Directions Aids for the Visually Challenged Using Image Processing Using Image Recognition

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Abstract - Direction signs are an indispensable part for easy mobility in unfamiliar locations. In public places there are many signs and symbols which help in navigation, one amongst them are emergency exit signs. These signs can be easily interpreted by sighted people, but are unsuitable for visually impaired persons, which is an issue of concern particularly in cases of emergency. This paper deals with tackling this problem with the help of mobile image processing and using the principles of object detection and pattern recognition. In the first part we study the need of addressing this problem. We then list down the technologies currently being used around the world to ease navigation for the visually challenged .In the next part we have proposed an architecture that detects and recognizes the direction of exit sign by carrying out image processing. The last section deals with the analysis which include the evaluation and testing of the application.

Keywords - *Image Recognition, Surf Algorithm, Feature Vectors, Feature Descriptors, Client Server Architecture.*

1. Introduction

About 285 million people are visually impaired worldwide: 39 million are blind and 246 million have low vision (severe or moderate visual impairment). India is home to the world's largest number of blind people. Of the 37 million people across the globe who are blind, over 15 million are from India. Two of the biggest challenges to independence for blind individuals are difficulties in accessing printed material and the stressors associated with safe and efficient navigation. Access to printed documents has been greatly improved by the development and proliferation of adaptive technologies such as screen-reading programs, optical character recognition software, text-to-speech engines, and electronic Braille displays. By contrast, difficulty accessing room numbers, street signs, store names, bus numbers, maps, and other printed information related to navigation remains a major challenge for blind travel The reason for the limited adoption of technologies in navigation inevitably stems from several factors. Most navigational technologies cost hundreds or thousands of dollars. This makes it prohibitively expensive for most blind people to buy these devices on their own budgets. Rehabilitation agencies for the blind will often assist in the purchase of adaptive technology for print access but rarely provide their clients with technologies for navigation. In addition to cost constraints, broad adoption of navigational technologies will likely not occur until greater emphasis is given to perceptual factors and end-user needs [1]. Though there has not been much progress in the field of locomotion for the visually challenged, there have been many interesting proposals in this field in recent times.

The development of efficient orientation and mobility skills is essential for blind is essential in order to acquire good mental mapping of spaces, and have the ability to navigate efficiently within these spaces. Good navigation capabilities can undoubtedly improve life quality and provide greater independence to blind people [2]. For easy mobility direction signs and symbols are of utmost importance. Emergency exit signs are found in public buildings like educational institutions shopping malls, airport and railway stations. They play an important role for safety precautions in public places. They basically comprise of a green and white sign with icons showing a running person, a door, an arrow pointing into the direction of the escape route and the word Exit (or other words describing an emergency exit), in different combinations. These signs can be easily detected and interpreted by sighted people, but are unsuitable for visually impaired persons who cannot rely on visual indicators [3]. In this paper we propose an architecture which could tackle the shortcomings of the existing technologies.

The project deals with the problem of recognizing direction signs by visually impaired people with the help of a smart phone. On detection of such a sign, the application gives an acoustic signal, and if an arrow is present on the sign, the software also tells the direction of the sign. Keeping in mind, the limited processing power of mobile phones and different resolutions of cameras, we aim at adopting an algorithm which will help achieve the output at real time.

2. Literature Survey

Though there has not been much progress in the field of locomotion for the visually challenged, there have been many interesting proposals in this field in recent times.

A new smart phone app has been developed for the people using the London Tube by the Royal London Society for Blind People Youth Forum and digital product studio ustwo could help them in the future to navigate the city independently. The app, called Wayfindr, uses Bluetooth and beacon technology to trace the users location in the subway and give him audible directions.

A headset that talks visually impaired people around cities has been designed by Microsoft. It works with a Windows phone and uses location and navigation data with a network of information beacons in urban locations to describe routes. The headset was tested on a journey from Reading to London, including shopping, bus and train travel.

The New York-based company Tactile Navigation Tools is developing a hands-free wearable device that uses sensors to detect obstacles and can alert the wearer to them with vibrations. Known as Eyeronman, the device could aid not only the blind, but also firefighters, soldiers and others, its developers say.

There are a few other technologies which augment the commonly used cane and guide dogs. Some of them can be listed as follows:

2.1. Sonar Based Devices

The first sonar-based mobility aid was the handheld sonic torch, using a special ultrasonic sensor developed by Leslie Kay in the early 1960s. The cell-phone-sized device can be affixed to the handle of a long cane, increasing its effective range to detection of a 40 mm diameter object out to 5 m. With the help of this technology, a user is able to hear echoes from multiple sources, facilitating simultaneous tracking of more than one object in the environment. The auditory output, delivered through earphones, modulates pitch proportionally to distance[9].

2.2. Optical Technologies (Camera or Laser-Based Devices)

The first incarnation of a laser-based navigational technology was the Nurion laser cane, developed in the late 1970s and is now updated and commercially available. This device is similar to the cane-mounted sonar ETAs but uses diode lasers rather than ultrasonic sensors. Three laser transmitters and receivers, directed up, ahead, and down, provide the user with three levels of extended obstacle detection, including drop-offs and overhead obstructions, out to 4 m. The output is signaled by the rate of auditory tones or vibration felt in the cane's handle[8].

