Review of Robotics Systems Available to aid Visually Impaired Persons

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Abstract –

The need for assistance robots has risen dramatically in this time of age for persons with disabilities particularity for visually impaired persons as their number continues to rise. For them independent living can be performed by an aid robot which is one of the key assistive technology devices that can help to regain dignity and self-confidence. This paper reviews the existing design and development of a personal assistant robots that uses a certain scientific algorithm to detect and estimate the relative location of an objects in an indoor environment using voice instructions. These semi-humanoid robots have built in multiple HD cameras located on different parts of the robots. Autonomous movement, object detection, distance measuring, and motion planning are all done with the cameras. Furthermore, the robot's utility is increased by keeping the user informed about the results of its actions.

Introduction

The number of visually disabled individuals is rapidly increasing in tandem with the overall population growth. According to the World Health Organization, there are over 2.2 billion people are blind or visually impaired (WHO, 2021), among which 36 million people are blind (Albogamy et al., n.d.). Vision loss is a common and unpredictable occurrence and the safe navigation in everyday life environment is one of the most important challenges. To tackle this problem there are two common types of assistive technology devices for in-door and out-door navigation.

Outdoor navigation devices are generally relying on Global Positioning System (GPS) technology. Some systems like the white canes with GPS functionality and the use of guide dogs are widely available for the persons with visually impairments to assist with detecting objects, mobility and travel in both in-door and out-door environments. However, in many cases patricianly in the middle east region blind and visually impaired people are heavily relying on others' assistance to perform their daily tasks. Advance Artificial Intelligence technology and deep learning devices have been developed over the recent time to aid with the ability to detect objects in the surrounding environment, to develop an alert system for daily living smart aids and medication schedule, suggest possible routes and to recognise faces and object. This kind of recognition process uses facial and objects recognition technology similar the one used in the smart phones. Hence robots' systems have been developed and made available taking the advantage of these advances in technology to aid persons with visually impairment.

Assistive Robots for Mobility

For sighted people, GPS-based systems have increasingly become effective for outdoor navigation, however indoor navigation remains an open problem. Sighted people can easily rely on visual cues to get to destinations in large buildings such as shopping malls and airports, but for blind people, indoor navigation is a major challenge (Feng et al., 2015).
Robots developed to help with in-door navigation through voice commands and object recognition using cloud API. These robot devices are geared up with a visual sensor using HD multi cameras, laser range finders, speaker, gives visually impaired humans statistics approximately the surroundings round them. Recorded laser data are analysed the use of the clustering technique, making it feasible to discover obstacles, steps and stairs (Fig 7). By way of the use of the visual sensor, the system is capable of distinguish among gadgets and people. The built-in processors analyse the sensors information and convey records to the visually impaired humans by means of natural language or beep sign.

Figure 1. A blind lady walks with the robot as sighted guide

In addition, other types of physical robots are trained with various objects in the indoor environment, it sends voice commands to the robot via Google Assistant to find the objects the user needs. Using voice commands, the physical robot finds the target object and the reference object, and successfully provides the necessary relative position of the object to the user (Fig 8). In general, physical robots act as personal assistants for the visually impaired indoors.

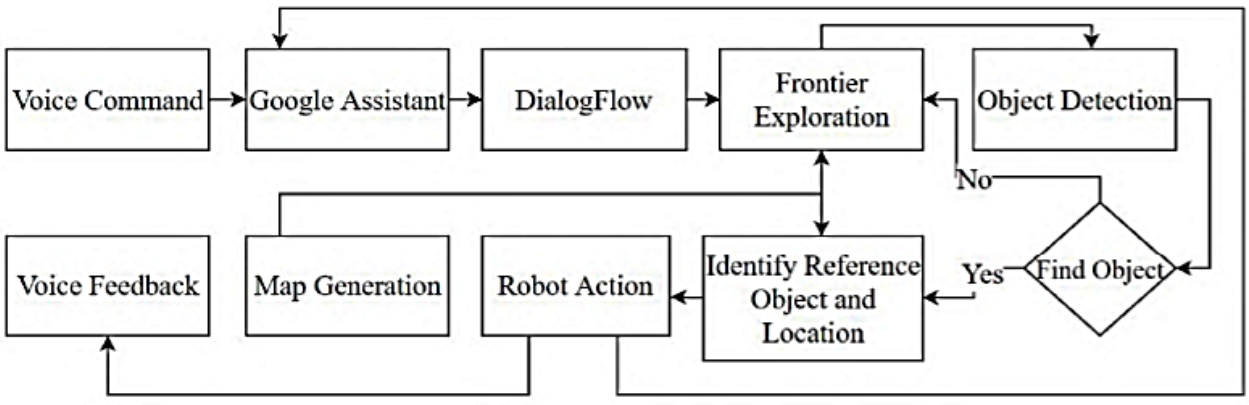

Figure 2. A typical model of assistant robot system flow to detect object via voice command

Autonomous AI Robot

This robot has been developed by University of California ("Mini Cheetah - ROBOTS: Your Guide to the World of Robotics", 2021) which known as Mini Cheetah. It has four legs and equipped with a laser mapping system, cameras, and sensors to safely guide the visually impaired people out-doors. This autonomous AI robot could safely guide its handler through difficult and narrow streets which has many barriers just like a real guide dog (Fig 9). Mini Cheetah can also plot the shortest route for the visually impaired and blind people, reducing travel time and scanning the path with the fewest obstacles.

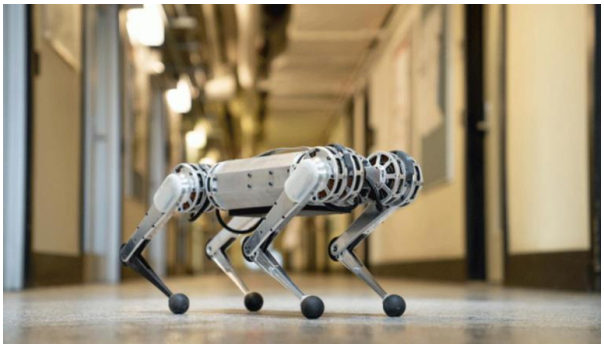

Figure 3. Mini Cheetah AI Autonomous Robot

Guidance Robot

This robot is in use at the Kanagawa Rehabilitation Hospital, Japan for the purpose of guiding visually impaired and blind patients. Depending on the force with which the person with visually impairment pushes on the robot, it navigates to its target while guiding (Tobita, Sagayama & Ogawa, 2017). In a barrier-free setting, such as hospitals, the robot should securely accompany visually impaired people to their destinations. As a result, the moving mechanism with wheels, localization, path generation, obstacle avoidance, voice announcements, and an input interface that is not dependent on visual sense are all design criteria for the robot (Fig 10)

Figure 4. Guidance robot for visually impaired and blind patients in Japan

Conclusion

There are several projects and manufactures who have explored the use of robots to replace blind people's personal mobility aids or personal assistants following the successful new trend of technologies such as handheld devices such as radar equipped white canes, wayfinding technology and robotic walkers for older blind people with mobility challenges. However, with the recent development of AI, IoT, cloud technology, 5G and robotic systems, a new approach has been adopted by technology providers to build a new robot that have the capability to overcome the challenges that facing visually impaired and blind people in their daily life and activities. These robotic systems are very smart, and they can be trained and customised for certain individuals or ideally can be in public service areas such airports for multi-users and multi-purposes.

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