ALICE - ASSISTANCE FOR BETTER MOBILITY AND IMPROVED COGNITION OF ELDERLY BLIND AND VISUALLY IMPAIRED:

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ABSTRACT

This paper describes the achievements accomplished within the framework of the ALICE project (*AAL-2011-4-099*) (www.alice-project.eu), supported by the European AAL (*Ambient Assisted Living*). program. After a short description of the project's main challenges, objectives and adopted approach, we detail the various technological advances that are considered for development, together with the first achievements that will be demonstrated. Some user-centric development/evaluation-related issues are also discussed.

1. CONTEXT AND OBJECTIVES

The objective of the ALICE project is to improve the quality of life of ageing people with impaired vision (totally blind and partially blind) by providing a navigational assistant with cognitive abilities. People that have an impaired visual cognitive system face problems with an overall contextual understanding of space semantics, interaction with surrounding objects and have serious difficulties with planning, orientation, communication and navigational skills.

The navigational assistant developed within the ALICE project will be able to offer visually impaired users a cognitive description based on a fusion of perceptions gathered from a range of sensors. The ALICE project is combining research developments in cognitive sciences, psychology, computer vision, artificial intelligence and robot navigation. The basic requirements of navigation include global localisation/positioning, near distance localization, obstacle detection and route/path following.

Started in June, 2012, the ALICE project has reached today the phase of the first technological achievements. They notably concern: (1) an enhanced GPS navigation system, particularly useful for geo-localization purposes; (2) an object detection and recognition methodology, applicable for reliably detecting objects of interest in an urban scene (*i.e.*, street sign, obstacles...). In addition, an evaluation protocol, performed with the help of end-user associations has been elaborated.

The demonstrator will include all the above-mentioned achievements.

2. THE ALICE APPROACH

In contrast with existing solutions, the ALICE project focus on the multi-modality analysis, within the framework of multisensorial information fusion/integration approach.

One of the main objectives is to deliver computer vision assistive methods that would work in parallel with state of the art approaches for localization and obstacle/object detection. In order to achieve robust personal positioning and navigation devices, we will combine GPS localization and vision-based cues, for an increased and guaranteed reliability. In addition, microwave, ultrasonic, infrared, camera and laser sensors can be utilized as radars. The system will be used in indoor/outdoor scenarios. An integrated, smartphone-dedicated platform will be provided in order to deploy the various processes that handle data from multiple sensors.

In order to achieve the enounced objectives, the ALICE consortium gathers industrial partners/product developers (Comland - SV, I&IMS - SP, Alpineon - SV, Granite 5 - UK), academia (Institut Mines-Télécom - FR), and end-user associations (Communication for Blind and Disabled People Itd – COMDB - UK, Union for the Blind and Partially Sighted of Slovenia - UBPS), under the leadership of the Comland.

3. DEMONSTRATOR

The various technological bricks that we intend to demonstrate are detailed in the following sections.

3.1. Enhanced GPS navigation system

All satellite based Positioning technologies (GPS, GLONASS, Galileo, DGPS, EGNOS, EDAS, WAAS ...) share a common problem: their accuracy and availability depends on visibility of at least 3 satellites. Otherwise errors due to satellite obstruction, bad geometry and multipath effect can reach astonishing 50 m in urban environments. People with normal vision can easily compensate for that error – using visual markers in environment. For blind or visually impaired, the positional information needs to be highly precise. With use of cane blind user can compensate positional error of about 3m, visually impaired from 5–10m.

The state of the art map-matching techniques do not work well when pedestrian navigation is considered since the movement of pedestrians is not restricted to a vectorized road network. Operational solutions concern receivers that use signals from both global GNSS – GPS and GLONASS thus doubling number of required satellites. However, no such receiver exists for mobile devices yet.

In the ALICE project, we developed a solution for smartphone devices. Sensory fusion and hybrid positioning system based on SatNav, INS navigation and visual localization are used. The system is able to calculate position along predefined path and issue in real-time warnings regarding both expected/unexpected elements. The method lowers positioning error to less than 20% in the direction of movement on average – in proximity to landmarks the accuracy is around 2m.