2.3. Infrared Signal

The most notable remote infrared audible signage (RIAS) is a system called "Talking Signs." This technology, pioneered and developed at the Smith-Kettlewell Eye Research Institute in San Francisco, consists of infrared transmitters and a handheld IR receiver[10]. The Talking Signs system works by installing the transmitters in strategic locations in the environment. Each sign sends short audio messages, via a constantly emitted IR beam, which can be decoded and spoken when picked up by the receiver.

A person carrying the Talking Signs receiver uses hand scanning to search the environment for a signal. The signal can be picked up from up to 20 m away, and when detected, the navigator hears a message from the onboard speaker (or attached headphone) indicating that he/she is in the proximity of a particular location[11].

But the technologies for navigating the visually impaired during an emergency have not been explored much. This project deals with tacking this issue.

3. Proposed Architecture

Image processing operations will be carried out using OpenCV implemented in java using netbeans. The OpenCV library of programming functions has become the de-facto industry standard for software based computer vision. It is completely open-sourced (BSD licensed) and has support. The input and output operations will be carried out using an android phone .

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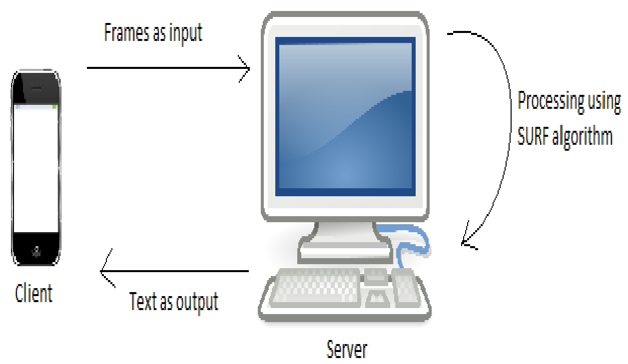

Fig.1: Proposed Architecture

3.1. Detection

In general the technique to achieve scale invariance is to examine the image at different scales,scale space, using Gaussian kernels. Both SIFT and SURF divides the scale space into levels and octaves.

SURF uses a hessian based blob detector to find interest points. The determinant of a hessian matrix expresses the extent of the response and is an expression of the local change around the area.

$$H(x,\sigma)=\begin{bmatrix} L_{xx}(x,\sigma) & L_{xy}(x,\sigma) \\ L_{xy}(x,\sigma) & L_{yy}(x,\sigma) \end{bmatrix}$$

$L(x,\sigma)$in the equation is the convolution of the image with the second derivative of the Gaussian. The convolutions is very costly to calculate and it is approximated and speeded-up with the use of integral images and approximated kernels.

An Integral image I(x)is an image where each point x= (x,y) stores the sum of all pixels in a rectangular area between origin and x.

$$I(x)=\sum_{i=0}^{i<x}\sum_{j=0}^{j<y} I(x,y)$$

3.2. Descriptors

The purpose of a descriptor is to provide a unique and robust description of a feature, a descriptor can be generated based on the area surrounding a interest point. The SURF descriptor is based on Haar wavelet responses and can be calculated efficiently with integral images. SIFT uses another scheme for descriptors based on the Hough transform. Common to both schemes is the need to determine the orientation. By determining a unique orientation for a interest point, it is possible to achieve rotational invariance. Before the descriptor is calculated the interest area surrounding the interest point are rotated to its direction.

The interest area is divided into 4x4 subareas that is described by the values of a wavelet response in the x and y directions. The wavelet response in the x and y direction is refered to as dx and dy respectively. Having calculated the descriptors finding a match between two descriptors is a matter of testing if the distance between the two vectors is sufficiently small.

3.3. Matching

By comparing the descriptors obtained from different images, matching pairs can be found.

4. Analysis

Processing is carried out on an Android smart phone.The application works in the following steps:

- The user opens the application possibly with a shortcut.
- Clicks a picture of all directions.
- If a direction sign is present in the scene scanned by the camera, the sign is detected and the corresponding direction is given to the user with the help of an audio output.

Testing procedures will take place throughout the different stages of the application development, which will include checking both the performance of the image processing module and the robustness of the software. Regarding the correctness of the software, we will carry out informal tests for each completed unit and module integration. On the completion of every module, the prototype will be tested for compliance with the requirements. In terms of object recognition performance, we are aiming at a relatively high rate of true positives and a low number of false positives, in combination with a short processing time. Since imperfect results are more acceptable for users than long latency , we will focus mainly on the efficiency of the application and if the desired results for the tests are not achieved, the code will be reviewed in order to improve the performance.

The low processing power of smartphones and a software-emulated floating point unit require careful memory management and choice of datatypes. In order to deal with this problem, we will try to avoid floating point operations where possible in favour of integer operations. Lastly, despite the high resolution of up to several megapixels, the image quality of mobile phone cameras is still poor compared to digital compact cameras. This causes the image to suffer from blur, over- or underexposure and noise. Since there is no way of improving the camera quality, these errors can only be mitigated by choosing image processing methods that do not rely too heavily on flawless image quality.

5. Results

Fig.2: Results

6. Conclusion

The need of direction aids for assisting the visually impaired with navigation has been studied. An architecture for tackling the above problem has also been suggested. Various methods for implementing this proposed scheme have also been suggested. The need of navigation technology for the visually challenged, various technologies currently being implemented in this field , a proposed architecture of its implementation has been successfully been presented in this paper.

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