LuzDeploy: A Collective Action System for Installing Navigation Infrastructure for Blind People

Published version:

DOI:10.1145/3058555.3058585

(Article begins on next page)

LuzDeploy: A Collective Action System for Installing Navigation Infrastructure for Blind People

Cole Gleason
Carnegie Mellon University
cgleason@cs.cmu.edu

Dragan Ahmetovic
Carnegie Mellon University
dragan1@cmu.edu

Carlos Toxtli
West Virginia University
ctoxtli@gmail.com

Saiph Savage
West Virginia University
National Autonomous University of Mexico
saiph.savage@mail.wvu.edu

Jeffrey P. Bigham
Carnegie Mellon University
jbigham@cs.cmu.edu

Chieko Asakawa
Carnegie Mellon University
IBM Research-Tokyo
chiekoa@cs.cmu.edu

ABSTRACT

Providing navigation assistance to people with visual impairments often requires augmenting the environment with after-market technology. However, installing navigation infrastructure in large environments requires a critical mass of trained personnel. Recruiting, training and managing participants for such a task is difficult.

LuzDeploy is a computational method to recruit, instruct and orchestrate volunteers to perform physical crowdsourcing tasks. We use LuzDeploy to orchestrate volunteers to install physical infrastructure for the navigation assistance of people with visual impairments. Our system provides on-the-go enrollment so that volunteers can participate to the collective action whenever they have time, coming and leaving as needed. Providing automated instructions also allows to avoid instructing participants directly, so experts do not need to be available on-site.

CCS Concepts

•Information systems → Crowdsourcing; *Location based services;* **•Human-centered computing → Accessibility technologies;** *Activity centered design;* **•Social and professional topics → Systems development; People with disabilities;**

Keywords

Physical Crowdsourcing, Visual Impairments, Assisted Navigation

1. INTRODUCTION

For individuals with visual impairments, real world accessibility is a long-standing challenge [Jacobson 1998]. Sighted individuals can examine their surroundings in a long-range and grasp the layout of the environment with a glance, but blind pedestrians can usually sense only their immediate vicinity through haptic exploration (e.g., scanning the surroundings with their white cane).

W4A 2017 April 02-04, 2017, Perth, Western Australia, Australia

ACM ISBN 978-1-4503-4900-0/17/04.

DOI: http://dx.doi.org/10.1145/3058555.3058585

GPS location-based services are commonly used to provide navigation assistance to sighted travelers. However, these systems are only available outdoors [Kacorri et al. 2016, Ahmetovic et al. 2016b], and even then, often they achieve a localization accuracy limited to tens of meters [Modsching et al. 2006]. This makes them incapable of providing navigation assistance to individuals with visual impairments. The dominant approaches for indoor and accurate navigation assistance for individuals with visual impairments often consist in augmenting the environment with after-market assistive infrastructure [Iwahashi 1983]. Among proposed approaches, an accurate and cost-effective solution is NavCog, described in [Ahmetovic et al. 2016a]. This approach proposes to install Bluetooth Low Energy (BLE) beacons in the environment and to use them to detect the location of a person carrying an off-the-shelf smartphone. The user's location is then leveraged to provide navigation instructions and information about the user's surroundings.

Installing navigation infrastructure relies on expert personnel with prior training [Ishii et al. 2013]. However, recruiting a sufficient number of experts to simultaneously perform the installation of the infrastructure in large spaces is difficult since experts are rare and have limited time [Vaish et al. 2014]. Training new volunteers to assist in the installation can serve to increment the number of participants, but it takes time and effort. In addition, even when a sufficient number of experts is available, it is still difficult to organize a large group of participants to perform a collective action [Vaish et al. 2014].

We present LuzDeploy: a computational system that performs live orchestration of participants during physical crowdsourcing. LuzDeploy is designed with two key features in mind:

1. It stimulates *broad participation*: LuzDeploy does not require proprietary devices or software. Instead, it performs all the activities, from the on-boarding, to the training and coordination of participants, through Facebook Messenger app installed on the user's smartphone. This allows anyone who has a mobile phone with Facebook messenger installed to participate, without any prior training.

2. It enables *flexible volunteering*: LuzDeploy fragments the collective action into simple tasks, easily performed by non-experts in short time. The on-the-go task assignment is based on the availability of the participants. Thus, LuzDeploy permits the volunteers to join and leave the collective action as needed. This allows volunteers with just a few minutes of free time to significantly impact the collective effort.

2. LUZDEPLOY

To provide mobility assistance with a bluetooth beacon-based navigation system such as NavCog, a number of complex and time-critical activities must be performed [Ahmetovic et al. 2016a]. Typically, it is necessary to install the beacons in the environment, take measurements of the designated paths, collect Bluetooth signal samples across all the areas of the environment, and prepare the map data with the collected measurements and samples. During the execution of the system, it is also required to periodically verify that the beacons are working properly, replace depleted batteries and malfunctioning beacons. While these activities would ordinarily be performed by a small number of trained experts, our goal is to allow even non-experts to perform the system installation without requiring prior training. For this purpose we introduce **LuzDeploy**, an end-to-end system that performs efficient orchestration of a large volunteer workforce for installing and maintaining a Bluetooth beacon-based navigation infrastructure for individuals with visual impairments.