In the demo (Figure 1), we will show how to turn ordinary City Map (Google Maps) into a safe route by annotating missing information infrastructure (like traffic lights, pedestrian crossings and pavements) and landmarks. Unexpected/ anticipated elements are also checked, since user moves in an uncontrolled environment that can change in time. The user is then gradually guided through its itinerary.





Your orientation is correct. Continue straight. Keep left.

Crossing near Parliament Sq



Crossing Found. Reach pedestrian zone Wait for directions signal Continue straight, keep right.

Figure 1. Enhanced GPS navigation with ALICE.

3.2. Object of interest/obstacle detection in urban scenes

One of the most difficult tasks to be performed by ALICE is the detection of the obstacles in the path of the user. Traditionally this task has been performed by the cane, which serves both for detecting nearby objects and obstacles and for announcing the surrounding persons of the visually impaired condition of the user. In the ALICE framework, a real-time, vision-based solution is proposed.

Using the camera of the smartphone, ALICE performs an analysis of the surroundings of the user and tracks moving entities. The temporal analysis on the movement of the detected entities (groups of interest points) identifies hypothesis on the direction of movement of the respective entities. A region of collision risk is defined in the immediate vicinity of the user. When an object is detected to be in this region or is estimated to reach this region, the user is notified by an audio alert about the existence of an obstacle. The possible obstacles are categorized in moving and static obstacles and in avoidable or non-avoidable obstacles.

We firstly segment the frames with the MeanShift algorithm and use the segmented regions as hypothetical objects. We describe such objects by employing the interest points detected under the area covered by the region and their descriptors. Each object is queried against various classifiers and the scores are used for identifying objects. For the classification, we perform a one-against-all linear SVM classification, using as training data a collection of urban images. The descriptors are extracted locally, while the queries are processed on a remote server.

This approach makes it possible to recognize a set of objects/landmarks of interest for the user such as: bus station, drug store, traffic light, postal box, by leveraging on both GPS coordinates and visual descriptors. This process is illustrated in Figure 2, for the case of a tram.



Figure 2. Vision-based object detection (the case of a tram).

4. EVALUATION PROTOCOLS

The ALICE project has developed an end-user involvement plan in order to engage active end users throughout the project lifetime. Such a user-centric approach will ensure that the project is carried out in the correct direction to achieve a successful and socially acceptable solution. ALICE benefits from the participation of end-users associations (COMDB, UBPS) who work as consultants for the development teams and personally test the system in real-life situations.

To develop the first prototype of the device, a strategic questionnaire for extracting the end-users main needs and concerns has been developed and used. To evaluate the quality of a system, the device will be tested first in a virtual and dynamic model of a city (including several types of pavements, crossings, cars, cyclists, and pedestrians).

In a first phase, suggestions from end-users concern usability issues and human machine interfaces. By incorporating these suggestions in the final version of the product, it is expected that the device finally meets all expectations of the target group. In the evaluation phase, the "Man behind a curtain" method will be used for safety reasons. The final product will be evaluated when the first testing phase reaches less than 10% of noncritical detection errors and by the same users that participated in the development stage. In addition, new users will be included, which will provide a reliable test of usability. Evaluation will show not only if all functional and user requirements are met, but also, if ALICE can be trusted to assist the blind user in everyday activities.

Two consecutive prototypes are intended to be developed. Each prototype is an autonomous device, therefore testing and evaluation will be performed as a final step of each iterative development cycle. End-users will be in charge of determining (and validating) each functionality of the application.

4. CONCLUSION AND PERSPECTIVES

In this paper, we have described the objectives addressed by the EU AAL project ALICE, which proposes an integrated navigation assistant for blind and visually impaired people. The first achievements, including, enhanced GPS positioning and vision-based obstacle detection have been then described. Some elements related to the evaluation of the developed technology have also been provided.

Future work concerns the integration of the various technological bricks within an unified platform, to be deployed on smartphones with appropriate user interfaces, as well as the experimental evaluation/validation of the system.