

Traffic Light Detection for Blind People

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Abstract: - Context-awareness is a critical aspect of safe navigation, especially for the blind and visually-impaired in unfamiliar environments. Existing mobile devices for context-aware navigation fall short in many cases due to their dependence on specific infrastructure requirements as well as having limited access to resources that could provide a wealth of contextual clues. In this work, we propose a mobile-cloud collaborative approach for context-aware navigation, where we aim to exploit the computational power of resources made available by Cloud Computing providers as well as the wealth of location-specific resources available on the Internet to provide maximal context-awareness. The system architecture we propose also has the advantages of being extensible and having minimal infrastructural reliance, thus allowing for wide usability. A traffic lights detector was developed as an initial application component of the proposed system and experiments performed to test appropriateness for the real-time nature of the problem.

Keywords:-mobile; zigbee; context-awareness

I. INTRODUCTION

Mobility is important for the quality of life. The ability to see, hear, and experience the context of the environment is critical for safety. Visually impaired or blind persons rely on their previous knowledge of an environment to navigate, usually getting help from guide dogs or the white cane, which leaves them handicapped in achieving desired level of mobility and context-awareness especially in unknown environments. Existing navigation systems for the blind and visually impaired people provide some level of help, but fail to address the important aspects of context-awareness, safety and usability. They also are not open and not designed for extensibility, which makes them unable to integrate or take advantage of the newer, more advanced technology and the wealth of relevant Internet resources. Most of these systems depend heavily on the underlying infrastructure, limiting their use in places

where the infrastructure requirements are not met. Context information provided to the user by the available devices is usually very limited and the devices aiming to provide more detailed information (such as recognizing particular classes of objects) sacrifice portability, which is undesirable especially for long trips. Much can be done to enhance the experience and increase the safety and capabilities of individuals in navigating freely in buildings, college campuses, and cities. By providing maximal awareness of the environment and its contexts, without requiring any modification to the existing infrastructures, the quality and experience of navigation will be significantly enhanced for the blind user as well as other users in unfamiliar environments.

The urban world is becoming more complex every day with advances in technology, products of which such as quite cars, make it more difficult especially for the blind and visually-impaired to fully sense their environment. Existing route planning devices provide guidance in terms of directions to follow, but fail to address important safety issues such as when to cross at an intersection, which requires awareness of the status of traffic lights and dynamic objects such as cars. Accurate and fast object recognition and obstacle detection, which require the use of computationally intensive image and video processing algorithms, are becoming increasingly important for systems aiming to help the blind navigate independently and safely. The limited computational capacity and battery life of currently available mobile devices make fast and accurate image processing infeasible when the devices are to be used in isolation (i.e. without communicating with any external resources for the computations). In this work, we propose a context-rich, open, accessible and extensible navigation system, bringing the quality of the navigation experience to higher standards. We use currently available infrastructure to develop an easy to use, portable, affordable device that provides extensibility to accommodate new services to help in high quality

navigation as they become available. This paper particularly focuses on a traffic lights detector developed as an initial component of the proposed context-aware navigation system, which we aim to build on in future work.

II. RELATED WORK

Systems based on different technologies have been proposed for the task of helping the blind and visually-

impaired find their way at indoor and outdoor locations. After the introduction of the Global Positioning System

