RFID Poker Table

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Introduction

Problem Statement

Live poker has a unique social and tactile appeal, but it also comes with challenges that online poker has largely solved. In casual games, players and dealers must manually track cards, blinds, and betting order, which often leads to mistakes such as misdeals, misreads, or losing track of the action. Unlike online platforms, live games lack conveniences like automatic hand evaluation, win probability calculations, and game state visualization. As a result, live poker can feel slower, less precise, and less accessible, especially for new players who may struggle to keep up with the rules and flow of the game.

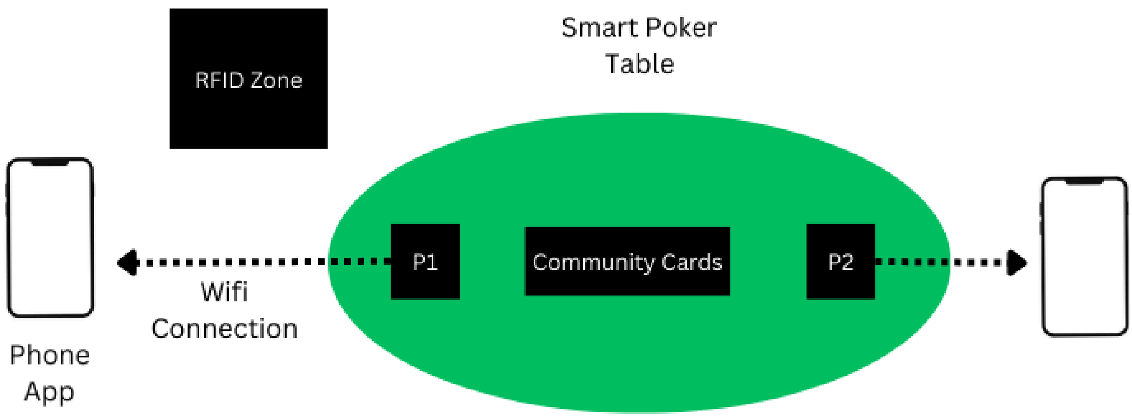
Solution

To address the challenges faced by casual poker players, we propose a smart poker table that integrates RFID technology and a companion app to track game state in real time. The table will automatically detect each player's hole cards, the community cards, and when a player folds, reducing errors and eliminating the need for players to constantly monitor the game manually. A companion user interface for each player will display key information such as their own cards, the community cards, whose turn it is, blinds and dealer positions, and fold status. By providing these visual cues and game updates, the system brings the benefits of online poker into the live experience.

Our system is designed specifically for Texas Hold'em, assuming standard rules. The MVP focuses on the core functionality: RFID scanning for players' cards, community cards, and a dedicated fold spot; a cross-platform UI for each player to display the current game state; and automated tracking of dealer position, blinds, and turn order. The system will use RFID antennas embedded in the table connected to a central microcontroller that scans cards in real time and communicates updates to the app over Wi-Fi.

In addition to the core MVP, several stretch goals could further enhance the live poker experience. Chip tracking using computer vision would allow the system to automatically detect each player's bets, updating the pot size and individual holdings in real time without disrupting gameplay. LED indicators embedded in the table could visually highlight the dealer position, blinds, active turns, and folded players, giving players clear, intuitive cues without needing to constantly check the app. A GTO-based move suggester could provide strategic recommendations, helping casual players make better decisions and learn optimal play patterns. Recording action history and hand logs would allow players to review previous hands for analysis or learning purposes. Finally, a spectator mode could present all hole cards and game probabilities in a view-only interface, enhancing the social and entertainment aspects of live poker.

