Bench Organizer Proposal

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ECE 445 - Senior Design

1 Introduction

1.1 Problem and Background

Most desk organizers function only as storage compartments without actively helping users maintain organization or productivity. Small but frequently used items such as pens, keys, and tools are often misplaced, leading to unnecessary time spent searching for them. While digital organization tools exist, they do not integrate well with physical workspaces. A solution is needed that combines digital tracking with physical organization to help users maintain a tidy workspace effortlessly.

1.2 Solution with Visual Aid

Our proposed **Bench Organizer** is a *smart desk organizer* that uses **RFID technology** to track items and notify users when they are missing or misplaced. The system will include:

- **RFID/NFC tracking** to detect item presence in designated slots.
- **Visual and audio alerts** (LEDs and buzzer) when an item is misplaced or missing.
- **Bluetooth notifications** to send reminders to a smartphone or computer.
- **A custom PCB** to integrate and manage all electronic components efficiently.
- **(Optional)** Wireless charging pad for convenience.

1.3 High-Level Requirements

1. The system must detect and track **at least 90% of tagged items correctly** within 2 cm of the RFID reader.
2. The organizer must provide **real-time notifications** through LEDs, buzzer alerts, or Bluetooth within **1 second** of detecting a missing item.
3. The system should function **under normal indoor lighting conditions** and work effectively on a standard desk setup.

2 Design and Requirements

2.1 Block Diagram

The Bench Organizer consists of three main subsystems:

- **Item Detection (RFID/NFC Reader)**: Reads RFID-tagged items and checks their presence.
- **Notification (LED, Buzzer, Bluetooth)**: Alerts the user when items are missing.
- **Custom PCB (Power Management Microcontroller)**: Ensures proper power distribution and communication between components.

2.2 Subsystem Descriptions

Item Detection Subsystem:

- **Technology:** RFID/NFC tracking.
- **Components:** PN532 RFID Reader, NFC Tags.
- **Functionality:** Reads item tags, verifies placement, and signals the notification subsystem.

Notification Subsystem:

- **Technology:** LED indicators, buzzer, Bluetooth module (HC-05).
- **Functionality:** Alerts users when an item is missing via LEDs, sound, and Bluetooth notifications.

Custom PCB Subsystem:

- **Technology:** Microcontroller (Arduino or ESP32), voltage regulators.
- **Functionality:** Integrates all components, manages power distribution and signal processing.

2.3 Subsystem Requirements

- **RFID detection** must work for items within **2 cm of the reader**.
- **Alerts (LED, buzzer, Bluetooth)** must activate within **1 second** of detecting a missing item.
- **Power consumption** should not exceed **500mA at 5V** to ensure efficiency.

2.4 Risk Analysis

The biggest challenge is ensuring **RFID accuracy** and minimizing **false negatives** (when an item is present but not detected).

- **Potential risks:** RFID interference, range limitations, power inefficiencies.
- **Mitigation strategies:** Optimizing antenna placement, software filtering, power management.

3 Ethics and Safety

3.1 Ethical Considerations

Our project follows IEEE/ACM ethical guidelines, ensuring user **privacy, safety, and accessibility**. Key considerations include:

- Ensuring **data privacy**: The system does not store or transmit sensitive user information.
- Reducing **electronic waste**: Designing an **energy-efficient PCB** to minimize power consumption.

3.2 Safety Considerations

- **Electrical Safety:** Low voltage operation (5V), circuit insulation.
- **Mechanical Safety:** Enclosures to prevent accidental short circuits.
- **Lab Safety:** ESD protection during PCB prototyping.
- **User Safety:** RFID operates within standard consumer device limits, ensuring no harmful radiation exposure.

4 Citations and References

All references are formatted according to IEEE citation guidelines.

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