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Development of Object Detection Glasses for the Visually Impaired

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***Abstract*—Mobility among visually impaired individuals still largely depends on traditional assistive devices such as white canes, which have limitations in detecting objects beyond the reach of the cane, particularly at head or upper-body height. This study designed and developed an object-detection glasses system that provides early warnings of objects in front of the user. The system utilizes HC-SR04 ultrasonic modules to detect object distance, while a vibration motor module and DFPlayer Mini provide warning outputs in the form of vibration and sound. An Arduino Uno serves as the main controller to regulate the operating logic of all modules. The system development methodology uses the V-Model, comprising requirements analysis, design, implementation, and testing stages. Testing was conducted to evaluate the accuracy of distance detection by the ultrasonic modules, vibration response, and audio output. The test results show that the system can provide sufficiently fast and accurate warnings for objects located at specified distances according to the system configuration. The proposed system is expected to serve as a more informative and adaptive alternative to conventional canes in assisting visually impaired individuals in recognizing objects in their surroundings.**

***Index Terms*—Object-detection glasses, visually impaired individuals, ultrasonic module, vibration motor, DFPlayer Mini, Arduino Uno, V-Model.**

I. INTRODUCTION

Visually impaired individuals face significant challenges in recognizing objects in their surroundings due to limitations in visual function. In performing daily activities, they rely on tactile, auditory, and olfactory senses. A white cane remains a primary assistive device; however, it can only recognize obstacles within a limited range, determined by the length of the cane and the user's arm reach. According to Murakami in Gumilar (2010), a cane functions to overcome obstacles directly and to assist in recognizing the surrounding environment, but it does not provide early detection of objects located beyond the range of physical contact. Sijabat (2012) also emphasizes the importance of safe and independent mobility for visually impaired individuals as part of quality of life.

Technological developments have enabled the development of assistive devices based on microcontrollers and various modules. Several previous studies have demonstrated this potential. Maliak et al. (2023) designed an Arduino Uno-based smart cane integrating three types of modules: an ultrasonic module, a fire-detection module, and a water-detection module. The system provides warnings using a buzzer when an object or hazard is detected. However, the use of a cane still presents limitations in terms of flexibility. Another study by Chandra et al. (2020) developed a vehicle distance-control device using a 40 kHz ultrasonic module and an AT89S51 microcontroller. The system was effective in detecting various types of objects and provided LED and buzzer responses when an object was too close. The ultrasonic-wave reflection principle used in that study is relevant to wearable systems.

Furthermore, Tyas Utami et al. (2024) developed a camera-based object-recognition system for visually impaired individuals using the YOLO algorithm on a Raspberry Pi. The system communicated detection results through audio output, indicating that auditory responses can assist users in recognizing environmental conditions. However, camera-based systems have limitations under low-light conditions and do not always provide real-time responses.

Considering the advantages and limitations of previous studies, the present study designed Arduino Uno-based object-detection glasses integrating two HC-SR04 ultrasonic modules, a PWM vibration motor module as a vibration actuator, and a DFPlayer Mini as an audio player. One ultrasonic module is mounted on the front of the glasses, while the other is installed on a small box positioned on the chest to detect objects from two directions. The vibration motor is mounted on the arm, while audio is delivered through an earphone. The system is designed to provide warnings according to the distance measured by each ultrasonic module.

System development was conducted using the Research and Development (R&D) method with the V-Model approach,

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which consists of structured verification and validation stages. The main objective of this design is to create a responsive, portable, and easy-to-use mobility aid that helps visually impaired individuals recognize obstacles earlier, thereby improving safety and independence in daily activities.

II. METHODS

The research method used in the design and development of object-detection glasses for visually impaired individuals, with sound and vibration outputs as assistive media, was Research and Development (R&D), using the V-Model development approach consisting of seven stages.

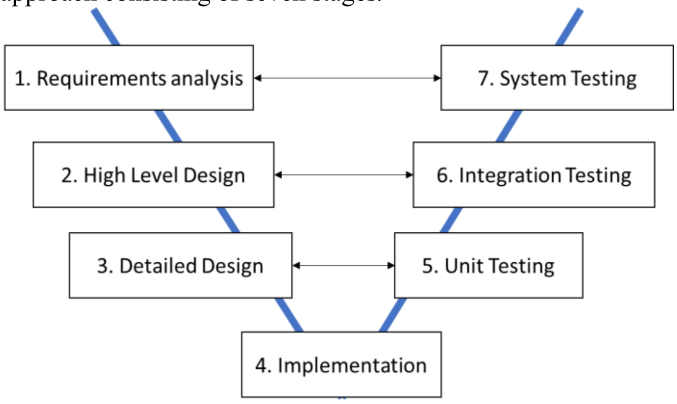

Fig. 1. V-Model Development Method

III. DEVELOPMENT PROCEDURE

This research was conducted at the Electronics Control Instrumentation Laboratory, Building L, Department of Electrical Engineering, Electronics Engineering Education Study Program, Faculty of Engineering, Universitas Negeri Jakarta. The research was conducted from May to July 2025.
Testing consisted of several activities, including object-detection system testing, distance-module testing, audio-module testing, vibration-module testing, and overall system testing.

