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BLIND ASSISTIVE DEVICE - SMART LAZY SUSAN

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Abstract:

This study designed a smart Lazy Susan as a daily life aid for the visually impaired people to improve their dining convenience and safety. This smart device was realized by combining a Lazy Susan, electric motor, gears, voice integrated circuit (IC) module, radio frequency identification (RFID), blue-tooth module, mobile application (APP), speaker, single-chip microcomputer, and a set of buttons with Braille. After a button is pressed, the proposed device turns automatically to move the corresponding dish to the front of the diner, while the introduction of the dish is played through the speaker to help the visually impaired diner with dish selection.

Keywords:

Blind assistive device; RFID; APP

1. Introduction

Because of their visual limitations, visually impaired people face various inconveniences in daily life, learning, movement and social activities. According to VIDE Magazine, dining out has become a major difficulty in the life of visually impaired people. Studies have found that visually impaired people generally bear the psychological burden of not wanting to cause inconvenience to others. However, the scenario of dining out could happen on a daily basis, in which visually impaired people would need to seek assistance frequently [1]. Furthermore, identifying the dish in front of them is a major challenge to visually impaired diners. When dining, visually impaired people usually do not know what they have eaten until the food is in their mouth [2].

Except for visual limitations, visually impaired people do not differ much from ordinary people in other aspects. Several visually impaired people have developed unique abilities in the identification of tone changes, spatial concepts, and abstract ideas. Visually impaired people should be treated with sincerity, providing them with a warm, safe, and comfortable living environment. The general suggestion for dining with visually impaired people is to read the menu and prices to them, let them order by themselves, and inform them the positions of eating utensils. In addition, accompanying diners may explain to them the position of each dish, or collect a portion of food from each dish to their plates according to their preferences for them to eat independently [3].

The Lazy Susan is a common device used in Chinese dining occasions. Currently, commercially available Lazy Susan mostly consists of two overlapping tables, where the upper one is used to carry dishes and turn upon the lower one. Therefore, diners can manually turn the upper table to position a dish in front of them, allowing an easier access to the food in the dish. To minimize the inconvenience of manual turning, current technology has entailed electric versions of the Lazy Susan that enables diners to control the rotation of a Lazy Susan without manually turning it. However, both manual and electric Lazy Susan are designed for diners with proper vision. For visually impaired people, dining with family and friends using a Lazy Susan always entails relying on their friend or family member sitting next them to select dishes for them or turn the Lazy Susan to change the dish in front of them.

Statistics have shown that currently Taiwan has a visually impaired population of approximately 56,529 [4]. Among this population, approximately 42% suffered total blindness before the age of 5 mainly due to genetic inheritance or accidental injury. Considering that Taiwan has a large group of visually impaired people in need of care and assistance, the motivation of this study is to care for them in daily lives and save the dining inconveniences faced by them. By designing and realizing a set of table aids to assist visually impaired people with dining, this study can provide dining information for visually impaired diners, and enhance their dining convenience and safety. Visually impaired people can learn the dishes independently and choose the dish they prefer comfortably without relying on others. Thus, they would feel more secure and fulfilled rather than socially isolated when dining with family and friends. The schematic diagram of the smart dining table aid is displayed in Fig. 1.

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2. System Architecture

Using the proposed smart Lazy Susan improves diming convenience and safety for visually impaired people; the system block diagram is shown in Fig.2 and the software flow chart is shown in Fig.3. To realize the prototype, this study used an Arduino UNO development board as the single-chip microcomputer, a wooden Lazy Susan, a direct current motor and L298N motor driver board, a WT588D as the voice IC module, an MF RC522 as the RFID module, and an HC-05 as the blue-tooth module. In addition, a 3D printer was adopted to render suitable gears, a support shaft for the flywheel, as well as the Braille on the control panel. Moreover, a mobile APP was designed for mobile phone remote control.

