BLACK JACK+

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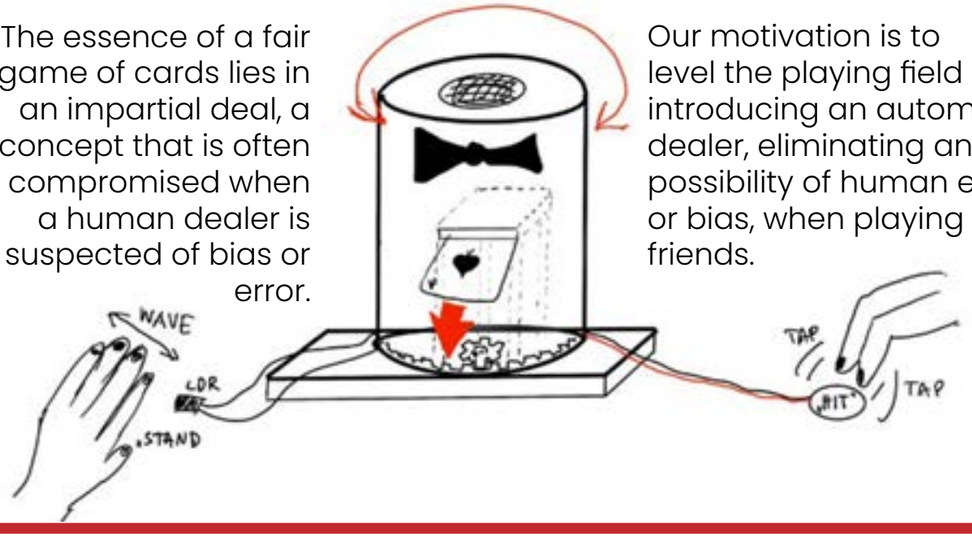
IDEA, REQUIREMENTS & PLAN

The Initial Idea

The essence of a fair game of cards lies in an impartial deal, a concept that is often compromised when a human dealer is suspected of bias or error.



Our motivation is to level the playing field by introducing an automatic dealer, eliminating any possibility of human error or bias, when playing with friends.

Black Jack Rules

Objective: Beat the dealer without going over 21.
Card Values: Number cards at face value, face cards = 10, Ace = 1 or 11.
Player Choices: Hit, Stand, Double Down.
Dealer Rule: Hits until 17 or higher.
Pay-out: Blackjack (21) pays 3:2; regular win pay 2:1.
Bust: Over 21 is a loss.

Deal: Every player gets 2 face-up cards except the dealer who has 1 face-up and 1 face-down card which is revealed at the end of the round. Dealer goes last.

Requirements - Specification

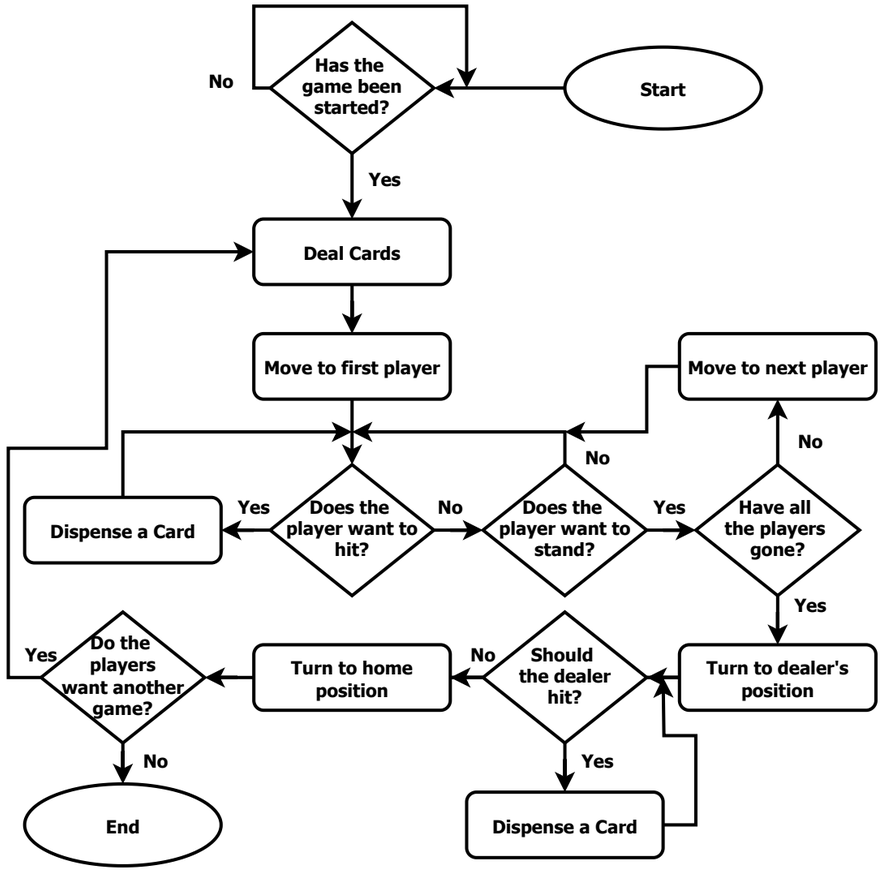
The project will be a compact, cylindrical machine, designed to occupy the space traditionally reserved for the dealer's cards.
This autonomous dealer will be equipped with:

- a slot for card dispensation
- an auditory feedback system via a speaker
- a piezoelectric sensor for detecting 'hit' commands through taps
- a sensor for recognizing 'stand' commands via hand waves

The interaction must:

- be intuitive, leveraging familiar gestures synonymous with blackjack
- allow for the dealer to know whether to hit or stand, ideally without the need for extra input from the users
- game should follow common blackjack rules

Flowchart - Black Jack



Pseudocode - Black Jack

```
// Initialize game state variables
GameStarted = false
PlayerTurn = 0
GameEnded = false
// Main Game Loop
WHILE NOT GameEnded
    IF NOT GameStarted
        // Start the game
        GameStarted = true
        Deal cards to players and dealer
        Move to first player's position
        PlayerTurn = 0
    ELSE
        // Player's turn logic
        IF Player wants to hit
            Dispense a card to the current player
        ELSE IF Player wants to stand
            Move to the next player's position
            PlayerTurn = PlayerTurn + 1
        // Check if all players have finished their turns
        IF All players have gone
            Move to the dealer's position
            WHILE Dealer needs to hit
                Dispense a card to the dealer
            // Check if players want another game
            IF Players want another game
                Reset the game state for a new round
            ELSE
                Move to home position
                GameEnded = true
    // End of player's turn logic
END WHILE
```

DESIGN PROCESS 1

Rotation

1. Using a Servo Motor as the supporting axle and the rotation device.

- Rotation angle not sufficient
- Too much weight on the servo
- Cables reaching out get tangled when rotating

2. Using a DC motor, gear system and a separate support axle.

- Not enough control over the position.
- DC motor speed too unreliable

3. Using a Stepper Motor and Driver, an orbital gear system and a separate supporting axle and a bearing.

- Middle support axle allow to run cables outside the rotating plate without tangling
- Bearing supports smooth rotation and decreases torque
- Orbital gear systems helps with more accurate rotation positioning

Card dispensing

We decided to dispense the cards using a rubber wheel that pushes cards off the deck one at a time.

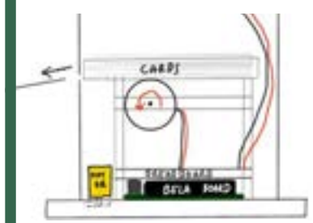
For this we explored two options:

1. Dispensing cards off the top of the deck

- More than one card was pushed off due to higher friction caused by the weight of the motor and wheel pushing on the deck
- Extra mechanism needed for keeping a constant pressure and contact with the declining deck

2. Dispensing cards off the bottom of the deck

- Deck's own weight pushes new card into position for dispensing
- Due to the specific dispensing location we were able to design a more secure deck holder



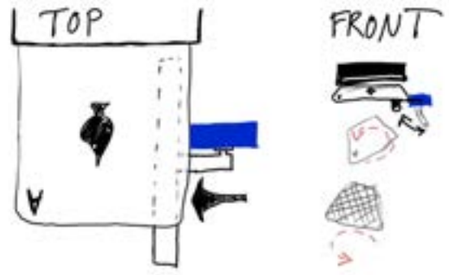
Cards are placed in the dispenser face-up as this is the most occurring card direction in blackjack.