A. Distance Module System Testing

The distance-module system was tested by comparing the actual distance between the ultrasonic sensor and the object with the distance measured by the sensor. A manual measuring tape was used as the reference measurement.

TABLE I. OBJECT DETECTION SUBSYSTEM TEST DOCUMENTATION

engujian	Jarak Objek Menggunakan Meteran[cm]	Jarak Pada Serial Monitor Modul Ultrasonik di Kepala	Jarak Pada Serial Monitor Modul Ultrasonik di Dada	Keterangan	Gambar
1	145 [illegible]	142 [illegible]	141 [illegible]	Selisih 3-4 [illegible]	
2	24 [illegible]	23 [illegible]	22 [illegible]	Selisih 1-2 [illegible]	
3	45 [illegible]	42 [illegible]	41 [illegible]	Selisih 3-4 [illegible]	
4	93 [illegible]	90 [illegible]	88 [illegible]	Selisih 3-5 [illegible]	
5	117 [illegible]	115 [illegible]	115 [illegible]	Selisih 2 [illegible]	
6	72 [illegible]	69 [illegible]	69 [illegible]	Selisih 3 [illegible]	

B. Audio Module System Testing

The audio module was tested by measuring the sound intensity produced by the DFPlayer Mini using a digital sound level meter. The measured values were used to evaluate the audio warning output at different detection distances.

TABLE II. AUDIO MODULE TEST DOCUMENTATION

Pengujian	Jarak ke Objek (cm) Modul Ultrasonik Pada Kacamata dan Pada Dada	Volume Program (dB)	Keterangan	Gambar
1	50[illegible] dan 60[illegible]	88,6[illegible]	Hidup	
2	60[illegible] dan 63 [illegible]	85,2[illegible]	Hidup	
3	73[illegible] dan 75 [illegible]	78,2[illegible]	Hidup	
4	130[illegible] dan 133 [illegible]	67,5[illegible]	Hidup	
5	142[illegible] dan 144 [illegible]	65,8[illegible]	Hidup	

C. Vibration Module Testing

The vibration module was tested by observing the vibration response generated by PWM signals at different levels. The vibration motor was evaluated according to the detected object distance.

TABLE III. VIBRATION MODULE TEST DOCUMENTATION

Pengujian	Jarak ke Objek (cm) Modul Ultrasonik Pada Kacamata dan Pada Dada	Output DFPlayer Mini	Output Motor Getar	Gambar
1	50[illegible] dan 60[illegible]	Hidup	Hidup	
2	60[illegible] dan 63 [illegible]	Hidup	Hidup	
3	73[illegible] dan 75 [illegible]	Hidup	Hidup	
4	130[illegible] dan 133 [illegible]	Hidup	Hidup	
5	142[illegible] dan 144 [illegible]	Hidup	Hidup	

D. Overall System Testing

Overall system testing was conducted by integrating the ultrasonic distance sensors, Arduino Uno, DFPlayer Mini, and PWM vibration motor. The system was tested under operating conditions to verify that the warning outputs responded to the detected object distance.

IV. RESULTS AND DISCUSSION

Figure 5 shows the use of the developed object-detection glasses on a test model. The glasses were worn by the model together with the supporting components positioned on the body to evaluate the integrated operation of the system.

Fig. 2. Use of the Device on the Test Model

Based on the test results for each subsystem and the overall system, all modules operated according to the design. The ultrasonic modules were able to detect the presence of objects at various distances, after which the measured data were processed by the Arduino to regulate the intensity of the vibration and audio outputs. The vibration module provided an intensity response according to distance, while the DFPlayer Mini successfully played warning sounds whose volume also adjusted according to the detected distance.

V. CONCLUSION

After conducting the design and development of the object-detection glasses for visually impaired individuals, it can be concluded that the system was successfully designed and developed in accordance with the objectives of the study. The object-detection glasses were implemented using an Arduino Uno as the main controller, two HC-SR04 ultrasonic modules to detect objects from the eye and chest directions, a DFPlayer Mini, and a PWM vibration motor module to provide auditory and vibration feedback.

The system provides warnings when objects are detected at near, medium, and far distances, with output variations adjusted to the environmental conditions around the user.

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