Crowdsourced Geocaching for Indoor Maps Reconstruction

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1 MOTIVATION

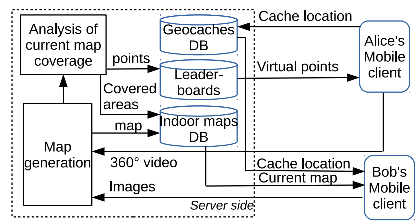
Indoor mapping is an emerging application in Visual Crowdsourcing (VCS). It is utilized to construct indoor floor plans [5] and enable indoor positioning services [1]. However, VCS based mapping is labour intensive, as visual data has to be collected from all around the venue. To mitigate the problem, incentive mechanisms were proposed such as rewarding payments and reverse auctions [2], however they may incur notable costs for large data collection.

In our work, we propose to utilize Geocaching [4] as an incentive to aid collection of VCS data for building indoor maps. In Geocaching, mobile users hide virtual treasures in arbitrary locations, which can later be discovered by other service users. Geocaching typically requires no monetary payments to engage users in the activity. Currently, most Geocaching services rely only on Global Positioning System (GPS). In our work, we extend the range for hiding geocaches to also include indoor areas. We utilize techniques from our previous work [3] to build indoor maps and enable accurate image based positioning services.

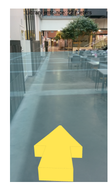
2 SYSTEM DESIGN

The main goal of our work is to efficiently collect VCS data for map reconstruction in an unknown indoor venue (building), thus we propose a system that implements a following scenario. A first user, Alice, enters a building and goes to an arbitrary location, where she wants to hide a virtual treasure (geocache). She then shoots a 360° video around, in an area which has enough visual features. We then store the cache location and build an indoor map from the feature-full video. Alice gains additional virtual points if she hides a treasure in an unmapped area - an area where no visual data was collected yet. In this way we encourage users to collect data in undiscovered places. In order to get an approximate location where Alice hid the treasure, we utilize dead reconing using the last known accurate location (either GPS or image based) as an initial anchor. An another user, Bob, gets a notification that a geocache is hidden in a building. He enters a building and uses an augmented reality based guidance to locate the treasure (Fig. 1b). Note, that at this point we only approximately guide Bob, since a full area model is not yet available. While he is walking, the application collects photos and builds an area map until the map connects to the piece of map created by Alice. At this point Bob receives the treasure and an indoor map coverage is increased (Fig. 1c). The process of hiding and finding geocaches continues, until the venue map is fully built.

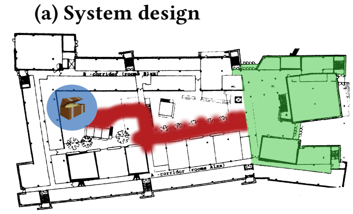
We build our system utilizing a client-server architecture (see Figure 1a). The server side is responsible for storing treasure locations, building maps from input images and analyzing coverage of the already built maps. We utilize Structure-from-Motion (SfM) to build indoor maps from 360° videos and input images. SfM is robust in building large scale maps, though not suitable for real time map



(a) System design



(b) User being guided to a treasure location



(c) Example scenario. Green area indicates already mapped building, white area indicates unmapped areas, blue area shows a treasure location and map coverage from the 360° video, red area shows treasure seeker's path and an area mapped on the way.

generation. Therefore we propose to utilize Simultaneous Localization and Mapping (SLAM) toolkits[1] that provide accurate enough tracking for a short period of time, to track positions of treasure seekers. Once the geocache is found, we run SfM to build a robust and accurate map from all the collected images while searching for and hiding the geocaches.

We plan to conduct a user study to prove that it is feasible to adapt geocaching as an engaging incentive to collect crowdsourced images required to build complete indoor maps. We further intend to compare our approach with other incentive mechanisms and state-of-the-art indoor mapping systems.

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