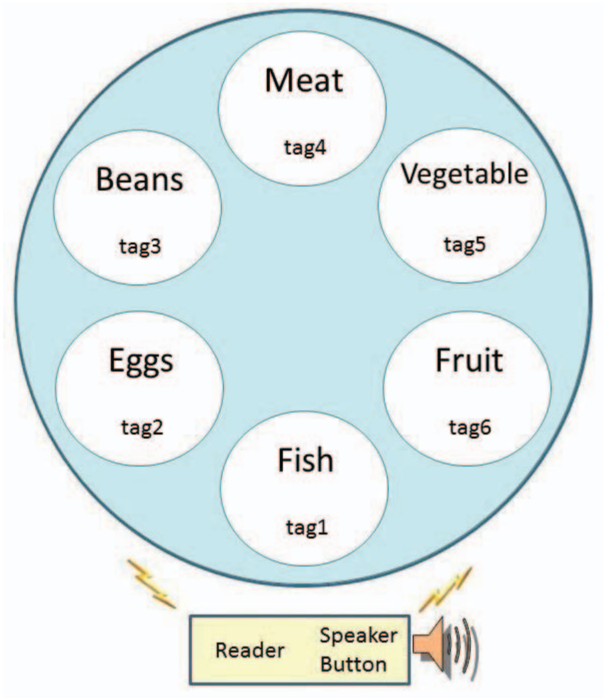

FIGURE 1. The schematic diagram of the smart Lazy Susan.

3. Implement and Results

3.1 Single-Chip Microcontroller

Arduino is an open-source, single-chip microcontroller applicable to either hardware or software tools. It is easy to access, learn, and use. Arduino provides abundant examples, and uses a program language similar to C/C++. Users can download the Arduino integrated development environment from the official website [5].

3.2 DC Motor

Direct current motors are advantageous for their easier control of turning speed, which can be configured merely by adjusting voltage. L298N is a high-voltage and high-current motor driver module. The module features high working voltage and output current, contains a bridge circuit and voltage-stabilizing IC, demonstrates high drive capacity and low heat emission, and can drive direct current motors and stepper motors, as well as control their turning speed [6].

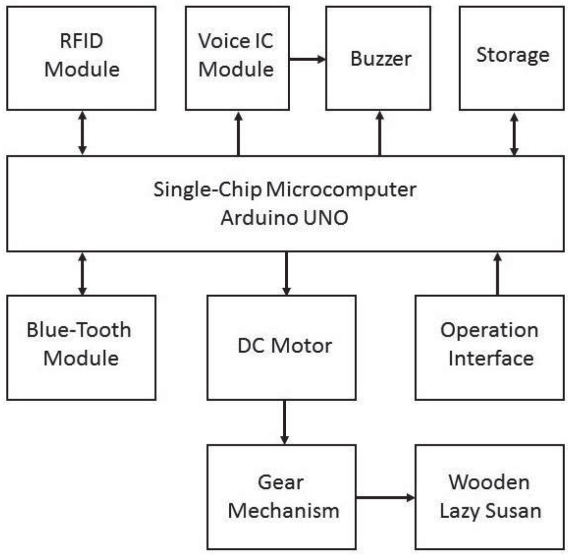

FIGURE 2. System block diagram.

3.3 Voice IC Module

This study used a WT588D voice chip as the voice IC module. WT588D is a powerful and rewritable single-chip voice module that does not require complex peripheral control circuits. The operation of the voice burning and writing software is simple and easy to understand; moreover, the software incorporates speech synthesis technology, which saves substantial time required for voice editing [7]. LM386 is a low-voltage audio power amplifier specifically designed for low-voltage devices; it is manufactured by the National Semiconductor Corporation, and is mainly applied in low-voltage consumer electronics.