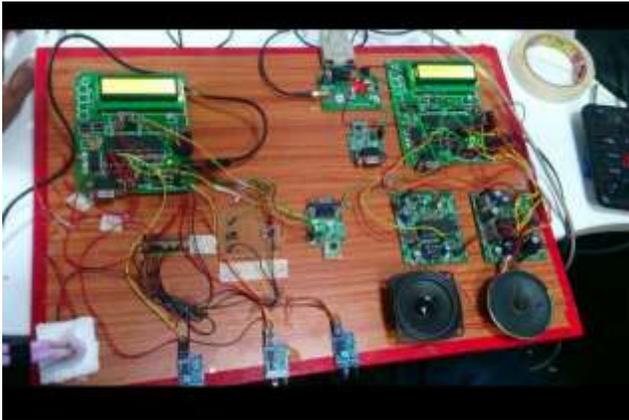
(GPS) in the late 1980s, many systems based on the GPS to help the visually impaired navigate outdoors were proposed and some were commercially released. Among those systems are the LoadStone GPS (<http://www.loadstone-gps.com/>), Wayfinder Access (<http://www.wayfinderaccess.com/>), BrailleNote GPS and Trekker by Humanware (<http://www.humanware.com>), and StreetTalk by Freedom Scientific (<http://www.freedomscientific.com>). The disadvantage of these GPS based devices is that their use is limited to outdoor environments and they provide limited contextual information during navigation. Drishti [1] developed at the University of Florida provides both indoor and outdoor navigation help, taking into account the dynamic changes in the environment. InfoGrid [2] uses an RFID (radio frequency identification) tag grid to allow for a localized information system, describing the surroundings at finer granularity, but its use is limited to places meeting the infrastructure requirements. Among indoor navigation systems are Jerusalem College of Technology's system [4] based on local infrared beams informing the user of the names of specific places in a building and Talking Signs (<http://www.talkingsigns.com/>) based on audio signals sent by invisible infrared light beams decoding names of indoor locations. SWAN by Georgia Institute of Technology [5] uses an audio interface to guide the listener along a path, while indicating the locations of other important features in the environment. There are also more specialized efforts such as facilitating grocery shopping as aimed with ShopTalk [6]. Although ShopTalk enables users to find the specific items they are looking for at a grocery store, it requires carrying hardware including a barcode scanner, its base station, a computational unit in a backpack and a numeric keypad, which is not desirable for most users. Despite the many efforts resulting in the development of the mentioned navigation systems, the blind population today still does not have access to an easy to use, sufficiently accessible and portable device providing detailed context information to ensure safe and independent navigation both indoors and outdoors. Systems specifically for detecting the status of traffic lights to aid blind and visually -impaired as well as color- blind drivers were also proposed. Among those are [7], which consists of a digital camera and a portable PC analyzing the video frames captured by the camera and [8], which uses a 2.9 GHz desktop computer to process video frames in real time. Although these systems provide fairly accurate recognition of traffic lights, they are cumbersome due to the hardware they depend on for image and video processing. To be complete, a context-aware navigation

system needs to achieve other vision based tasks such as detecting generic moving obstacles, as in [9], which requires around 400 ms video processing time on a dual core 2.66 GHz computer, which again hinders portability.

III. PROPOSED SYSTEM

In our prototype as a initial component we developed a system for traffic light detection that is for outdoor navigation ,and we used some IR sensors for indoor navigation. A switch is initialized which indicates the blind to navigate indoor or outdoor. The context-aware navigation system architecture we propose is a two terminal structure, the two main structure is transmitter section and receiver section. Both section consist of 8051 micro controller, zigbee, the Tx of the transmitter is connected is connected to the Rx of the receiver section of the zigbee and vice versa. The transmitter part is initialized at traffic light system and receiver part will be with the blind person. The transmitter part consist of 8051 microcontroller, zigbee .whenever the blind person comes in contact with the transmitter region .The transmitter provides the current status of the traffic light to the blind people. The current status of the signal transmits to the micro-controller, which is already initialized with a LED program. It compares the signal to the preloaded data which is stored in microcontroller and it sends to the zigbee of the transmitter section. Whenever the zigbee in the receiver part comes in contact with the transmitter section it sends the data to zigbee this data again transmitted to the microcontroller in the receiver section. Again data is compared with the pre-defined data in the microcontroller and it is converted into the voice.

The next part of our system is indoor navigation, here we used some IR sensors which is initialized with pre-defined data in the transmitter section, whenever the blind met with any of these sensors the data which is already initialized with that specific sensor is transmitted to the microcontroller in transmitter section and this data is again transmitted to zigbee. When the receiver section zigbee comes in contact with transmitter it sends the data to receiver section zigbee. The data in receiver section is transmitted to microcontroller which is converted into voice through voice module in the receiver section.



