A Highly Accurate and Reliable Data Fusion Framework for Guiding Visually Impaired

Wafa Elmannai and Khaled Elleithy
Department of Computer science and Engineering
University of Bridgeport, Bridgeport, CT

Motivation

Statistics of the visually impaired community

- 25 million Americans with significant vision loss: costs US ~$51.4 billion annually.
- There are 285 million visually impaired worldwide, 39 million are blind [1].
- There is a growing community: age-related diseases are the leading causes of blindness.

The need of the visually impaired community

- A wearable device can effectively ensure safety and independent mobility to the visually impaired people [2].

Objectives

Create a framework that significantly improves the life of visually impaired individually

Develop a computer vision method for real time obstacle detecting and avoiding

Route guidance, navigation, and locomotion

Develop an efficient algorithm for data fusion

Methodology

This work consists of two parts : hardware and software. The hardware design is represented in figure 5. The aim of this software part is to develop a data fusion algorithm among the hardware components with help of the computer vision to provide an accurate navigational instructions that ensure the safety for the blind's mobility.

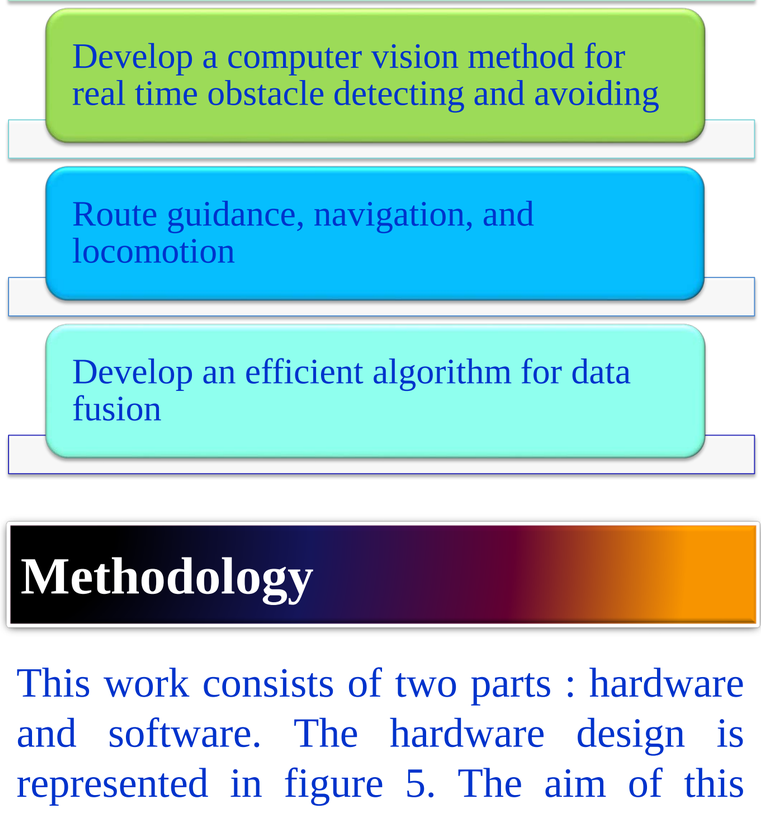

Figure 1: System Architecture

Results

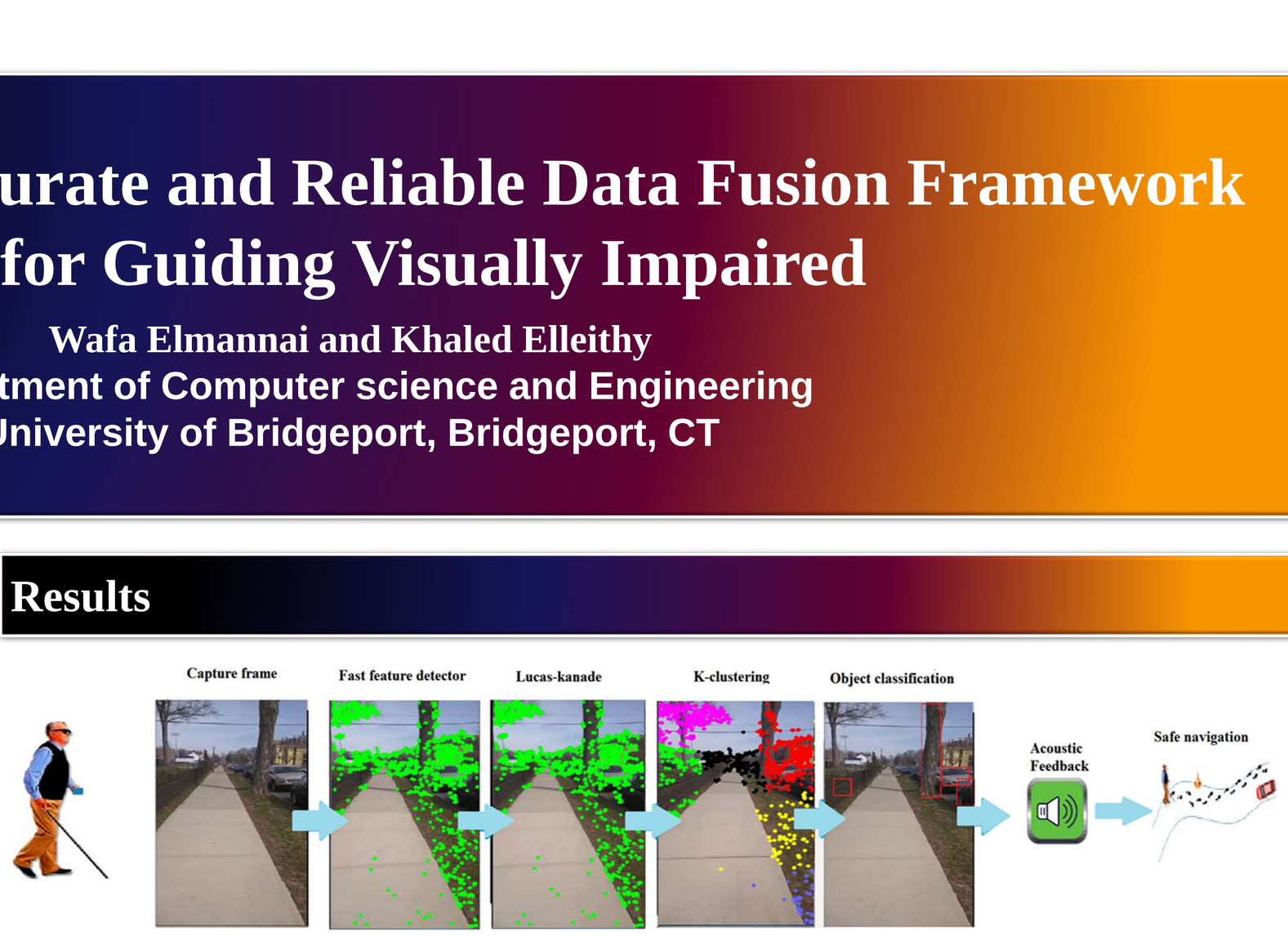

Figure 2: Outdoor Navigation

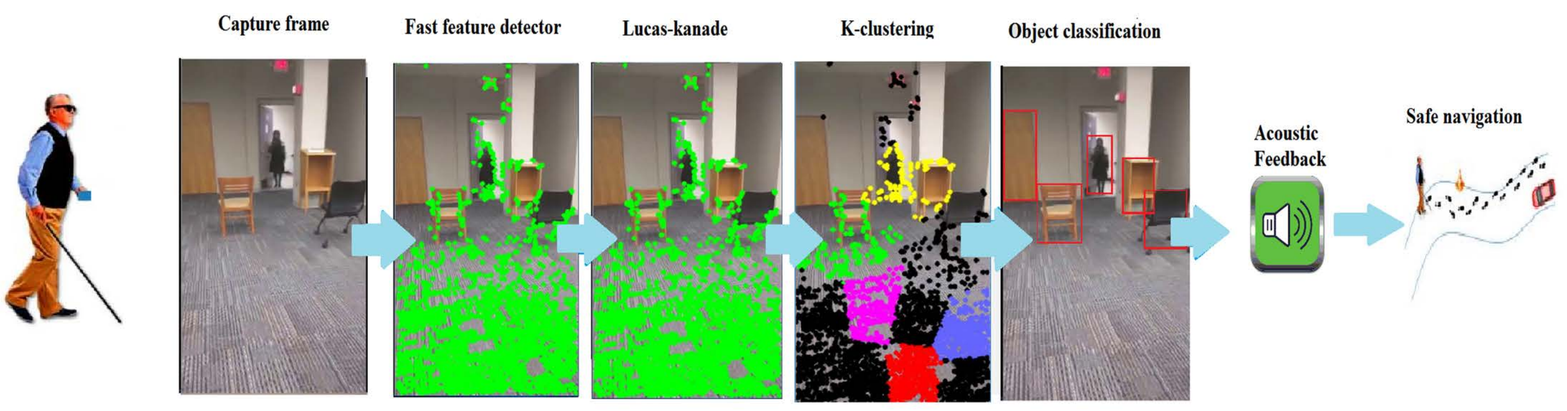

Figure 3: Indoor Navigation

After capturing a frame, the fast algorithm is applied to extract interest points within that frame. Since fast algorithm is relatively more expensive to apply on every frame, the Lucas-Kanade optical flow estimation technique is used to determine motion of vectors. To determine the outliers and inliers, we used RANSAC algorithm to determine the homography. After the separation of background and foreground objects we can apply k-clustering to group interest points together to determine objects in the picture.

