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NAVATAR

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1 Abstract/Summary

Navatar is an indoor navigation system for visually impaired students. Unlike existing systems that rely on expensive equipment, Navatar only requires an Android smartphone. Sensors in the phone are used to approximate a user's location and audio is used to provide directions. Buildings on University campuses often have the GIS maps and the design required for Navatar's accelerometer based localization. With the application's open source status and modular design, crowdsourcing efforts can be used to integrate maps for buildings on any campus. The application is still under development and Team 6 will be working on a variety of new features alongside other open source contributors.

2 Project description

The main goals and objectives of this project are to help blind people navigate indoor environments using a mobile phone and open source software which allows for a very low overall cost. Most people already have a cell phone and earbuds, and mobile phones have a wide array of sensors available for environmental information. Accessibility is a major issue for many students with disabilities, and the technology necessary to ease the burden of some tasks that can be needlessly complicated is available and waiting to be utilized. Currently, there is no free and open source software capable of gathering environmental information and assisting students with indoor navigation for an entire college campus.

The high level business requirements and characteristics of this software are very clear. This software must be simple to use, low-cost, scalable, maintainable, and efficient in its assistance to blind users. The intended audience of this project, as stated, is blind students and partially blind students. There are students with various degrees of visual impairment, and so having another way of understanding their surroundings would be highly beneficial. Users will benefit from our project by being able to seamlessly understand buildings on campuses and find new rooms and unfamiliar locations simply through audio and use of this application. Existing and familiar environments will be conquered through the use of landmarks and bookmarks. A bookmark in this case would be a landmark that the user sets manually, that gets stored specifically for that user. The reason behind this is that many partially-sighted and blind users remember details that sighted people may not utilize or need, such as a metal strip on the floor, that help them remember where they are in an indoor setting relative to where they want to go.

The project itself currently exists as a repository on github that contains a mobile android app. The members of our group all currently have a fork and will be developing features. The future of this software depends greatly on what we are capable of achieving in the time-frame provided, but we plan on implementing many features. Future enhancements include geofencing to determine what building the user is in, the ability for users to declare and input their own landmarks, third party device integration to improve usability and accuracy (i.e. smart watches, Bluetooth earpieces), using additional environment information such as wifi SSIDs, making the app more scalable, improving map conversion and creation, user profile learning, stride detection, and gesture-based UI/UX improvements. The technology is an android application, built with android studio and using gradle for the build system. The features will be coded in the Java programming language.

The functional components and characteristics of this project are compartmentalized and modular. The phone itself will use wifi, gps, and other sensors to pinpoint a user's location. Geofencing will be utilized to determine if a user is inside of a specific building. Essentially a boundary is defined using gps coordinates (i.e, a 'geofence') and the user will be considered as inside of a building when their gps position is within this boundary. From there, a data format called a protobuffer containing the environment's interior map will be parsed and analyzed to provide audio feedback about the position. An algorithm determines gait of the user, since people with poor vision or no vision typically have irregular gaits that need to have their stride detected and calibrated in a unique way.

Challenges and obstacles that we may encounter during the project's development are that the project relies on input from protobuffers that may or may not be up to date. The protobuffers are going to be stored directly in the application as static resources and currently we only have protobuffers available for UNR. To have the protobuffers as dynamic resources would require external data access permissions and serialization and deserialization overhead that may affect the performance of the application. Optimization will be a huge consideration when developing this app, because users in the best case would be using this application frequently. For instance, we wouldn't want it to drain their battery before they are finished with all of their classes for the day.

There are three team members. The first is Matthew Berger. He is a senior computer science and engineering major who works for Hamilton Company as a software engineering intern. He has been programming using a variety of systems programming languages for about 8 years. He will be a feature developer on this project similar to his teammates. The second is Liam Gomez. He is a software engineering intern at No-IP and has been programming for around 7 years. He will be a feature developer as well as helping to do code review on code submissions for the project. The final member is Connor Parkinson. He is a software engineering intern at Hamilton Company and has experience with mobile development. He will also develop features, but additionally he will serve as a team leader for our group to help keep us focused and organized. Eelke Folmer is our advisor, and he devised the original idea for this project and oversaw the initial development that led to the current version on github.

This project will help each member of our team grow as software developers and will impact our professional growth by giving us a major project to list on our resumes and allow us to say that we have experience developing accessibility oriented software that actively improved the lives of its user base and was developed with a mainstream git workflow that familiarized us with the cycle of open source development utilized by most FOSS that companies produce to this day.

3 Market potential / open source significance

For students who are visually impaired, navigating indoor facilities can be challenging. Typical navigation applications that rely on GPS cannot be used indoors due to service availability. Thus solutions to this problem usually require physical modification to the indoor environment, which can be quite expensive or simply not possible. One such solution involves the installation of RFID tags throughout the building, requiring extensive installation costs due to the sheer amount of tags required for a single building.[1] The Hagisonic StarGazer is another potential solution used for robot localization, which involves installing expensive beacons around the building and requires the user to carry a cumbersome sensor.[2]

Navatar uses common smartphone sensors in combination with GIS maps of indoor facilities to provide a low cost and easy to implement solution. The use of GIS maps and local landmarks to provide locational information means no physical modifications to the facility are necessary, thus lowering implementation costs. The use of common smartphone sensors also means that the user is not required to wear any inconvenient hardware. Navatar is also an open source project which could help with the widespread adoption and implementation of this technology.

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[1] Ilias Apostolopoulos, Navid Fallah, Eelke Folmer, Kostas Bekris. Feasibility of Interactive Localization and Navigation of People with Visual Impairments, Proceedings of 11th Intelligent Autonomous Systems Conference, Pages 22-32, Ottawa, Ontario, August 2010.

[2] Navid Fallah, Ilias Apostolopoulos, Kostas Bekris, Eelke Folmer, The User as a Sensor: Navigating Users with Visual Impairments in Indoor Spaces using Tactile Landmarks, Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems (CHI'12), Pages 425-432, Austin, Texas, May 2012.

The need for this type of indoor localization system for the visually impaired cannot be overstated. In a user study of Navatar conducted by the University of Nevada, Reno it is noted that all six visually impaired participants admitted to getting lost both indoors and outdoors. After the study a participant remarked, “I have never used such a system before and I think it could be really helpful, despite its current shortcomings”.[3] The new features and potential improvements that our group is proposing to make could help Navatar become a more viable solution as an indoor localization system for the visually impaired.

4 Time worked on project concept

All team members worked approximately three hours each on this project concept. Matthew Berger and Connor Parkinson worked on the abstract and project description sections. Liam Gomez worked on the cover page and market potential / open source significance section.

[3] Navid Fallah, Ilias Apostolopoulos, Kostas Bekris, Eelke Folmer, The User as a Sensor: Navigating Users with Visual Impairments in Indoor Spaces using Tactile Landmarks, Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems (CHI'12), Pages 430-431, Austin, Texas, May 2012.