Proposed System Prototype

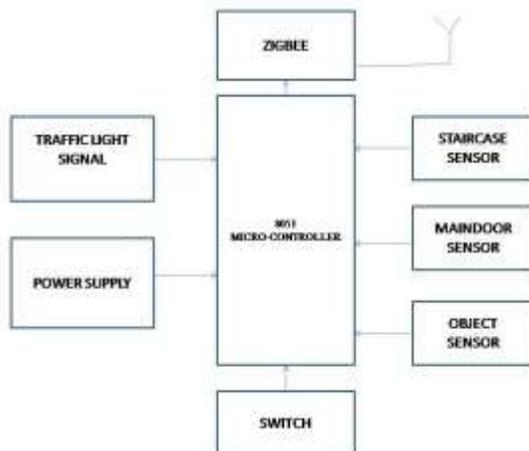


Fig (1) Block Diagram of Transmitter Section

IV. TRAFFIC LIGHTS DETECTOR

The ability to detect the status of traffic lights accurately is an important aspect of providing safe guidance during navigation. The inherent difficulty of the problem is the fast image processing required for locating and detecting the status of traffic lights in the immediate environment. As real-time image processing is demanding in terms of computational resources, mobile devices with limited resources fall short in achieving accurate and timely detection. An accurate traffic lights status detection service would benefit not only the blind and the visually-impaired, but also the color-blind as well as systems like autonomous ground vehicles and even careless drivers. The shortcomings of mobile devices in terms of computational power and short battery life in providing this type of service can easily be compensated with the wealth of resources made available by Cloud Computing providers.

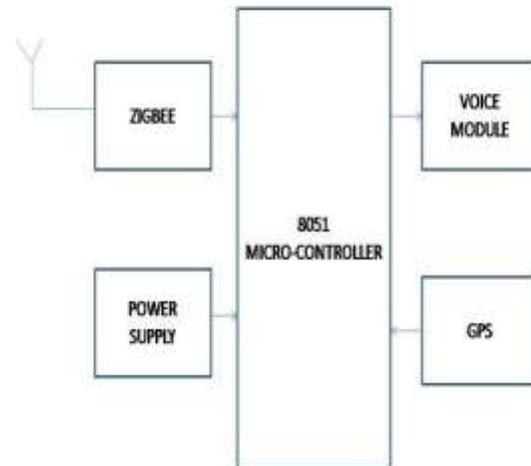
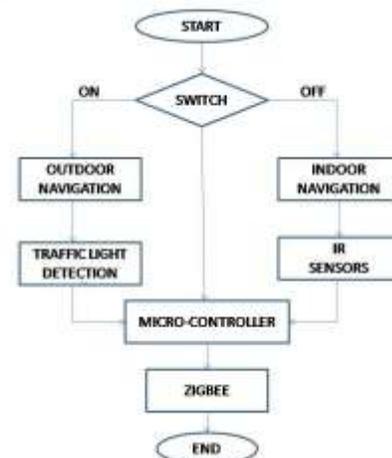


Fig (2) Block Diagram of Receiver Section



Flow Diagram of Proposed System

V. ZIGBEE TECHNOLOGY

There are a multitude of standards that address mid to high data rates for voice, PC LANs, video, etc. However, up till now there hasn't been a wireless network standard that meets the unique needs of sensors and control devices. Sensors and controls don't need high bandwidth but they do need low latency and very low energy consumption for long battery lives and for large device arrays. There are a multitude of proprietary wireless systems manufactured today to solve a multitude of problems that also don't require high data rates but do

require low cost and very low current drain. These proprietary systems were designed because there were no standards that met their requirements. These legacy systems are creating significant interoperability problems with each other and with newer technologies.

VI.OBJECT DETECTOR

AdaBoost [10] is an adaptive Machine Learning algorithm used commonly in real-time object recognition due to the short detection time it allows for. It is based on rounds of calls to weak classifiers (classifiers whose detection rates are slightly better than random guessing) to focus more on incorrectly classified data samples at each stage to increase classification accuracy.

