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Obstacle Detection Technologies to Empower Visually Challenged: A Short Notes

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Abstract: ***Statistics on blindness diverge because there is no universal definition. Factual statistics are hard to come by, but, as stated by the World Health Organization 285 million people with a visual disability existacross the world. That's a plenty of people who could stand to benefit from some adept technology and 90% of them live in developing countries. There are 12 million people in India with blindness, the greatest number forany country in the world, according to 2011 census data. From the study, reviewing the Indian scenario, I learnt that neither can Indian citizens afford the technologically advanced and premium products of the west nor can they adapt to these technologies. So, the primary motive of the present review is to enlighten the need of a solution-in-aid for visually challenged keeping in mind two important constraints, being, Cost effectiveness, meaning inexpensive solution and Easy adaptability, meaning smaller learning curve and easy to use solution.***

Keywords: visually-challenged, obstacle-detection, review, state-of-the-art technologies, blindness

1. Introduction

Browsing the Internet, observing one's facial expressions or looking at the night sky – these are mundane tasks that hardly require our attention. Although, not everyone can call them conventional; for the 285 million visually impaired people across the globe; these simple tasks are farfetched and theoretical.

But if this number is so high and the condition is so prevalent, why don't we see them around us every day? That's because these helpless people prefer to stay home hands-tied, owing to their pitiful ailment.

Today, technology is advancing in leaps and bounds to the extent that the world has launched phenomenal projects like 'Blue Brain' (EPFL), Search for Extra Terrestrial Intelligence (SETI) and our own country (India) takes pride in indigenous projects like 'Mangalyaan'. But any invention or any research is eventually aimed at improving living standards of the general public. So, what inventions around the globe and India in particular are catering to improve the standard of life of our visually challenged lineage? I have a gist demarcated in the section *Review of advancements in the proposed area*.

2. Objectives of the Proposed Review

Objectives of the proposed review are pointed as below,

Technology is assumed to make our lives effortless. Too often accessibility is seen as something to tick off the list for developers, and there's a missed opportunity to transform lives for the better.

a) Need to develop a cost-effective solution for visually impaired Indian citizens, especially for the benefit of those who cannot afford a pricey product.
b) Requirement to develop an adaptable solution that can easily be integrated with the lifestyle of its users without extra effort to adapt to it, meaning 'smaller learning curve' and 'easy to use' solution.
c) An indigenous solution will benefit the country by saving on foreign exchange. A reduction in imports will help improve the value of rupee against foreign currencies, and make it a stronger currency.
d) Local products are likely to increase the probability of foreign investors.
e) It will ensure independent mobility, safety and regains confidence to the visually impaired.
f) Reduce injuries and awkwardness of collision during mobility for visually impaired by giving pre-warning of obstacles and allow path finding without collisions.

3. Review of Advancements in the Proposed Area

Technological advances such as microbiology and microelectronics are creating new opportunities to restore sight to blind, for example, efforts of a young French company, Pixium Vision [1]. Let us hope that such attempts become plausible but the cost to each patient is estimated to be around 1,00,000 Euros to get treated for blindness [1] which is approximately INR 7,00,00,000.

Projects like 'Bionic Eyes' and 'Argus2' [3] help patients suffering with Retinitis Pigmentosa to recognize contours and boundaries of an object, particularly when there is contrast between light and dark. The device, which costs about $150,000 not including implant surgery or training, can not make a blind person see — at least not in the normal sense [2]

Research that aims on developing Assisted Vision Smart Glasses like CINVESTAV [4] may have an estimated $1500 as product cost but, is far from becoming a reality. Optical Character Recognition devices like 'Google Glass' and 'Orcam' may cost around $2500 but for an Indian middle-class blind man, these technologies pose accessibility constraints.

Reviewing the Indian scenario, I learnt that neither can Indian citizens afford the technologically advanced and high-priced products of the west nor can they adapt to these technologies. So, primary motive of the present review is to enlighten the need of a solution-in-aid for visually challenged keeping in mind two important constraints, being,

1) Cost effectiveness, meaning inexpensive solution.
2) Easy adaptability, meaning smaller learning curve and easy to use solution.

The above-said constraints are moderately attained by studies involving Assistive Technology aids like Ultrasonic devices (Sonic pathfinder, Sonic torch, Mowat sensor), Infrared Sensors, Radio Frequency Identification, Laser and Global Positioning Systems which have been examined, researched and advanced to benefit navigation in known and unknown environments. Regardless of these studies, disadvantages hindering the cause exist [9]. For instance, Ultrasonic devices cannot be used inside closed premises like offices, houses, schools, etc., due to multiple reflection of an ultrasonic beam by the boundary walls [9]. This makes it challenging for visually- impaired to navigate in their homes, offices and community centers to mention a few.

An Indian economically median blind person customarily do not even have access to mobility devices like the above mentioned smart walking sticks embedded with sensors [5]. In this context, I like to highlight an inspiring work done by students of IIT Delhi [6], called 'SmartCane'. This is an additional device weighing 138 grams to be fitted to a traditional white cane that blind people use. It detects obstacles using sonic waves and the existence of obstacles is conveyed through intuitive vibratory patterns. Though this haptic feedback device comes for an affordable INR 3000 and can be adapted by users in not less than 4 to 5 weeks of training, it has its fair share of the downside too [7], which is,

a) SmartCane device is essentially used to detect knee-to-head range obstacles, but for detecting the ground-to-knee range obstacles, use of traditional white cane is essential. It should be noted that the device does not detect obstacles below the knee-level. So, it is not a replacement to the white cane.
b) The device detects obstacles which appear within its ultrasonic cone range only. And the cone once fixed is difficult to vary its angle by the users without external help (as they will not be able to see the angle of fixture of the cone).
c) The device cannot be used for detecting change in surface level, for example, staircases, main halls etc., because the SmartCane device detects knee-above obstacles.
d) The purpose of the SmartCane device is to detect the presence of any obstacle from a safe distance only.

However, it does not identify the type or nature of obstacles that are being detected.

a) Similar to any other dependent devices, SmartCane suffers from False alarms too. The device vibrates constantly when it is used in crowded environments, leaving its users annoyed and confused.
b) SmartCane uses ultrasonic sensors to detect obstacles. Changes in the environment, such as temperature, pressure, humidity, air turbulence, and airborne particles affect ultrasonic response which in turn affects the device detection capability [10].
c) Ultrasonic devices cannot be used inside closed premises like offices, houses, schools, etc. due to the multiple reflection of an ultrasonic beam by the boundary walls [8].

Owing to the above-mentioned disadvantages, I propose to enlighten the need to come up with an affordable, portable, and easy-to-adapt solution to allow the visually impaired citizens of India trustfully navigate in both known and unknown environments.

4. Future Work

Skepticism involving questions stated below should be predetermined to be solved to aid existent technologies.

1) What if there are water bodies? What if there are changes in surface level like staircases? Will the algorithm/technology detect them as obstacles?
2) What if there is a fast moving or fast approaching object coming towards the user? Will the algorithm/technology detect objects in motion? If yes, at what speed?

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