Additionally, to improve the card dispensing rate we implemented a weight on the deck the also acts as a cover to hide the top card from players seeing it.

Flipping mechanism

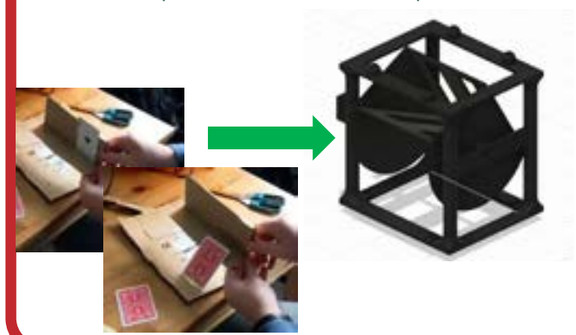
1. Flipping cards when they're falling by letting one side hit a ledge and turn the card

- Free-fall of the card makes the system unreliable
- Card's final position is unpredictable and the card can get stuck in the system



2. Use a v-shaped rotating catcher to catch, flip and dispense the dealers card

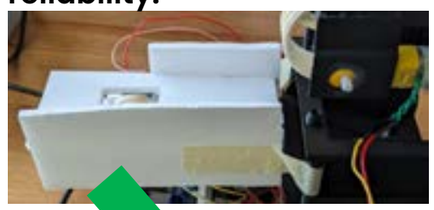
- More secure catching of the card
- Very reliable flipping if card is caught
- Dispenses card lower and at a lower speed in front of the robot (dealer) where it should be, meaning no additional control of motor speeds is needed
- One of the v-shaped walls was used as a platform on top of which the dealer's face-up card would be dispensed

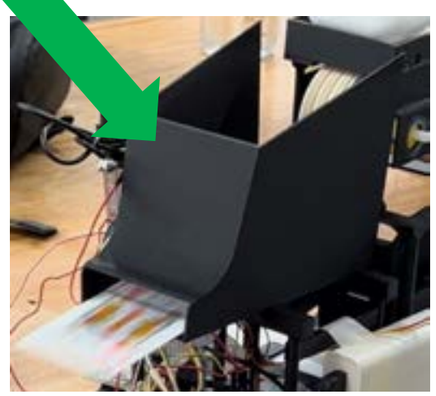


Card delivery

We planned the card delivery system to work two ways - one to eject the cards towards players, the other to move the cards to the flipping mechanism or eject it from the dealer's side.

We tested various angles of the ejection platform. Incline made the cards fly and flip and decline didn't eject the cards far enough. We decided to use a surface parallel with the floor. This was a good compromise between range and reliability.





DESIGN PROCESS 2

Interactive sensors

For the interaction, we wanted to make it as close to real life blackjack conventions as possible. Meaning that we had to implement a tap detection for hitting and wave detection for standing.

Tap = Hit

For tap detection, 2 solutions were considered:

1. Trill sensor for conductive touch detection

- Difficulties hiding the sensors & making it blend in
- Tap has to be very precise for it to work

2. Piezo sensor for vibration detection

- Responsive even at lower accuracy
- Easy to implement (Bela forum [1])
- Easy to hide

Wave = Stand

For waving, also 2 solutions were considered:

1. Light dependent resistor (LDR)

- Too short range
- Sensitive to different lighting conditions

2. IR sensor

- Adjustable higher range of detection distance
- Works flawlessly in dark settings (casino)
- Less wiring & easy to control

Finishing touches

Bowtie [2]

- Adds a touch of sophistication, aligning with the upscale and formal atmosphere of blackjack tables.
- Pays homage to the classic attire of casino dealers, creating a sense of tradition and nostalgia identity.

Game Fabric

- Covering cables with fabric creates a clean and polished appearance, contributing to a visually appealing design for the blackjack robot.
- Allows for visual clues as to the operation of the robot.

Acrylic Plate

- Allows cards to slide smoothly, enhancing the functionality of the robot during card handling. This feature ensures efficient and precise card movements in the game.

