



**BUSITEMA
UNIVERSITY**
Pursuing excellence

**FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF COMPUTER ENGINEERING AND INFORMATICS**

FINAL YEAR PROJECT REPORT

A Smart Glasses System for the Visually Impaired People using an Object Detection Model

By

SSEMUJJU RAYMOND

BU/UG/2020/1976

+256 751 709 546/+256762051794

Email: ssemujjuraymond0@gmail.com

SUPERVISOR

Dr. ALUNYU ANDREW EGWAR

A Final Year Project Report Submitted to the Department of Computer Engineering and Informatics in Partial Fulfillment for the Award of the Degree of Bachelors of Science in Computer Engineering of Busitema University

June, 2024

DECLARATION


I SSEMUJJU RAYMOND hereby declare that the information provided in the report is my own original gathered authentic work and has never been submitted before to the Department of Computer Engineering and Informatics of Busitema University main campus and any another institution of high education.

Signature.....

Date.....28th June, 2024.....

APPROVAL

This project titled a smart glasses system for the visually impaired using an object detection model has been submitted with the approval of the supervisor.



.....

04/7/2024

.....

(signature)

(date)

Dr. Alunyu Andrew Egwar (Academic Supervisor)

DEDICATION

I dedicate this report to my lovely family, friends and more especially my mentor Mrs. Ocora Mary N Dawn who have always been there for me whenever they can. Thanks a lot for their love, prayers, emotionally, financially and academic support during the due course of my academics. May the Almighty God bless them abundantly.

ACKNOWLEDGEMENT

Great thanks to the Almighty God for always being with me and I also want to thank Him for the gift of life, a loving family and loving friends who have stood by me at all times.

I would like to say thank you to Department of Computer Engineering and Informatics. Also, I appreciate my parents for supporting me and my dreams no matter the cost.

Finally, I thank Dr. Alunyu Andrew Egwar, a lecturer at the department of Computer Engineering and Informatics for supervising my final year project.

I am really grateful for your individual contribution to my success; may the good Lord bless you all.

ABSTRACT

To date there are challenges experienced by visually impaired individuals in perceiving their surroundings resulting in navigation and accessibility problems. Therefore, to address this limitation, this project designs a system using a microcontroller, object detection model, and camera to assist blind people in recognizing their surroundings, including faces, objects, and obstacles. The visually impaired individuals receive output in form of audio from the system. The design method is used to develop, integrate and test the system components. A prototype and results of such tests were compiled, reported and will be submitted for examination to the department of Computer Engineering and Informatics, Busitema University.

LIST OF ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
IEEE	Institute of Electrical and Electronic Engineers
OCR	Optical Character Recognition
TTS	Text-to-Speech
YOLO	You Only Look Once
CNN	Convolutional Neural Network
GPU	Graphics Processing Unit
GSM	Global System for Mobile computing
GPS	Global Positioning System
LED	Light Emitting Diode
USB-TTL	Universal Serial Bus-time to live
PCB	Printed Circuit Board
DAC	Digital to Analog Convertor
TPU	Tensor Processing Unit
FPS	Frames Per second

LIST OF TABLES

Table 1 Table showing the comparison of the existing systems.	8
Table 2 Design Specifications for ESP32-CAM board.....	15
Table 3 Design Specifications for Arduino Nano board	15
Table 4 Design Specifications for MP3 player module	16
Table 5 Predictions for object class 'Laptop'	27
Table 6 Predictions for object class 'Door'	27
Table 7 Predictions for object class 'Person'	27
Table 8 Predictions for other object classes	27

LIST OF FIGURES

Figure 1 Scene Video Filter settings in VLC media player.....	11
Figure 2 Enhancing low-light images with Retinex.....	12
Figure 3 Image Augmentation using ImageAugmenter	12
Figure 4 Data Annotation using LabelImg.....	13
Figure 5 Training a custom model on Colab.....	14
Figure 6 ESP32-CAM board.....	15
Figure 7 Arduino Nano board	15
Figure 8 MP3 player module	16
Figure 9 Block diagram showing the smart glasses system.....	19
Figure 10 flowchart of the smart glasses system	20
Figure 11 Fritzing Breadboard View showing the assembly of components.....	21
Figure 12 Physical design of the smart glasses system.....	21
Figure 13 training results for the custom object detection model.....	24
Figure 14 model results showing accuracy of 88.38%	24
Figure 15 model results showing the F1 Score of 55.5%	25
Figure 16 unit testing for an ESP32-CAM board	25
Figure 17 integration testing of Object detection algorithm and esp32-cam	26
Figure 18 integration testing of the modules in the system	26
Figure 19 Predictions made by the object detection model	28
Figure 20 Serial monitor showing trigger of the audio files	28