LuzDeploy has been designed with two core capabilities in mind: 1) *broad participation*: LuzDeploy allows non-experts to significantly contribute during the system installation, and 2) *flexible volunteering*: LuzDeploy makes it easy to participate with even only a few minutes of spare time.

The architecture of the LuzDeploy system revolves around 2 core components, shown in Figure 1:

> **LuzDeploy Map** is a remote web service, an extended version of the NavCog map server, built as an overlay tool on top of the Google Maps GIS. It allows administrators to create maps of the environment by adding and positioning the venue floorplans on top of the world map.
>
> The administrators use this system to plan the installation of the system according to NavCog specifications [Ahmetovic et al. 2016a], and create tasks needed for installing the NavCog system. The tasks, extracted from LuzDeploy Map, are dispatched to the volunteers by the LuzDeploy Bot. The volunteers that receive the tasks are then guided using the LuzDeploy map to perform the desired tasks across the environment.
>
> **LuzDeploy Bot** is a Facebook messenger bot that performs the orchestration logic of the system. The main responsibility of this server is to handle the onboarding of new volunteers, assign tasks extracted from LuzDeploy Map, and track task duration. LuzDeploy Server communicates with volunteers through the Facebook Messenger Send API[1], which allows sending and receiving both of text and rich interactive messages (e.g., with buttons or pictures). Through a NodeJS server, the bot connects the Facebook Messenger Send API to the database containing imported task and information on subscribed volunteers.
>
> The LuzDeploy Bot can define the composition of the workforce on-the-go by dynamically assigning tasks to the available volunteers. This enables *flexible volunteering*, so that the volunteers can participate towards a collective goal according to their availability. Some volunteers may have to leave the collective action prematurely, while others may join after the deployment has already started.

[1] https://developers.facebook.com/docs/messenger-platform/send-api-reference

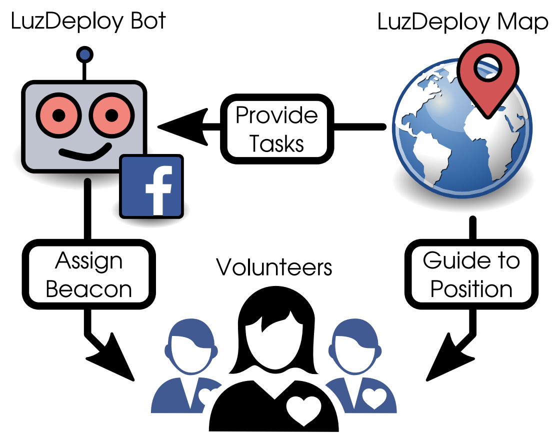

Figure 1: LuzDeploy components: LuzDeploy Bot assigns tasks created on LuzDeploy Map to volunteers using Facebook Messenger. LuzDeploy Map guides volunteers to perform tasks.

3. REFERENCES

[Ahmetovic et al. 2016a] Dragan Ahmetovic, Cole Gleason, Chengxiong Ruan, Kris Kitani, Hironobu Takagi, and Chieko Asakawa. 2016a. NavCog: A Navigational Cognitive Assistant for the Blind. In *Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI '16)*. ACM.

[Ahmetovic et al. 2016b] Dragan Ahmetovic, Roberto Manduchi, James Coughlan, and Sergio Mascetti. 2016b. Mind your crossings: Mining GIS imagery for crosswalk localization. *ACM Transactions on Accessible Computing* (2016).

[Ishii et al. 2013] Kentaro Ishii, Haipeng Mi, Lei Ma, Natsuda Laokulrat, Masahiko Inami, and Takeo Igarashi. 2013. Pebbles: User-Configurable Device Network for Robot Navigation. In *IFIP Conference on Human-Computer Interaction*. Springer, 420–436.

[Iwahashi 1983] Hideyuki Iwahashi. 1983. *Toward white wave - Story of Seiichi Miyake (in Japanese)*. Traffic Safety Research Center.

[Jacobson 1998] R Dan Jacobson. 1998. Cognitive mapping without sight: Four preliminary studies of spatial learning. *Journal of Environmental Psychology* (1998).

[Kacorri et al. 2016] Hernisa Kacorri, Sergio Mascetti, Andrea Gerino, Dragan Ahmetovic, Hironobu Takagi, and Chieko Asakawa. 2016. Supporting Orientation of People with Visual Impairment: Analysis of Large Scale Usage Data. In *International ACM SIGACCESS Conference on Computers and Accessibility*. ACM.

[Modsching et al. 2006] Marko Modsching, Ronny Kramer, and Klaus ten Hagen. 2006. Field trial on GPS Accuracy in a medium size city: The influence of built-up. In *3rd workshop on positioning, navigation and communication*. 209–218.

[Vaish et al. 2014] Rajan Vaish, Keith Wyngarden, Jingshu Chen, Brandon Cheung, and Michael S Bernstein. 2014. Twitch crowdsourcing: crowd contributions in short bursts of time. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems*. ACM, 3645–3654.