3.4 RFID Module

RFID is a communication technology that enables identifying specific targets through radio frequency signals. RFID technology has been available for more than 60 years. A basic RFID system consists of both hardware and software components. Hardware including tags, readers, antennas, and host system. Software including RFID system software, middleware, and application[8]. In the proposed scheme, every plate is attached with a tag. When a dish is turned to the front of a visually impaired diner, the RFID reader inside the controller reads the specific identification serial number of the tag through radio waves. After processing the signal, the microcontroller outputs the corresponding dish information to the amplifier, which then broadcasts the information for the visually impaired diner to identify the dish without relying on others. Noticeably, the use of RFID and the design of attaching distinct tags to different dishes provide restaurants with more flexibility to change dishes.

3.5 Dishes information

Dishes information played by the amplifier [9] includes dish name, type (e.g., appetizer, soup, salad, main dish, or dissert), major ingredients (e.g., beef, pork, mutton, or vegetables), spices and seasonings, cooking methods (e.g., baked, grilled, roasted, deep-fried, braised, or stewed), nutritional ingredients, calories, and whether the dish contains fish/pork/chicken/beef bones.

3.6 Mobile Application

Blue-tooth communication, as applied to the short-range transmission of information. This study adopted the blue-tooth module HC-05 to design a mobile phone APP that can control the smart Lazy Susan and lock or unlock the menu buttons through Bluetooth to prevent others from accidentally pressing the buttons or operating the device at will. Regarding the system setup, the baud rate of HC-05 was first set as 9600. Specifically, the Arduino was used to communicate with HC-05, the AT-command was executed to modify the data transmission speed of HC-05, and the built-in serial monitoring window was initiated for testing. After satisfactory test results are attained, the mobile APP was initiated to connect with HC-05 for data transmission. The APP program was designed using the Android Studio development environment. In the user scenario of the smart Lazy Susan, the mobile APP is used by restaurant staff or the accompanying caregiver in the dining occasion. When necessary (e.g., when a dish is served), the mobile APP user can lock the menu buttons, pause the operation of the Lazy Susan, and unlock the buttons to continue dining and dish selection when the situation permits, as show in Fig. 4.

3.7 3D Printing

3D printing is a rapid formation technology that first draws the model of an object through computer-assisted design, and then builds the prototype of the object through layered accumulation and stacking. During the realization of the smart Lazy Susan, this study experienced difficulty in concretizing the system architecture, which challenged the team's ability to solve interdisciplinary problems. Eventually, 3D printing was adopted as the final solution. The motor required mechanical components such as gears and chains to move the Lazy Susan. Originally, ready-made gears were used to assemble the device. However, the gears tended to jam, and did not show improvement after several parts were replaced and modified a few times. Therefore, 3D printing was utilized to render suitable gears and a support shaft for the flywheel. After repeated minor adjustments, the gears could operate more stably, and the problem of motor vibration was resolved by installing a base produced using 3D printing. Fig. 3-6 presents the 3D-printed components.

3.8 Braille

Braille is a tactile writing and reading system for people who are visually impaired. The system was invented and designed by Frenchman Louis Braille using the arrangement and combination of six raised dots. Several hospitals in Taiwan are considerate in providing Braille stickers of medication instructions which, when attached to medicine bags, enable visually impaired patients to read the instructions via Braille characters. When 3D-printing the control panel, Braille characters were printed on the corresponding menu buttons for visually impaired diners to identify buttons easily.

4. Conclusions and Discussion

This study designed and realized a Lazy Susan device that provides dining convenience and safety for visually impaired people. When a button is pressed, the motor turns the Lazy Susan with a specific angle which automatically turns the corresponding dish to the front of the visually impaired diner. At the same time, the speaker plays the dish information to assist the diner to fully understand the dish and thus they could select their preferred food. Accordingly, visually impaired diners can decide whether to take food from a dish or not according to personal preferences, as well as be forewarned about if the dish is hot or contains sharp bones.

Initially, this study was inspired by a student who suffered severe parallax between the right and left eyes due to a car accident. The student encountered multiple inconveniences in daily life and learning; therefore, the research team started to devise a dining aid for visually impaired people. Because the team specialized in electronics and information engineering, the research was directed towards the two fields in its early phase.

