



FlipAble Board Game

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Game begins

Balls are released

Players activate controls

Controls activate flippers

Goal is scored

Tally is displayed

Ball returned to field

Goal threshold is reached

Game ends

Introduction

Aim: To build an accessible four-player pinball-type game for children with disabilities at John Chilton School.

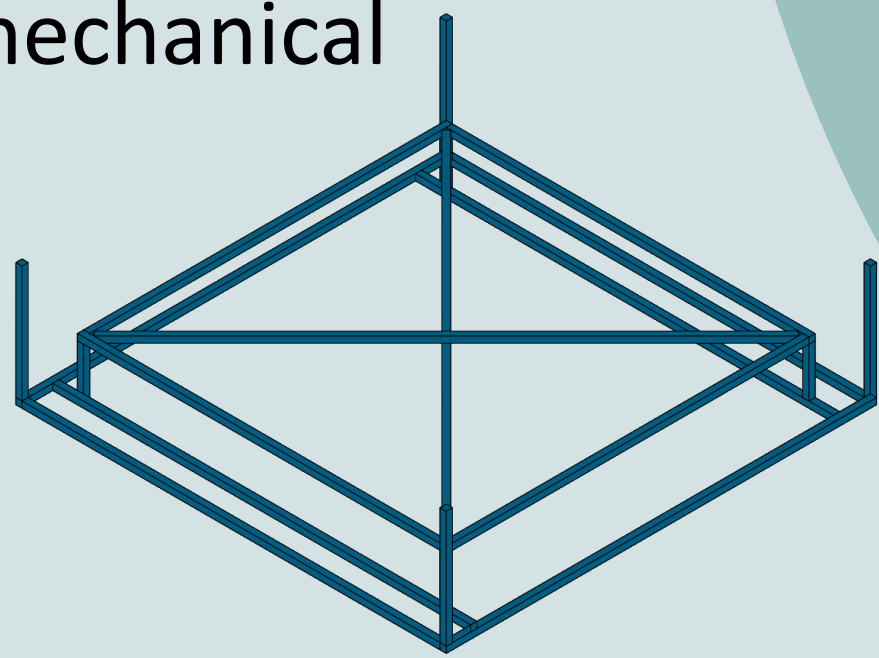
User Requirements

- 1 Functional Game Design
- 2 Variety of Control Technologies
- 3 Audio-visual feedback
- 4 Autonomous Game (CPU)
- 5 Safety and Security
- 6 Suitable size for a player on a wheelchair : 700 mm x 700 mm
- 7 Light-weight
- 8 Contrasting colours for visually impaired players

1 Functional Game Design

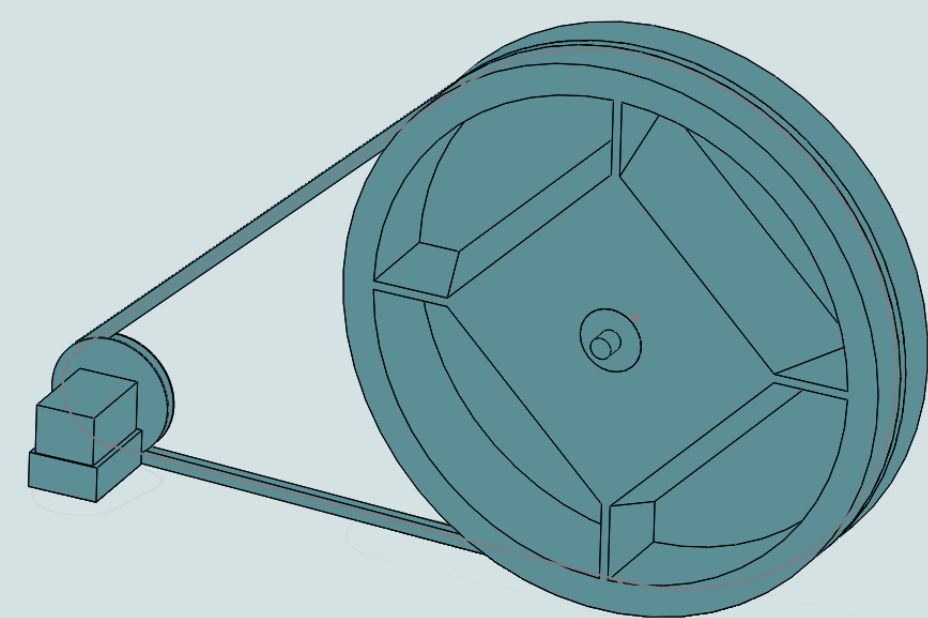
A. The Chassis

- Made of hollow stainless steel and aluminium tubes
- Provides mechanical support



