

Location Error Compensation for a Virtual World Application Using Mobile Phones with GPS

Hiroyuki Tarumi (Faculty of Engineering, Kagawa University & SpaceTag, Inc;
tarumi@acm.org.) and **Hirotoishi Hori** (Faculty of Engineering, Kagawa University)*

Abstract: Our virtual world system provides virtual scenes to GPS phone users. However, displayed views are very sensitive to location errors. We have developed a simulation system for location-compensation algorithms and evaluated them. We have found that a pathway-matching algorithm is effective.

1. Virtual World Application

Using the SpaceTag concept [1], we have been developing and evaluating a 3D virtual world system for users with mobile phones [2]. With this system, users can view and interact with virtual objects including virtual creatures (agents) virtually located at a particular position using their own mobile phones with GPS functions (Fig. 1). In Japan, more than ten million phones with GPS (more precisely, gpsOne by Qualcomm, Inc.) have been shipped out. With this project, we are aiming at deploying a virtual world system without costs of additional devices.

Some types of the GPS phones on the market have an embedded e-compass. In this research, we assume this type of phones.

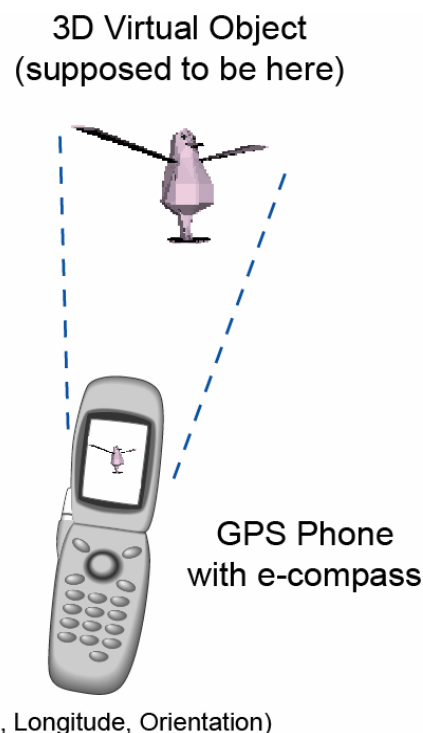
2. Location Error Problem

Differently from map-based user interfaces, our application is very sensitive to location errors. In case of map-based systems, ten meters of location error is a small difference on the map view, for example. However, on our system, scenes shown to a user might be quite different if the location of user is detected with an error of ten meters (Fig. 2). Usually, gpsOne phones may have about fifty meters of errors in the worst cases. This problem is the most

severe obstacle to the deployment of the virtual world system.

3. Compensation Algorithms

Our low-cost approach should avoid higher-cost location sensors or embedded markers in the environment, like Bluetooth or 2D barcodes. Hence we tried to design compensation algorithms for location errors and evaluated them. We have developed a simulator of algorithms and input some location data obtained from GPS phones to the simulator. The simulator produces a movie file showing



(Latitude, Longitude, Orientation)

Fig. 1: Virtual World Concept

*Currently, Hirotoishi Hori belongs to Chuden CTI Co. Ltd.

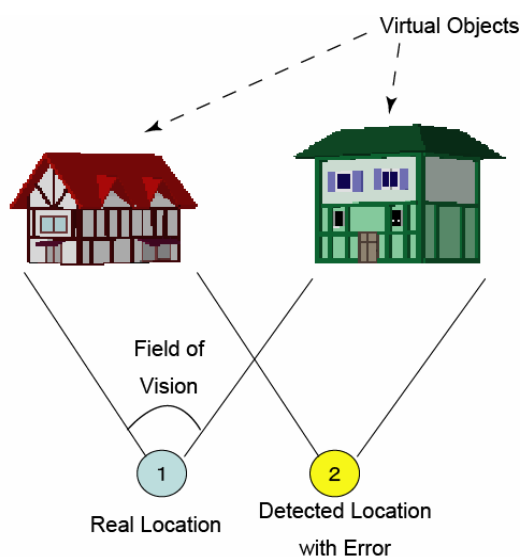


Fig 2: Location Error and Change of View

scenes that users would watch on their phone displays. We tried the following algorithms and their combinations:

- 1) adopts mean values of the last six data.
- 2) neglects small movements less than five meters.
- 3) if a movement is bigger than usual walking speed, adjusts it to a smaller value.
- 4) assuming that the user is walking into the direction that the e-compass indicates, adjusts a movement into the direction, by vector projection.
- 5) assuming that the user is walking on a pre-defined pathway, adjusts location values onto the pathway, by vector projection.

4. Evaluation

Ten subjects, who were students of the faculty of engineering, evaluated the output movie from the simulator. They gave scores ranging from 1 to 5 to each

simulated movie, where 5 is the best score.

As results, simulations including algorithm 5) received the best evaluation: 3.1 (mean value). For example, a combination of algorithms 2) and 5) received 3.3, and another combination of 2), 3), and 5) received 3.2.

5. Conclusion

In this paper, we have described that a pathway-matching algorithm like the map-matching for car navigation systems is also effective for virtual world applications for pedestrians with GPS phones. Adopting this algorithm, such applications would be more usable than those without location compensation. However, we need a pathway definition tool for contents design. Virtual world applications are better targeted to areas where users are restricted in movement than to widely opened fields where users can go anywhere.

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