Table of contents:

DECLARATION..... i

APPROVAL ii

DEDICATION iii

ACKNOWLEDGEMENT iv

ABSTRACT..... v

LIST OF ABBREVIATIONS AND ACRONYMS vi

LIST OF TABLES vii

LIST OF FIGURES viii

CHAPTER ONE: INTRODUCTION..... 1

 1.1 BACKGROUND 1

 1.2 PROBLEM STATEMENT 2

 1.3 OBJECTIVES OF THE PROJECT 2

 1.4 SIGNIFICANCE 3

 1.5 SCOPE..... 3

CHAPTER TWO: LITERATURE REVIEW 4

 2.1 Key Terms and Concepts 4

2.1.1 Smart Glasses 4

2.1.2 Object Detection 4

2.1.3 Blindness..... 5

2.1.4 Computer Vision 5

 2.2 Related Works and Projects 6

2.2.1 Smart Walking Cane 6

2.2.2 Low-Cost Ultrasonic Smart Glasses for Blind 7

2.2.3 Tap-tap see application..... 7

2.2.4 Smart Shoes..... 7

 2.3 Existing Systems Comparison Table 8

 2.4 Developed System 9

CHAPTER THREE: METHODOLOGY 10

 3.1 Data Collection..... 10

 3.2 Data Analysis..... 11

3.3 Model development and Training.....	13
3.4 Requirements Analysis	15
3.4.1 Hardware Requirements	15
3.4.2 Software Requirements	16
CHAPTER FOUR: SYSTEM ANALYSIS AND DESIGN	17
4.1 Functional Analysis	17
4.1.1 Functional Requirements	17
4.1.2 Non-functional Requirements	17
4.2 Requirements Analysis	18
4.3 System Design	18
4.3.1 System Block Diagram	19
4.3.2 System Flow Chart	19
4.3.3 System Circuit Diagram	20
4.3.4 Physical Design	21
CHAPTER FIVE: IMPLEMENTATION AND TESTING	22
5.1 System Implementation	22
5.1.1 Development Environments	22
5.1.2 System Components	22
5.1.3 Implementation Steps	23
5.2 Testing and Validation	23
5.2.1 Unit testing	23
5.2.2 Integration testing	26
5.2.3 System testing	27
CHAPTER SIX: DISCUSSIONS AND RECOMMENDATIONS	29
6.1 Work summary of the work done	29
6.2 Critical Analysis/appraisal of work	29
6.3 Challenges faced.....	30
6.4 Recommendations.....	31
6.5 Conclusion:	31
References.....	32
APPENDICES / INDEX:	34

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND

Blindness is a global health problem affecting millions of people worldwide. According to the World Health Organization, there were 39 million blind and 246 million visually impaired people in 2010 [1]. Recent health measures have reduced the number of people blind due to infectious diseases. However, injuries related to aging are increasing. Cataracts are still the leading cause of blindness worldwide, except in industrialized countries [1].

According to the International Agency for the Prevention of Blindness, about 0.19% of Uganda's population is blind (83,000), and 1.10% has moderate to severe vision impairment (475,965) [2]. The leading causes of vision impairment and blindness in Uganda are river blindness from black flies, cataracts, diabetic retinopathy, glaucoma and age-related macular degeneration [3] [4].

Blindness and low vision can have significant impacts on the quality of life, education, employment, and social inclusion of the affected individuals. As individuals lose their ability to work, participate in education, and contribute to the economy, the overall impact reverberates across communities and the nation.

Many technologies such as white canes, guide dogs, Braille alphabet and audio books have been developed to assist the blind and visually impaired. However, these methods have some limitations, such as requiring special training or being expensive and difficult to obtain. Therefore, more advanced and cheaper technologies are needed to help blind and visually impaired people see and interact with their environment.

One of the new technologies that can meet this need is smart glasses. Smart glasses can be used for many purposes such as education, guidance and entertainment [5]. For blind and low vision people, smart glasses can provide important information about their environment, such as the name, location and distance of objects, as well as exposure effects, words or faces. This