Performance Evaluation of the Implemented Framework

User's Requirements	Our Result	Validation
Real Time	0.14sec/ frame with resolution 320 X 240 ~10 frames/sec	Satisfied
Performance	Outdoor/ Indoor	Satisfied
Detection Range	1m < R < 10m	Highly Satisfied
Light Weight	total weight of all components: 68 gram	Satisfied
Low Cost	$ 242.41	Satisfied

Table1: Evaluation of Most Important Features that Correspond to the User's needs

Data Fusion Algorithm

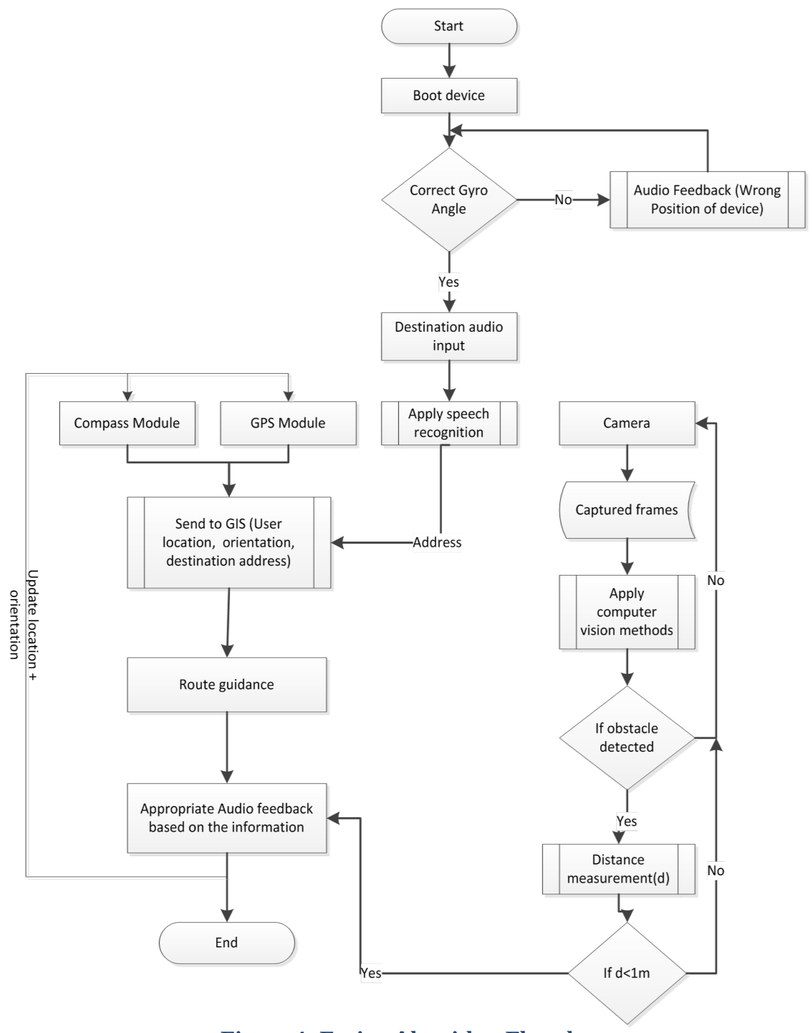

Figure 4: Fusion Algorithm Flowchart

Hardware Architecture

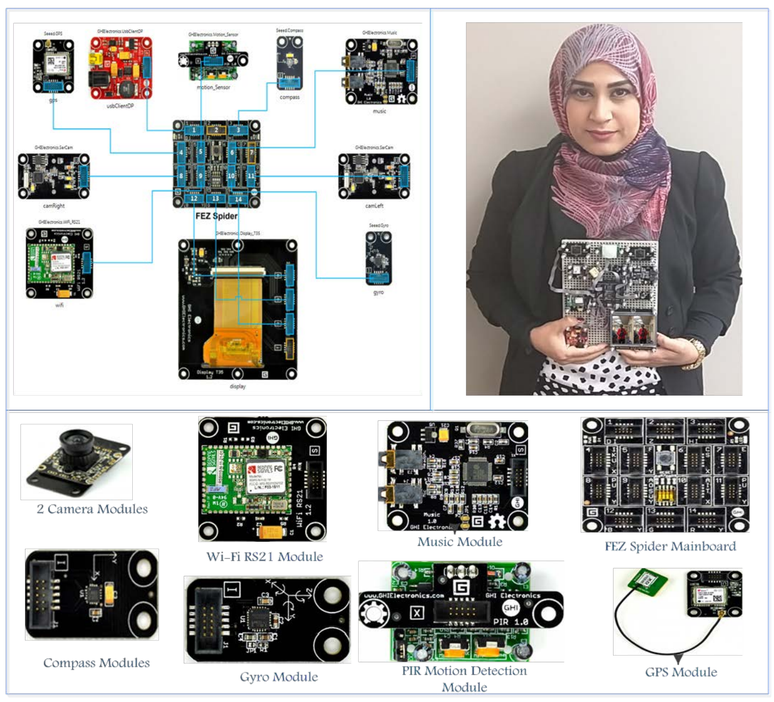

Figure 5: Proposed Hardware Design

Conclusion

In this work, we developed a hardware and software implementation that provides a framework for a device that can assist the visually impaired. The system was implemented using a .NET Gadgeteer compatible mainboard and modules from GHI Electronics.

References

[1] https://www.ghielectronics.com/
[2] W. Elmannai , K. Elleithy. Sensor-Based Assistive Devices for Visually Impaired People: Current Status, Challenges, and Future Directions. *Sensors*. (2017).