Visual Aid

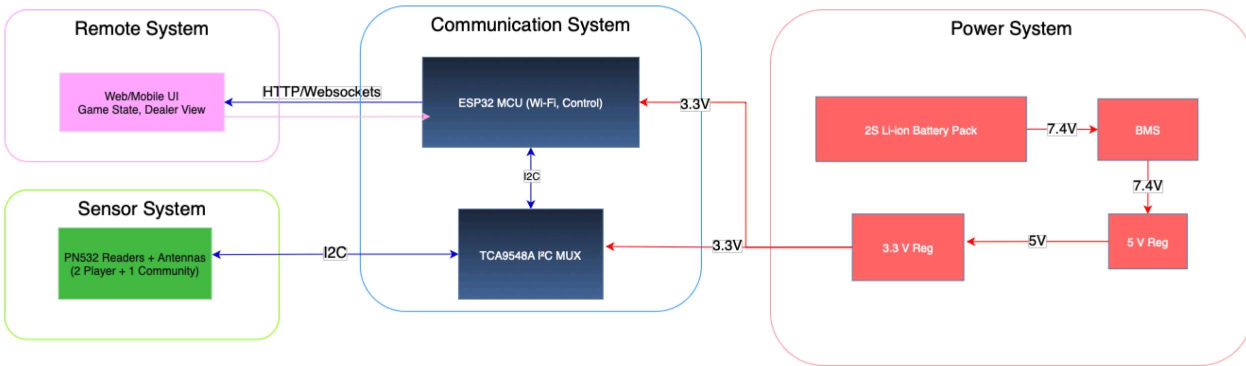


High Level Requirements

- The system must accurately detect and track each player's hole cards, the community cards, and folds with at least 95% reliability during a standard Texas Hold'em hand.
- The companion app must update the game state, including turn order, dealer position, and blinds, within 5 seconds of any change on the table.
- The user interface must clearly display each player's relevant game information, including their hole cards, community cards, turn indicators, and fold status, in a manner that is intuitive for casual poker players.

Design

Block Diagram



Subsystem Overview

Our design is divided into four primary subsystems: the power system, the communication system, the sensor system, and the remote system. Each subsystem performs a specialized role but is closely interconnected to achieve seamless detection of playing cards and real-time display of game information. The power system ensures stable operation across all electronics, the communication system manages control and data flow, the sensor system detects and identifies cards using RFID, and the remote system provides the user-facing game interface. Together, these subsystems form a complete design that converts physical card placement into a digital game state accessible to players and dealers.

Power System

The power system supplies stable voltages to all other subsystems. A 2S Li-ion battery pack (7.4 V nominal) acts as the main energy source, with a Battery Management System (BMS) providing safety features such as overcharge, over-discharge, and short-circuit protection. The regulated output is stepped down through a 5 V regulator, and then further to 3.3 V via a dedicated regulator to power the ESP32, multiplexer, and RFID reader (PN532) modules. By distributing the correct voltage rails, the power system ensures reliable operation and protects sensitive electronics across the table.

Communication System

The communication system serves as the control and coordination hub. It is built around the ESP32 MCU, which manages Wi-Fi connectivity and system logic, and the TCA9548A I²C multiplexer, which enables multiple RFID readers to share the same I²C bus without address conflicts. The ESP32 communicates with the remote system over HTTP or WebSockets, sending detected card data and game states. Within the local system, it handles I²C commands to select and read from specific PN532 modules. This subsystem bridges the sensor data with the remote interface while managing all logic flow.

Sensor System

The sensor system consists of PN532 RFID readers paired with antennas, positioned under the table at each player's position and the community card area. These readers detect HF (13.56 MHz) RFID tags embedded in the playing cards, identifying which cards are in play. Data from the readers is transmitted over I^2C into the TCA9548A MUX, which routes it to the ESP32 for processing. The sensor system provides the raw game state input, directly translating the physical playing card data into digital data for the rest of the system.

Remote System

The remote system is responsible for user interaction and game visualization. It consists of a mobile user interface that displays player hands, community cards, and card odds in real time. The ESP32 communicates wirelessly with this interface using HTTP requests or WebSocket connections, allowing for low-latency updates. Furthermore, the players and dealers using the mobile interface on their phones can input if they are folding out of the game and when the game is over. The remote system ensures that players and dealers have an intuitive, accessible interface of the game.

Subsystem Requirements

Power System

The power system provides stable operation to all electronic components. It consists of a 2S Li-ion battery pack (7.4 V nominal), a BMS, a 5 V regulator, and a 3.3 V regulator. The 5 V rail powers RFID modules, while the 3.3 V rail powers the ESP32 and multiplexer.

Contribution: Without regulated and stable voltage, RFID readers or the ESP32 would fail, preventing game state detection.

Interfaces: Provides 5 V ± 0.1 V at ≥500 mA for RFID modules and 3.3 V ± 0.05 V at ≥250 mA for logic components. Interfaces electrically with the communication and sensor subsystems.

Requirements:

- Must continuously supply ≥750 mA at 5 V ± 0.1 V.
- Must continuously supply ≥300 mA at 3.3 V ± 0.05 V.
- Must operate for at least 1 hour on a single charge.
- BMS must prevent overcharge (>8.4 V) and over-discharge (<6.0 V).

Removing any of these requirements would compromise runtime or damage components.

Communication System

The communication system is built around the ESP32 and I²C multiplexer. It processes sensor inputs, runs game logic, and sends updates wirelessly to the remote system.

Contribution: Provides the logic backbone for detecting and distributing game state.