B. Ball Return Mechanism

- Ball rolls down the ramp into one compartment of the wheel
- The wheel is controlled by a timing belt connected to a pulley rotated by a motor
- When the container with the ball reaches the top position, the ball rolls back due to the inner inclined planes of the wheel

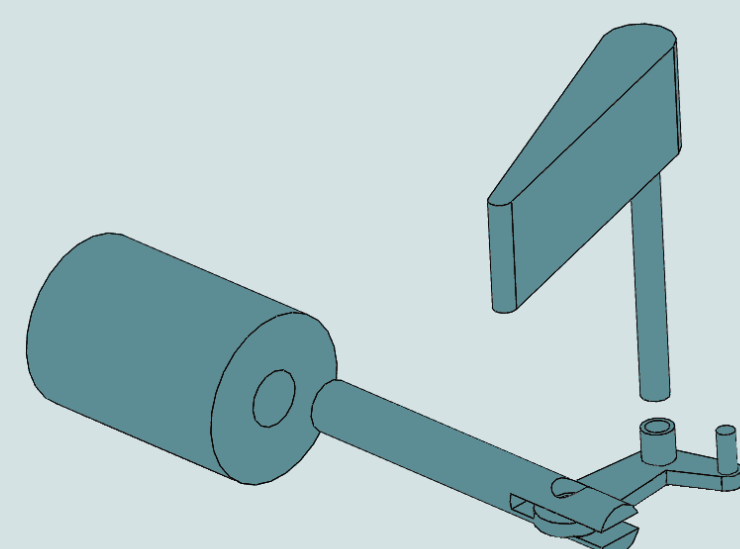


C. The Goal Counting Mechanism

- Consists of an infrared light emitting diode and a photodiode
- When a ball obstructs the infrared beam, the counter increments

D. Flipper Mechanism

A 50V coil pulls a cylindrical steel plunger which swings the flipper bat.

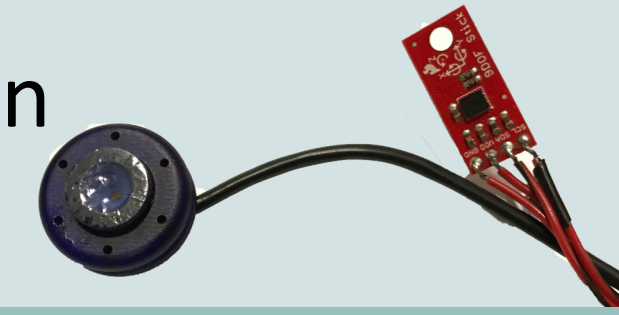


2 Variety of Control Technologies

Control 1: Eyebrow control

An Arduino Nano is processing the data from:

- MMG: Microphone placed on the player's forehead converting the sound of muscle contractions into an electrical signal
- An IMU unit sensing the head movement to cancel out false activation



Control 2: Button

- Pressing the button sends an impulse to the CPU



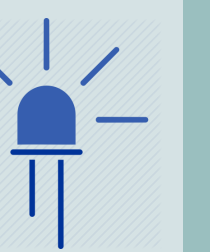
Control 3: Voice Recognition

- The keyword 'Go' is recognised using the 'Snowboy' software and sends an impulse to the CPU



3 Audio-visual Feedback

- 4 sounds respectively indicate the game starting, ending, flippers moving and scoring goals
- LEDs in the central pyramid light up when a goal is scored