References

- [1] I. A. C. (<http://ieeauthorcenter.ieee.org/>), "Sustainable Emerging Innovations in Engineering and Technology (ICSEIET)," IEEE Xplore, 14 - 15 September 2023. [Online]. Available: <https://doi.org/10.1109/ICSEIET58677.2023>. [Accessed 25 February 2024].
- [2] O. (<https://optimadesign.co.uk/>), "Country Map & Estimates of Vision Loss - Uganda," The International Agency for the Prevention of Blindness (IAPB), 23 February 2021. [Online]. Available: <https://www.iapb.org/learn/vision-atlas/magnitude-and-projections/countries/uganda/>. [Accessed 25 February 2024].
- [3] R. Athman, "River Blindness increases in Uganda," Africa News, 27 November 2021. [Online]. Available: <https://www.africanews.com/2021/11/27/river-blindness-increases-in-uganda/>. [Accessed 14 March 2024].
- [4] T. Abet, "Why Uganda has high blindness cases," MONITOR, 04 April 2021. [Online]. Available: <https://www.monitor.co.ug/uganda/special-reports/why-uganda-has-high-blindness-cases-3348236>. [Accessed 14 March 2024].
- [5] I. Xplore, "Smart glasses for blind people using obstacles detection," IEEE Conference Publication, 14 September 2023. [Online]. Available: Smart glasses for blind people using obstacles det<https://ieeexplore.ieee.org/document/10303495/>. [Accessed 14 March 2024].
- [6] A. Georgiou, "'Smart Glasses' Developed That Can Help Blind People Recognize Objects," NEWSWEEK DIGITAL LLC, 25 October 2023. [Online]. Available: <https://www.newsweek.com/smart-glasses-help-blind-people-recognize-objects-1837042>. [Accessed 25 February 2024].
- [7] T. S. & G. Balakrishnan, "YOLO glass: video-based smart object detection using squeeze and attention YOLO network," SpringerLink, 31 December 2023. [Online]. Available: <https://doi.org/10.1007/s11760-023-02855-x>. [Accessed 25 February 2024].
- [8] L. Steffen, "These AI-Powered Smart Glasses are Changing the Lives of Blind People," Intelligent Living Media Ltd, 21 March 2022. [Online]. Available: <https://www.intelligentliving.co/ai-powered-smart-glasses-changing-lives-blind-people/>. [Accessed 25 February 2024].
- [9] seva.org, "Uganda Fact Sheet," September 2023. [Online]. Available: http://www.seva.org/pdf/Seva_Country_Fact_Sheets_Uganda.pdf. [Accessed 25 February 2024].

- [10] I. R. blog, "What is computer vision?," IBM, [Online]. Available: <https://www.ibm.com/topics/computer-vision>. [Accessed 25 February 2023].
- [11] G. D. N. N. a. K. A. A. Krishnan, "Autonomous walking stick for the blind using echolocation and," *2nd International Conference on Contemporary Computing and Informatics (IC3I)*, pp. Pages. 13 - 16, 2016.
- [12] R. A. e. al, "Low cost ultrasonic smart glasses for blind," *8th IEEE Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON)*, pp. Pages. 210 - 213., 2017.
- [13] F. v. d. H. &. P. Regtien, "Wearable navigation assistance - a tool for the blind," *University of Twente, The Netherlands, Measurement Science Review*, vol. Volume 5, no. Section 2, 2005.
- [14] A. Kooser, "Smart shoes vibrate you in the right direction using Google Maps," CNET, 29 July 2014. [Online]. Available: <https://www.cnet.com/tech/mobile/bluetooth-smart-shoes-vibrate-you-in-the-right-direction/>. [Accessed 05 June 2024].
- [15] I. C. Publication, "Smart Glasses Application system for visually impaired people based on deep learning," IEEE Xplore, 1 February 2020. [Online]. Available: <https://ieeexplore.ieee.org/document/9181366>. [Accessed 25 February 2024].
- [16] R. Tatkar, "Object detection and translation for blind people using deep learning," 2021. [Online]. Available: https://www.academia.edu/63399837/Object_Detection_and_Translation_for_Blind_People_Using_Deep_Learning. [Accessed 25 February 2024].
- [17] I. C. Publication, "Smart Glasses: a visual assistant for the blind," IEEE Xplore, 10 March 2022. [Online]. Available: <https://ieeexplore.ieee.org/document/9751975/>. [Accessed 25 February 2024].
- [18] I. A. Center, "Computing, Analytics and Networks (Indo-Taiwan ICAN)," IEEE Xplore, 7 - 15 February 2020. [Online]. Available: <https://doi.org/10.1109/indo-taiwanican48429.2020>. [Accessed 25 February 2024].
- [19] M. &. C. J. Mukhiddinov, "Smart glass system using deep learning for the blind and visually impaired," *Electronics*, 10(22), 2756, 2021. [Online]. Available: <https://doi.org/10.3390/electronics10222756>. [Accessed 25 February 2024].
- [20] G. Jocher, "YOLOv8," Kaggle, May 2023. [Online]. Available: <https://www.kaggle.com/code/ultralytics/yolov8>. [Accessed 13 February 2024].