Interfaces: Reads card IDs from the sensor system via I²C (3.3 V logic, 100–400 kHz clock). Sends JSON packets to the remote system via Wi-Fi (2.4 GHz, latency ≤200 ms). Controls RFID readers via the multiplexer.

Requirements:

- Must process RFID reads and broadcast updates within ≤5 seconds.
- Must support simultaneous polling of up to 3 RFID readers.
- Must maintain a Wi-Fi link at ≥90% uptime during operation.
- Must store turn order and dealer state in non-volatile memory during resets.

Sensor System

The sensor system consists of PN532 RFID modules with antennas positioned under player and community card zones.

Contribution: Converts physical card placement into digital input for the system.

Interfaces: Communicates card IDs to the communication system via I^2C. Requires 5 V ± 0.1 V power supply. Antennas detect RFID tags embedded in playing cards at distances of 2–4 cm.

Requirements:

- Must detect standard HF RFID tags (13.56 MHz) with ≥95% reliability.
- Must differentiate between up to 2 cards placed simultaneously on one antenna (player hole cards).
- Must detect a card placement/removal within ≤2 seconds.
- Must not falsely detect cards outside designated zones.

Removing these requirements would lead to missed detections or false reads, making the system unusable.

Remote System

The remote system is a mobile UI displaying player hands, community cards, and turn information.

Contribution: Provides players with intuitive access to the game state, enabling usability.

Interfaces: Receives JSON updates from the communication system over HTTP/WebSockets. Displays data in a cross-platform app (Android/iOS). Accepts player inputs (fold, hand reset) and sends them back to the ESP32.

Requirements:

- Must display updated game state within ≤5 seconds of change.
- Must run on both iOS and Android devices.
- Must enforce access control so players only see their own hole cards.
- Must maintain connectivity with ≥95% reliability.

Tolerance Analysis

One critical challenge for the RFID Poker Table is reliable detection of multiple cards placed on a single antenna, as each player must hold two hole cards. RFID readers like the PN532 can sometimes fail to distinguish between closely stacked tags due to electromagnetic coupling or orientation misalignment.

The HF RFID protocol (ISO 14443A) supports anti-collision mechanisms, but in practice, simultaneous reads can be inconsistent. For example, if one PN532 antenna can reliably detect a single card at 95% accuracy, stacking two cards reduces detection reliability to ~85–90% without careful tuning. To ensure feasibility, we plan to:

- Use card-grade thin RFID inlays with tuned antenna orientations to minimize coupling.
- Optimize PN532 polling frequency (~30 ms per cycle) to allow multiple read attempts within the 2-second requirement.
- Run tests on stacked-tag detection and adjust antenna placement (e.g., small lateral offset in the fold zone) to improve accuracy.

Mathematically, the probability of failing to detect both cards in a 2-second polling window can be modeled as:

$$P_{fail}=(1-R)^N$$

Where R is the per-cycle detection reliability (e.g., 0.90 for stacked tags) and N is the number of polling attempts in 2 seconds (≈66 at 30 ms per attempt). With R=0.90,

$$P_{fail}=(0.10)^{66}\approx 10^{-66}$$

which is effectively zero, demonstrating feasibility if rapid polling is implemented.

Ethics and Safety

The RFID Poker Table raises important ethical considerations, particularly around gambling. While the project is intended for recreational and educational purposes, there is a risk it could be misused in unregulated gambling settings. According to the IEEE and ACM Codes of Ethics, engineers must prioritize public welfare and ensure that technology does not encourage harmful or illegal behavior. To address this, we will clearly document that the system is not designed for commercial or profit-driven gambling, but instead as a learning tool to enhance casual play. We will also implement safeguards such as encryption and controlled access so that the system cannot be exploited to gain unfair advantages, such as revealing opponents’ cards.

Beyond gambling concerns, ethical responsibilities extend to fairness, transparency, and honesty in development. We will report limitations accurately, such as potential RFID read errors, and avoid overstating capabilities like chip tracking or AI strategy suggestions. Ensuring fair play is also an ethical duty, our app and system will be designed to display only the information each player is entitled to see, preserving the integrity of the game. By aligning with IEEE principles of honesty and fairness, we aim to prevent misuse that could undermine trust in the system.

From a safety perspective, the project must comply with relevant standards and campus policies. The use of a Li-ion battery requires proper handling and protection under IEEE and UL safety standards to prevent overheating or short circuits. RFID readers operate at low power within FCC Part 15 limits, but we will still ensure compliance to minimize any risk of harmful exposure. Prototyping activities such as soldering and working with exposed electronics will follow lab safety policies, including protective equipment and safe handling procedures. By proactively considering both ethical and safety issues, the project balances innovation with responsibility, ensuring it benefits players without creating unnecessary risks.