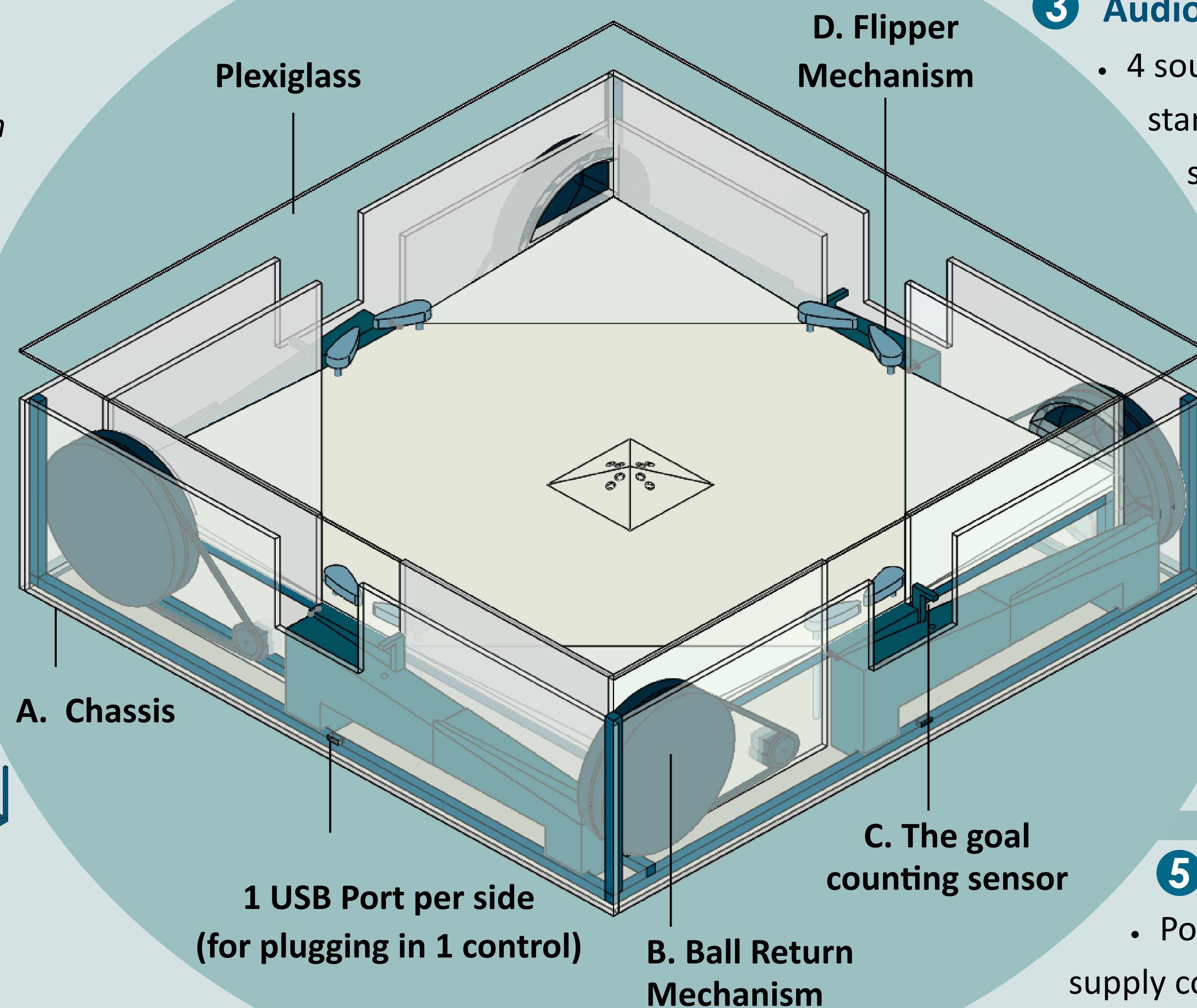


4 Central Processing Unit

- Triggers flippers upon activation of the control on the same side using parallel processing
- Tracks scores
- Runs ball return motor
- Provides audio-visual feedback

5 Safety and Security

- Power distributed from an external power supply connected to mains, equipped with fuses
- Plexiglass top prevents injuries from components