VII.TRAFFIC LIGHTS DETECTION CHALLENGES

The problem of providing real-time feedback about the status of traffic lights in the immediate environment faces challenges even when a mobile-cloud collaborative approach as explained is taken. One of the main concerns about this approach is the time it takes to send the video frames to the remote server for processing and to receive a response. The real-time nature of the problem requires response times ideally less than 1 second to provide accurate and safe guidance to the blind or visually impaired user. While the server having sufficient computation resources takes negligible time to process the received frames, network latency could create a bottleneck on the timeliness of the response to be received by the user. Continuous Internet connectivity is another problem faced by the proposed approach. Signals from wireless networks would be weak or mostly unavailable at outdoor locations, which is the main setting the application is supposed to work at. However, availability of data plans by major cell phone carrier companies today alleviates this problem. Many people are already subscribed for these data plans for a low monthly cost for continuous connectivity. Another major challenge faced is the short battery life of the mobile device. The continuous video recording approach taken in the current system exhausts the battery of the mobile device too soon, causing service interruption. A power-optimized approach as explained in the next part will need to be employed to ensure continuous guidance to the user.

VIII.PROPOSED SYSTEM ENHANCEMENTS

The traffic lights detector system developed is an initial attempt to demonstrate the effectiveness of a mobile-cloud collaborative approach for context-aware blind navigation. The system can be enhanced in many ways to ensure high quality service to the users. To

overcome the problem of service interruption due to short battery life, video capture by the mobile device should be performed sparingly based on previous knowledge of the location of traffic lights. This information is readily available in maps extracted for use in GPS devices, where locations of traffic lights are marked as points of interest. The only extra requirement to make use of this information is having a GPS receiver on the mobile device, which many devices already do. The GPS receiver is already an indispensable component of a blind navigation system due to its use in location tracking for route planning. With a simple modification to the current system, the mobile device would only need to capture frames at locations close to the GPS coordinates of a traffic light and send them to the server for processing, which would save battery life. Yet another modification that could prove useful for the system is performing a simple preprocessing of the frames captured to get lower resolution versions which could be transferred to the cloud in a shorter time for processing.



IX.EXPERIMENTS

The two most important aspects of the traffic lights detection problem are timeliness of response and accuracy. The real-time nature of the problem necessitates response times of less than 1 second as stated before, while high accuracy of detection should be achieved to ensure safety of the user. Experiments were performed to test the accuracy and response time of the traffic lights detector application developed. Test data used in the experiments consists of video recordings at outdoor locations of the Purdue University campus (disjoint with the training data), which include scenes of different traffic lights, a sample of which

The Android application developed was installed on an HTC mobile phone, connected to the Internet through a wireless network on campus. The sample task in the experiments involved processing five different resolution level versions of 934 video frames. The average

response times, which were determined by the time period between capturing a frame and receiving the response from the server running at Amazon Elastic Compute Cloud about the traffic lights status, were measured for each frame resolution level as determined by a Java platform-specific measure. A resolution level of 0.75 stands for the original frame as captured by the camera, whereas the lower resolution levels represent compressed versions of the same set of frames, where image quality falls with decreasing resolution level. Response times for the original frames were found to be around 660 milliseconds on average, which are acceptable levels for the real-time requirements of the problem. We also saw that response time decreases further when lower-quality, compressed versions of the frames are sent to the remote server instead of the originals.

X.CONCLUSION

In this paper we proposed an open and extensible architecture for context-aware navigation of the blind and visually impaired. The system proposed is based on collaboration between everyday mobile devices and the wealth of location-specific information resources on the Web as well as the computational resources made available by major Cloud Computing providers, allowing for richer context-awareness and high quality navigation guidance. We also described a traffic lights detector system developed as an initial component of the context-aware navigation system proposed and provided experimental results. Future work on the navigation system proposed will involve efforts in many different aspects including robust obstacle detection; integration of important context information into route planning such as traffic lights status and dynamic/static obstacles information as well as infrastructure-independent indoor route planning.

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