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Smart Glasses to Detect Obstacles and Provide Assistance for Visually Impaired People

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Abstract: ***Our aim is to introduce a new design of smart glasses that can provide assistance in multiple tasks while maintaining at a low building cost. Among all assistive devices, wearable devices are found to be the most useful because they are hand free or require minimum use of hands. The most popular type is head mounted device. Their main advantage is that the device points naturally at the viewing direction, thus eliminates the need of additional direction instructions, unlike other devices. This product focuses on people who have hearing abilities. The general principle of operation for such glasses is by giving instructions via switches and listening to the output through an earpiece. The design depends mainly on the processing unit, which is the raspberry pi 2, in this case. The main hardware is a Linux based ARM processor that accepts a micro SD card and thus allows us to increase the number of task functions as we wish. A raspberry pi camera was used for image acquisition. It was connected to the raspberry pi using a flex cable, and was fixed on the top middle of the glasses for optimal image capturing. The raspberry pi has an audio port which connects to earpiece. The raspberry pi GPIO port was configured to receive input from push button switches. To identify the text easier, the reading material is placed within a customly-designed frame with red borders. The general principle of operation for such glasses is by giving instructions via switches and listening to the output through an earpiece. Similarly in this case, the user starts the task mode by a push of the button. For text recognition mode, the glasses will first confirm if the text area is correctly positioned and readable. Otherwise, it will ask the user to change the orientation of the material. After confirmation, the view is processed in real time to get the image sent to optical character recognition (OCR) software for text extraction and subsequently forwarded to a text-to-speech synthesizer. The text is then read through the audio output port. In the reading mode, the main challenge is the image quality, text position and orientation in the image. Therefore, the first step is to detect the red borders and the frame orientation. To simplify subsequent image processing, we propose an indicator to inform user if the image is skewed significantly or part of the frame is cropped. Once the text area is localized and cropped, image is enhanced by noise filtering, contrast enhancement (histogram matching technique) and morphological operations.***

Keywords: smart glasses, visually impaired

1. Introduction

People with visual impairment face various problems in their daily life as the modern assistive devices are often not meeting the consumer requirements in term of price and level of assistance. The number of visually impaired people is growing over the past decades. As reported by the world health organization (WHO), about 285 million people worldwide are estimated to be visually impaired. However, until now many schools and jobs cannot accommodate them mainly due to lack of assistive technologies and economic barriers.

Blindness can cause significant social challenges, typically because there are activities in which blind people can't easily participate. Frequently, blindness impacts a person's ability to perform many job functions, which can limit their career options, according to the World Health Organization. This may adversely affect their finances, and their self-esteem.

Blindness may also cause difficulties when participating in activities outside of the workplace, such as sports and recreational activities. This can limit the blind person's ability to socialize and meet new people, affecting their emotional health.

Blindness can make it difficult to use the internet for research, recreation, social media and shopping.For example, someone who is blind can't directly read the information on a web page. Total blindness can make it necessary to rely on screen reading software to have the information read as audio. This can make surfing the web a slow and cumbersome process. Instead of seeing a picture, someone who is blind must rely on a description of what the picture shows.

People who are completely blind or have impaired vision usually have a difficult time navigating outside the spaces that they're accustomed to. In fact, physical movement is one of the biggest challenges for blind people, explains World Access for the Blind. Traveling or merely walking down a crowded street can be challenging. Because of this, many people with low vision will prefer to travel with a sighted friend or familymember when navigating unfamiliar places.

As a result, 90 % of them still live in low level of income. Even when the new aids or technologies become available, they are either too expensive or affordable but with single or limited task functions only. The major portion of visually impaired people is aged 50 or older and live in the developing countries. Everyday these visually impaired people face problems in understanding and interacting with the surroundings, particularly those which are unfamiliar. It is really hard for a blind person to go out alone and there are not so many available products that can assist them.

However, Researches have been going on for decades for developing an effective device for visually impaired people. Some devices, such as Lightweight Smart Glass System with Audio Aid, NavBelt, Guidecane, VA-

PAMAID, Electronic Travel Aid, and etc. have been made.

We present a new and unique design for the smart glasses that can aid in multiple tasks while maintaining at a very low building cost. The device can easily guide the visually impaired people and able to give proper direction.

2. Objective

Our aim is to introduce a new design of smart glasses that can provide assistance in multiple tasks while maintaining at a low building cost. Among all assistive devices, wearable devices are found to be the most useful because they are hand free or require minimum use of hands. The most popular type is head mounted device.

Their main advantage is that the device points naturally at the viewing direction, thus eliminates the need of additional direction instructions, unlike other devices.

This product focuses on people who have hearing abilities. The general principle of operation for such glasses is by giving instructions via switches and listening to the output through an earpiece.

The design depends mainly on the processing unit, which is the raspberry pi 2, in this case. The main hardware is a Linux based ARM processor that accepts a micro SD card and thus allows us to increase the number of task functions as we wish.