Cable Managment

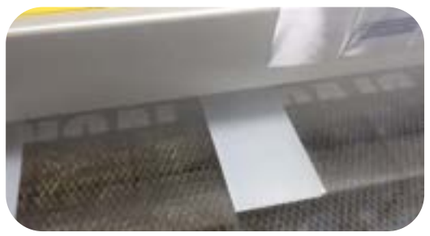
- Cables run in a well thought out way to minimise the chance of any wires coming loose or shorting and allow for easier debugging.

Manufacturing

3D printing

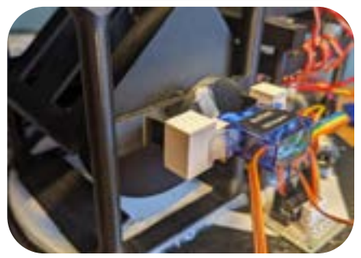
- CAD modelling for idea visualisation, testing & gcode generation
- Utilized 3D printing for complex geometries
- Most used technique in this project

Laser Cutting



- Used for flat parts
- Very efficient way of manufacturing simple geometries
- Etching used for aesthetic reasons

Joining Techniques



- Precise tight-fit joints used to connect different parts to each together
- Adhesive used to secure components
- Guiding geometries for assembly

Soldering

- Used to create strong and fixed electrical connection between wires and actuators
- Much more reliable than temporary methods

Future Improvements

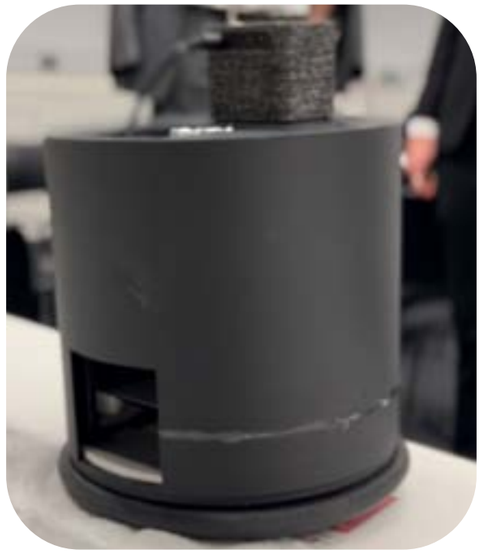
- Visual recognition of cards with machine learning
- Dealer's face-down card flipping mechanism for end-game
- Better DC motors for dispensing and ejecting cards
- Visual recognition of players' positions for dealing cards directly
- Interactive controllers integrated into the playing table or into a cloth

1. https://github.com/BelaPlatform/Bela/wiki/Example-projects-and-tutorials#sample-piezo
2. https://grabcad.com/library/bowtie

