Name and ID (Group 7)	Shadab Hafiz Choudhury Ishrat Jahan Ananya Sarah Suad Nabiul Hoque Khandakar	1631335042 1631636042 1632282642 1631164642

Research Title:

Navigational Assistance for the Visually Impaired through Computer Vision Techniques

Research Aims:

Visually impaired, or blind people, face many difficulties in daily life. As they are bereft of visual stimulus, they cannot interact or navigate the world around them easily. Locating and picking up an object is a difficult task, as they have to feel around to find out where the object is. However, this is possible if they take their time. Similarly, although they cannot read, they can use braille for physical texts and text-to-speech software for computerized texts.

However, there is no easy way for them to navigate through a room full of obstacles, as their perception is limited to the length of a walking stick, which itself has an extremely narrow “field of view”, and whatever they can touch. This causes a large number of inadvertent collisions with various obstacles in the room such as furniture and other objects, leading to injuries or damage to the contents of the room.

Background and Originality:

A lot of work has been done on providing navigational assistance for visually impaired people. However, most prior research had been focused on a hardware-based solution, whether it a high-tech walking stick equipped with a myriad of devices [1], or a multitude of sensors mounted all over the body. They mainly used radio or ultrasound waves to detect obstacles [2]. While this is an effective method, it has the same shortcoming of being unable to help visually impaired people perceive anything outside a very narrow “field of view”. As such, they were not a proper substitute for visual navigation.

A computer-vision based solution would come closer to providing the visually impaired with sight. It could act in a similar way as a human guide who directs the blind person away from obstacles. Using computer vision, we can also find out what type of obstacle it is, whether a chair, table, shelf, et cetera, further helping navigation. Previous research has been done on navigating outdoors using computer vision [3] and on developing CNNs that can decipher the general lay out of a room [4]. This project will take notes from the outcomes of previous research in similar fields but attempt to work from scratch to develop a functional device for indoors navigation with the intent of guiding a visually impaired person.

Research Plan and Features

The core research of the project will aim to achieve the following:

- Develop a computer vision algorithm that will ‘map’ out the layout of a room from either a snapshot or a live video feed.
- The ‘map’ of the room will note out which areas of the floor are ‘walkable’ and which areas are obstructed by furniture or other obstacles.
- By noting the current position of the user from either the image/video or an accelerometer, it will keep the user on the ‘walkable’ surface and give them a warning when they stray from the walkable area and ae about to hit an obstacle.

These capabilities will be built onto a device worn on the head. It would preferably be worn at eye-level, in order to best simulate normal human field of view. The view would be connected to either an integrated PC or smartphone, depending on our processing power requirements.

Additional features that are still in the planning phase include

- Elevation detection – Blind people are extremely insecure of the surface they walk on, as if there is an unexpected change of elevation (such as steps), they may fall down. Along with detecting a floor surface, it would detect steps or a sudden change in elevation.
- Object Recognition – In addition to navigating indoors by recognizing walkable surfaces and obstacles, it would try to classify the *type* of obstacle, such as a chair or table.
- Directed Navigation – The software could detect ‘landmarks’ (for example, a door at the opposite end of a room) and guide the person towards that position by using the ‘map’ of the room. In conjunction with the above feature, it could be used to direct someone specifically towards a chair or table.
- Detecting Objects on the Floor – There may be objects on the floor, such as a book, toy, or bag, which are too small to be detected during the ‘mapping’ of the room. This feature would attempt to pick out any objects seen on the floor and give a warning.

These additional features may or may not make it to the final product. The feasibilities of each of the features have not been determined yet and will require further research.

Our tentative research plan will be as follows:

1. April – May: We will focus on finding and curating a suitable data set for our research, and begin preliminary work in designing our CNN, as well as continue researching prior work in order to learn more about the specifics of the computer vision approaches used in prior research.

2. May-July: The main research work, in which we will develop and train the necessary models for our purposes as outlined above. This work will primarily be software-based, though we will begin to shift on focusing on hardware implementation as we finalize our model.

3. July-August: Hardware implementation. We will connect our model to a hardware interface with a visual input, and tune the speed and performance appropriately for daily use. We expect our software side to be fully functional by this time,

References

[1] Design and Implementation of a Walking Stick Aid for Visually Challenged People

[2] A Navigation Aid for Blind People

[3] Outdoor Navigation for Visually Impaired based on Deep Learning

[4] Recovering the Spatial Layout of Cluttered Rooms

Citations

Sahoo, N., Lin, H. W., & Chang, Y. H. (2019). Design and Implementation of a Walking Stick Aid for Visually Challenged People. Sensors (Basel, Switzerland), 19(1), 130. https://doi.org/10.3390/s19010130

Bousbia-Salah, M., Bettayeb, M. & Larbi, A. A Navigation Aid for Blind People. J Intell Robot Syst 64, 387–400 (2011). https://doi.org/10.1007/s10846-011-9555-7

V. Hedau, D. Hoiem and D. Forsyth, "Recovering the spatial layout of cluttered rooms," 2009 IEEE 12th International Conference on Computer Vision, Kyoto, 2009, pp. 1849-1856.

Saleh, Shadi & Hadi, Saleh & Nazari, Mohammad & Hardt, Wolfram. (2019). Outdoor Navigation for Visually Impaired based on Deep Learning.

H. Baskaran, R. L. M. Leng, F. A. Rahim and M. E. Rusli, "Smart Vision: Assistive Device for the Visually Impaired Community U sing Online Computer Vision Service," 2019 IEEE 4th International Conference on Computer and Communication Systems (ICCCS), Singapore, 2019, pp. 730-734.