Results and Evaluation

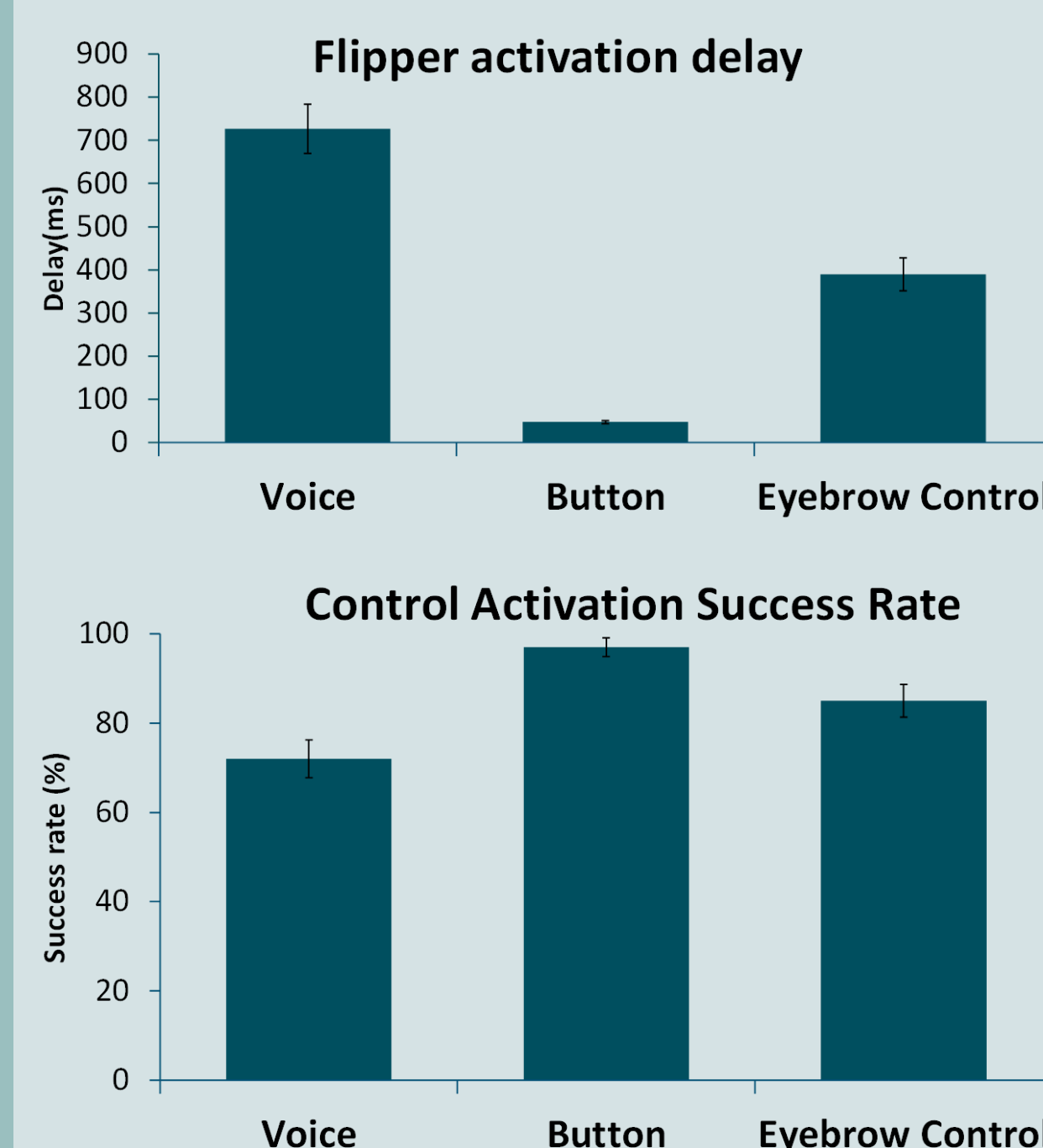


Fig. 1: Bar Chart showing the delay between the action of the player and the reaction of the flipper. A logic analyser was used to record the waves at input and output

Fig. 2: Bar Chart showing the success rate of each control. Ten participants tested each control 20 times

Note: Error bars in both charts show the standard deviation of the mean

The delays introduced by each control are negligible for the user experience, but can be corrected at the processing stage. The success rate is acceptable for playing the game.

Further Improvements

- Lighter materials can be used to increase the portability of the game
- More bumpers can be added to the playfield to make it more fun
- The success rate can be increased for MMG and voice recognition with better signal processing for both and further training of the model for the latter

Conclusion

The final board game is a fully functional assistive technology game which allows disabled students to play independently.

Acknowledgements

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