Red Light, Green Light Game System based on IoT Devices

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***Abstract*—With the progress of technology, most of the entertainment of the younger generation is related to electronic products. People gradually forget traditional games. Red Light, Green Light has ample liquidity that people worldwide know it. Therefore, to bring traditional games back to children's childhood, we use IoT devices to develop a Red Light, Green Light Game System. This system comprises three modules: an identification module, a distance measurement module, and a notification module. In the identification module, we use the Raspberry Pi equipped with the MediaPipe Pose to detect 33 pose nodes of the human body. Then the model reads the camera image through OpenCV and marks the players' skeleton position. Finally, we compare the players' skeleton positions in the front and rear images to determine whether the player has moved. The ultrasonic sensor "HC-SR04" is used in the distance measurement module to measure the distance. The change of the front and rear distances is used to identify whether a player is passing through the finish line. The notification module places the "TM1637" four-digit display and the speaker. It will display the remaining time and play the sounds needed for the game during the gameplay. The proposed game system allows adults to relive their childhood and introduces traditional games to younger generations.**

I. Introduction

With technology's progress, many childhood games are now just memories. The most popular traditional game is "Red Light, Green Light" This game is simple but has several things that could be improved. First, this game must require one person to be the cop, so not everyone can be a player. Second, the cop may struggle to fairly determine who's out with many players, impacting the game's fairness.

To improve the above problems, we design the "Red Light, Green Light Game System based on IoT Devices". The key to judging whether a player is out of the game is whether the player has moved. Therefore, we combine the human skeleton recognition model with the currently popular IoT devices. We use the Raspberry Pi as the system carrier and connect the ultrasonic sensor "HC-SR04", servo motor, camera, speaker, and four-digit display "TM1637". We divide the system into an identification module, a distance measurement module, and a notification module. This project not only lets the game be played in a fair environment but also combines technology with childhood games to bring childhood games back to life.

II. System Architecture

The system architecture is shown in Fig 1. A Raspberry Pi is used as the IoT device and connected to the servo motor and camera in the identification module and the ultrasonic sensor "HC-SR04" in the distance measurement module. Finally, use two LED lights, a four-digit display "TM1637", and a speaker in the notification module.

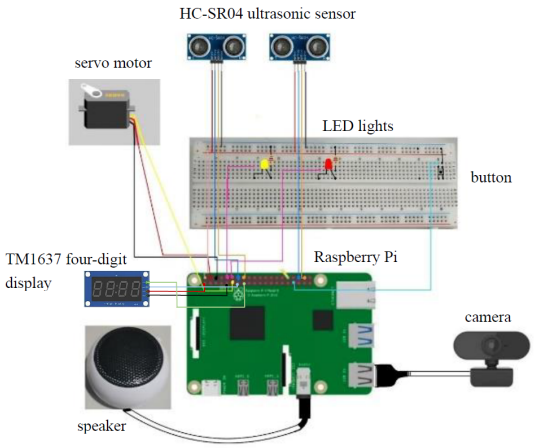

Fig. 1. System architecture.

III. Methods

Our system is divided into three modules: an identification module (IM), a distance measurement module (DMM), and a notification module (NM). In addition, we add a button to the system, and after pressing the button, the game will be launched or restarted. In this chapter, we will discuss the function of each module separately.

A. Identification Module

In the IM, the servo motor rotates the camera. When the camera faces the player, OpenCV is used to read the camera image, then pass the image through the MediaPipe Pose [1] to detect the 33 pose nodes of each player(Fig 2). Continuously scan whether the player's skeleton has moved during a random detection time. If the model judges that a player is moving, it will identify the player's number through the digital identification model and then notify the player to be out of the game through NM. If no player moves during the detection time, the game is continued until either no player is on the field or the time is up.

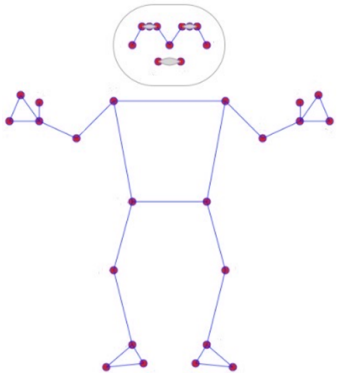

Fig. 2. 33 pose landmarks.

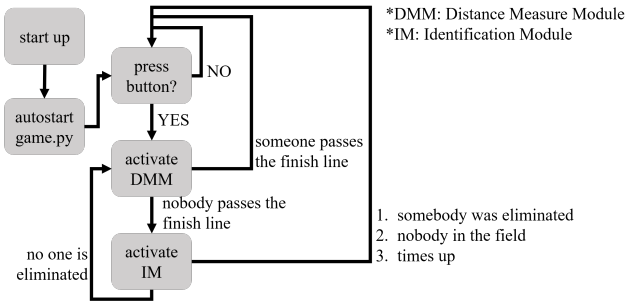

Fig. 3. Flowchart of the game system.

B. Distance Measurement Module

The clearance condition of the game is a player passes the finish line, that is, the two sides of the cop. Therefore, we place two ultrasonic sensors "HC-SR04" [2] on both sides of the cop to confirm whether players passed the finish line. The DMM triggers when the cop is facing away from the player. Players move towards both sides of the cop. If someone crosses the finish line, causing a change in the sensor's measurement, indicating the player has passed. At that time, NM emits a passing sound. When the cop faces the player, this module will be stopped, and IM will be activated.

C. Notification Module (NM)

NM provides game prompts so players can follow the prompts to play the game. We use a speaker to play the audio effect and the prompt sound. We also use a four-digit display "TM1637" [3], to remind players of the remaining time of the game. When a player is out, the speaker will play the player number, and the number will also be displayed on the four-digit display "TM1637".

IV. Experiment

A. Demonstration

Fig 3 is the system flowchart. The system executes automatically when the Raspberry Pi is turned on and checks for button presses. Upon button press, the green LED light will turn on, indicating the start of the game.

When the camera is facing away from the player, DMM will be activated to detect if someone passes the finish line. Each time in DMM, a random value is generated as the duration of the module which increases the unpredictability of the cop's head turns. When a player passes the finish line, NM will emit a game sound to notify the player.

IM is activated when the camera turns towards the player. A random value is generated as the duration of the module. During this period, it will continuously detect whether the players have moved. If the model detects that a player has moved, it will recognize the player's number, and NM will emit a sound to announce that the player is out of the game. To increase the game's difficulty and challenge, we set a threshold in IM to adjust the number of skeletons and the degree of movement the model needs to recognize. The game will end automatically when no players or a time limit is reached, and the red LED turns on.

B. Analysis

We analyze the pros and cons of this system. Firstly, it is easy to obtain the necessary equipment. Secondly, the setup process is straightforward. Thirdly, the game is highly flexible, allowing for easy parameter adjustment to customize players' difficulty levels. However, compared to traditional games that can play anywhere, this system requires a power supply to operate, thus limiting the gaming venue. In the future, this issue can be addressed by using batteries.

V. Conclusion

In this paper, we use IoT technology to address the unfairness and role limitations of the Red Light, Green Light game. The system consists of three modules: an identification module, a distance measurement module, and a notification module. The most prominent feature is that the Identification Module is equipped with the MediaPipe Pose to replace the cop in the traditional game and avoid the unfairness of human recognition. This approach allows all players to participate in the game without needing someone to act as the cop player. This system enables a single player to enjoy the game; up to 8 players can play simultaneously. In the future, we will combine more traditional games with IoT technology to let the younger generation experience the fun of these games.

Acknowledgements

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