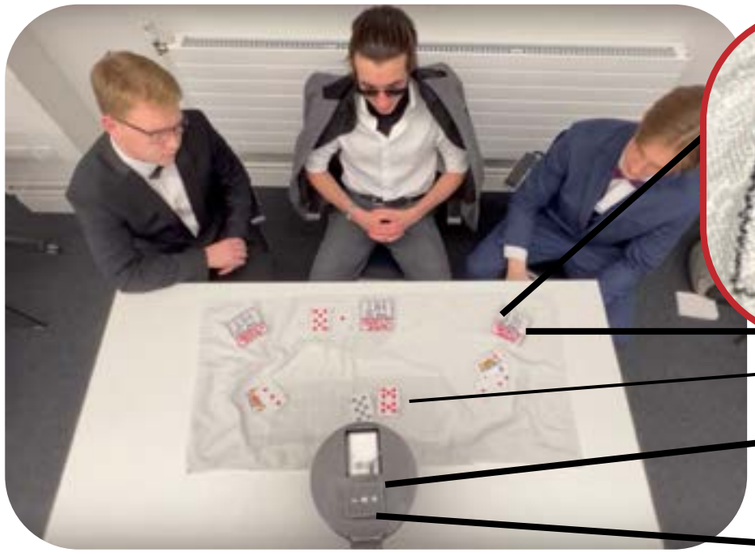
FINAL PRODUCT OVERVIEW

Players' Cards Dispenser

Dealer's Cards Dispenser

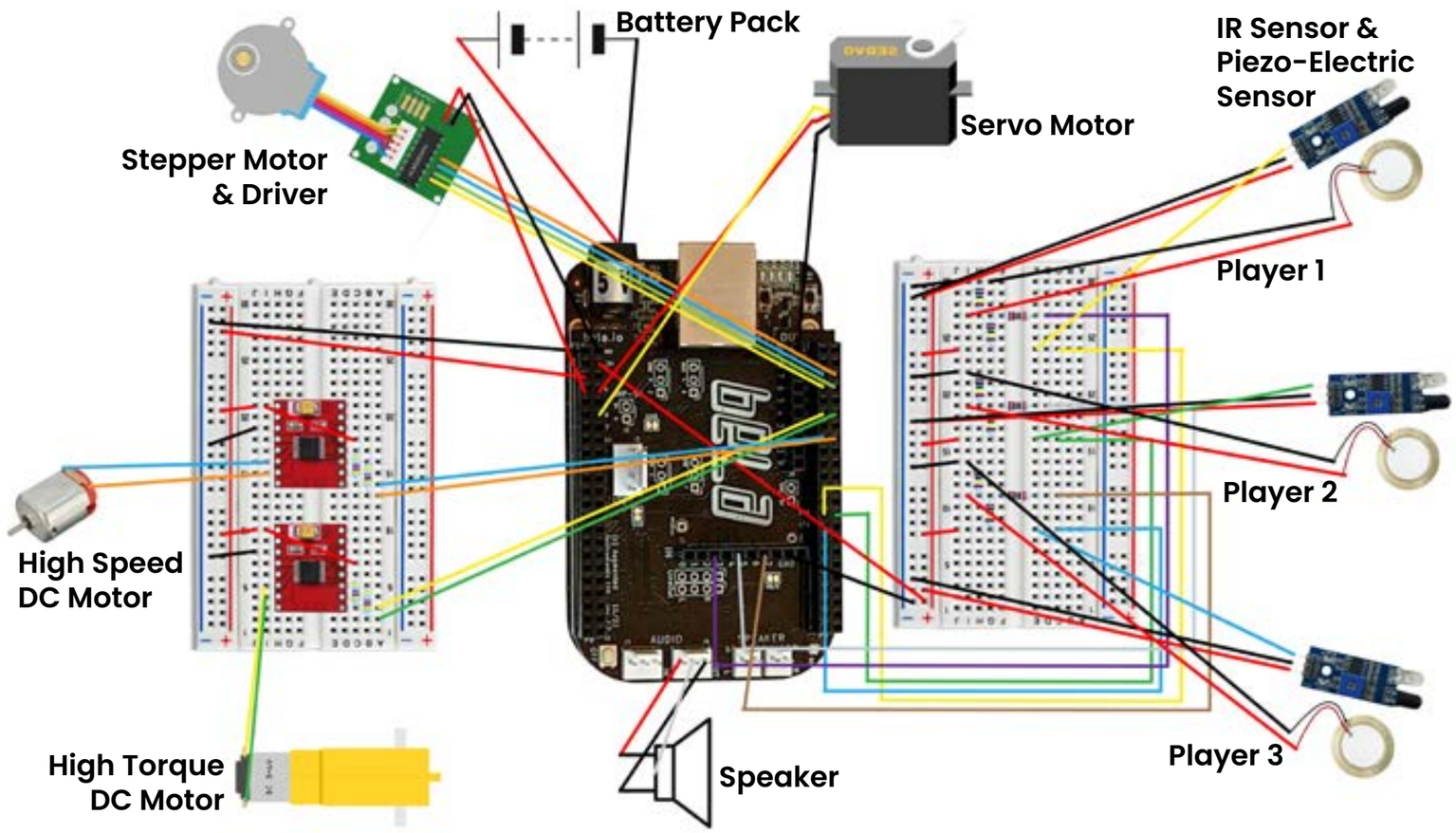


Example Game Play



The Construction

Circuit diagram



An Example Run: https://youtu.be/f2dUTYX-TN4
Presentation Video: https://youtu.be/Sd-Dzjxv1iA