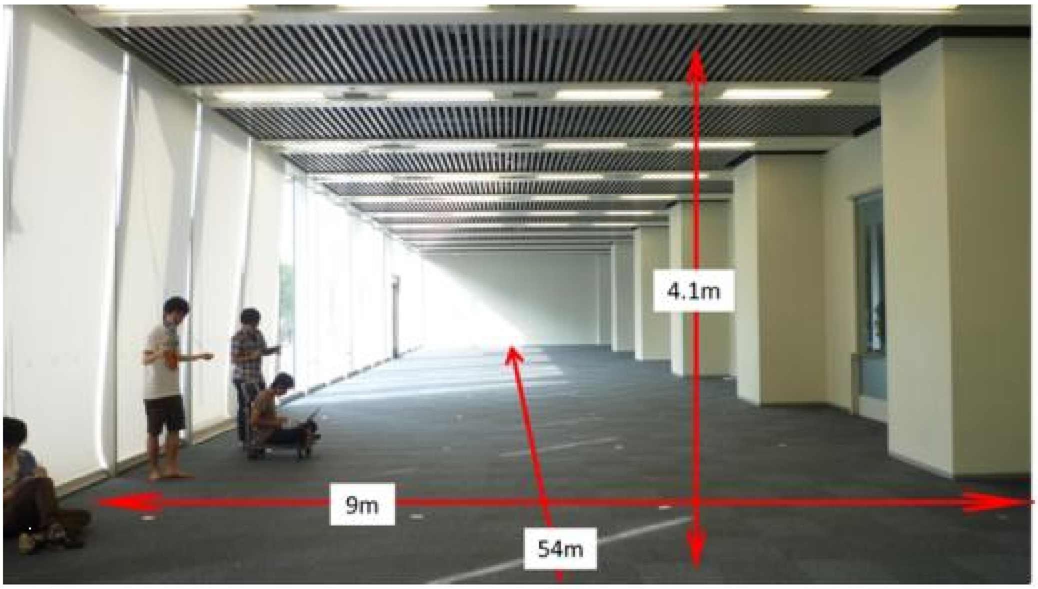

Figure 3: Study area

Figure 4: Sensors used in the test environment

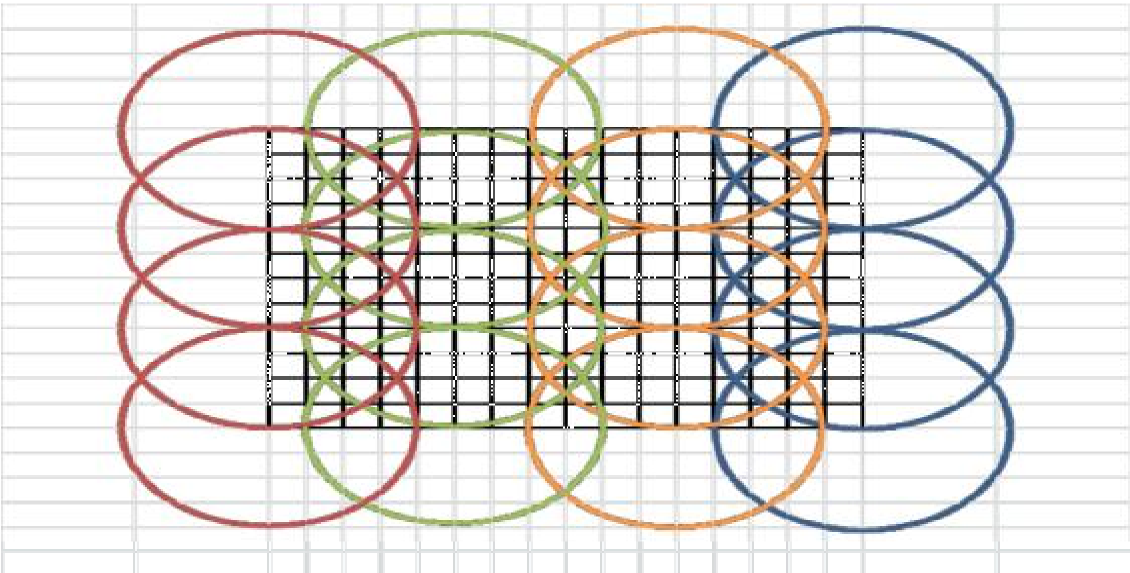

Figure 5: Service ranges of lightning tag

The result of calculation of each index based on SARPs is showed in Table 1

Table 1: Calculation results based on SARPs

		[illegible]	[illegible]	IMES
accuracy		10cm	1.5m	10m
integrity	[illegible]	100.00%	57.30%	94.49%
	[illegible]	79.75%	51.43%	34.15%
continuity	[illegible]	-	26.38%	74.37%
	[illegible]	-	97.70%	83.96%

Euclid space is better than the Maximum Likelihood Classification method to classify various position data taken from multiple sensors. Therefore, we set weight parameters with indices based on SARPs. Thus, we have confirmed a selectivity of multiple sensors has an importance in the both of the two situations, stability and moving.

4. CONCLUSION

We have proposed a new technique to improve location data using multiple positioning systems. Moreover, we have set weight parameters for a selectivity of the most high efficiency location data. However, fine resolution positioning using IMES including multipass estimation, automated data mapping for moving objects are required as our future works

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