No major challenges were encountered until the prototype was completed. Due to working behind a closed door in the early phase, the first version created by this study faced multiple problems that had never been considered. The functionality and practicality of the newer versions were gradually enhanced through the opinions and suggestions from others. We realized that all the criticisms and suggestions we received in the competitions or exhibitions that facilitated the continual improvement of the research team.

The proposed smart Lazy Susan is portable and easy to install, as shown in Fig. 7 and Fig. 8. It can be placed directly on a table, which is suitable for Chinese restaurants. Barrier-free spaces, such as aids for the visually impaired, are an indicator of social civilization and progress, and several disability-friendly restaurants also permit the entrance of guide dogs. More considerate designs are expected to be designed for visually impaired people to interact with others in a warm and safe environment [3].

Acknowledgement

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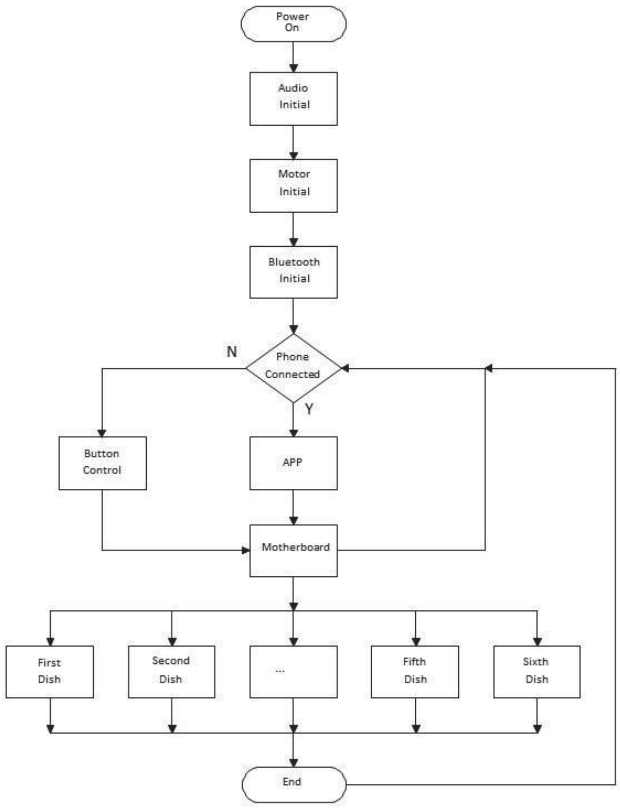

FIGURE 3. Software flow chart.

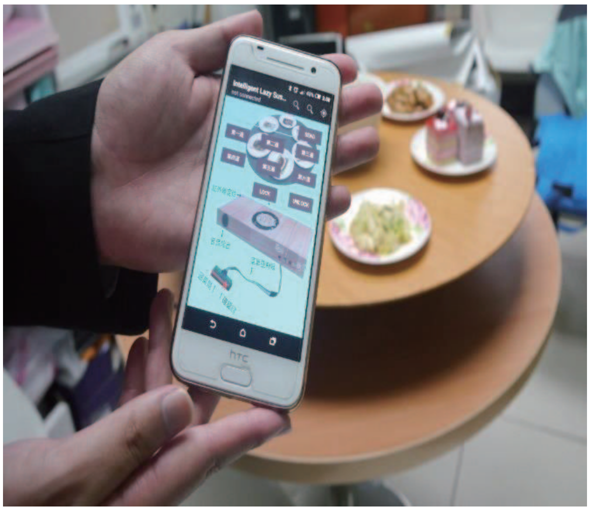

FIGURE 4. The mobile APP user can lock the menu buttons.

FIGURE 5. The control panel design by 3D-printing.

FIGURE 6. The control panel

FIGURE 7. The smart Lazy Susan is portable and easy to install.

FIGURE 8. Simulate the user scenario