A raspberry pi camera was used for image acquisition. It was connected to the raspberry pi using a flex cable, and was fixed on the top middle of the glasses for optimal image capturing. The raspberry pi has an audio port which connects to earpiece. The raspberry pi GPIO port was configured to receive input from push button switches. To identify the text easier, the readingmaterial is placed within a customly-designed frame with red borders.

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In the reading mode, the main challenge is the image quality, text position and orientation in the image. Therefore, the first step is to detect the red borders and the frame orientation. To simplify subsequent image processing, we propose an indicator to inform user if the image is skewed significantly or part of the frame is cropped. Once the text area is localized and cropped, image is enhanced by noise filtering, contrast enhancement (histogram matching technique) and morphological operations.

3. Methodology

The proposed product consists of a sensor, headphone, camera, LED indicator and internal computer chip that converts the received data into audio messages and passes it through the headphones. The sensors are placed on both the sides and the front side as well. This is to ensure proper detection of the object and to collect enough data to precisely compute that data and transfer them as audio signals.

The sensors collect data using wave inputs and with the help of cameras and decode them with the help of microprocessors and microcontrollers. The components used here are ultrasonic sensors and GPRS SIM900A module with an Atmega328p microcontroller. The Atmega328p microcontroller is an 8-bit programmable integrated circuit which has 16 MHz clock frequency. Here the data from ultrasonic sensors are processed by Atmega328p microcontroller.

A 12V lithium polymer battery is used as a power supply for the 12V requirement of the GPRS module and 5V for the other components.

Here the data from ultrasonic sensors are processed by Atmega328p microcontroller. The SD card module has the ability to communicate with Atmega328p microcontroller. The voices are recorded in the SD card module to instruct the visually impaired users, which is played through a headphone according to the ultrasonic data. A switch is connected to the system which is used for an emergency task like sending SMS to the subject's guardian when the blind person falls in danger. GPRS SIM900A module collects such data like location, temperature and time from the internet. All the data from the GPRS SIM900A module are processed by the microcontroller. An SMS including time, temperature and location can be sent to the subject's guardian when the switch is pressed. The LED indicator is used for day or night indication for blind's safety. It is controlled byacquiring the time from the internet with the help of the GPRS module. During the night the LED turn ON automatically so that others can understand the presence of blind when there is no light in the street. Although the device makes the blind to understand about the obstacle, the LED also helps others to understand about the blind person. As a result, the visually impaired person can visit any place without having any difficulties such collide to others.

4. Survey and Analysis

- About 10 million Americans are blind or visually impaired. Each year this number increases by 75,000.
- India is home to world's largest blind population. Of the 37 million people blind all over the world, almost 15 million of them are in India.
- 75% of these are avoidable blindness
- While India needs 40000 optometrists it has only 8000 presently

- While India needs 2.5 lakh donated eyes every year the country's 109 eye banks manage to collect only a maximum of 25000 eyes of which 30% are not usable.
- Of the 15 million people, 26% are children, suffer due to corneal disorders.
- Only 10000 corneal transplants are done due to shortage of donated eyes
- Total number of students: 3,900,000
- By reporting agency:
- Reported by state departments of education: 3,327,000 (83.9%)
- Reported by residential schools for the blind: 273,000 (7.8%)
- Reported by rehabilitation programs: 234,000 (6.0%)
- Reported by multiple disability programs: 89,700 (2.3%)
- By primary reading medium
- Braille readers: 273,000 (7.8%)
- Print readers: 1,259,000 (32.3%)
- Auditory readers: 421,000 (10.8%)
- Non-readers/Symbolic Readers: 1,259,000 (32.7%)
- Pre-readers: 639,000 (16.4%)

5. Result

It is a unique smart device for visually impaired users, which can help them to travel anytime avoiding any kinds of obstacle indoor and outdoor environment. Our proposed device is more comfortable and less expensive.

The ultrasonic sensors are used in this device which is small, light in weight, and consume less power thus users friendly. Although our proposed model response quickly, but it cannot detect the ground level object.

This new concept is expected to improve the visually impaired students' lives despite their economic situations. Immediate future work includes assessing the user-friendliness and optimizing the power management of the computing unit.

Each model represents a specific task or mode. The user can have the desired task run independently from the other tasks.

6. Future Scope

- Building a website for marketing: A website will be made using the free software tools which will be promoted using social media. (2 weeks)
- Finding resources to setup a production line: Human resources and capital need to be sorted. (1-2 months).
- Starting up the venture in a local market: The product or its prototype will be put to test in the local market and if any errors are identified it will be ironed out. (1-2 months).
- Reaching out our product to the global market: Sales will hit the Indian market after production line starts and transport network is established. (3-4 months).
- Building a mobile app for helpline services: Mobile app services like Emergency detection, Maintenance, etc. can be started soon after production starts. (2 months)

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