Case study: Creating a functional project combining software-hardware elements

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Project Summary

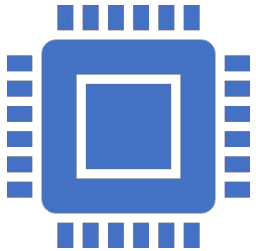
Design a smart toolbox that can:

Detect and distinguish different tools being held by a user

Indicate where to the user where to put the tool

General Design

Attached each tools with a key tag and use radio-frequency wave electrical components to detect and distinguish between tools

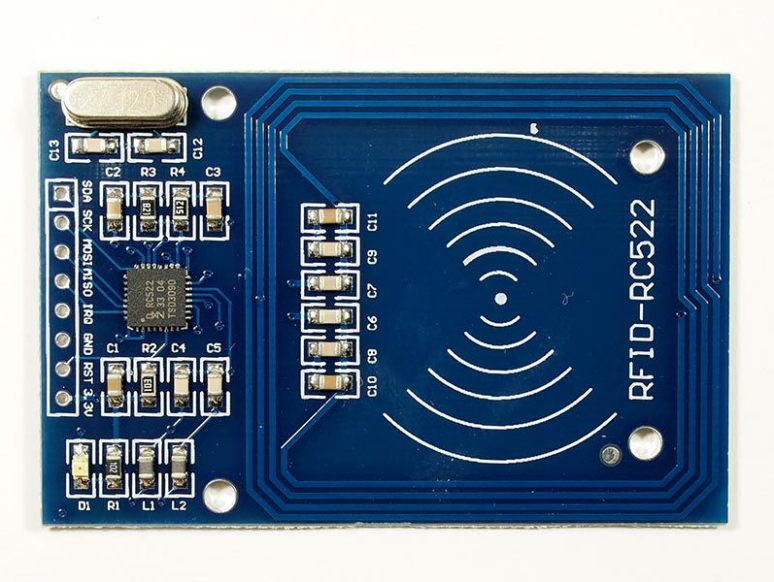


Use a microcontroller (Arduino Uno) to store software to process information

Use LEDS to show the user where to put the tool in the toolbox

Notable Hardware Components

- Sensor: MFRC522 RFID Reader:
  - Continuously emits radio frequency into the surrounding
  - Capable of receiving inbound signal from nearby tags
- Detection: RFID key tag:
  - Passive components attached to tools
  - Awaits radio wave to be energized
  - Relay signal (Unique ID) back to sensor

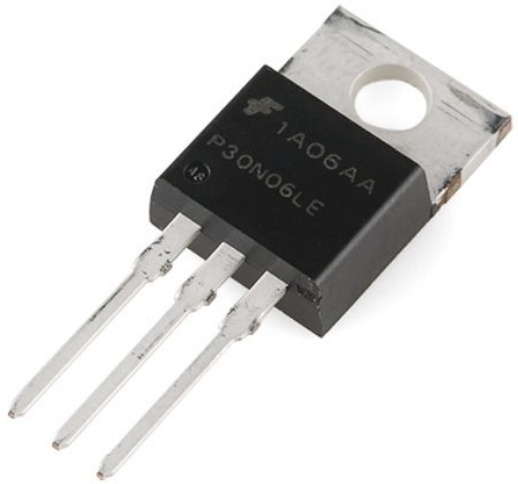


Radio wave

Relay ID

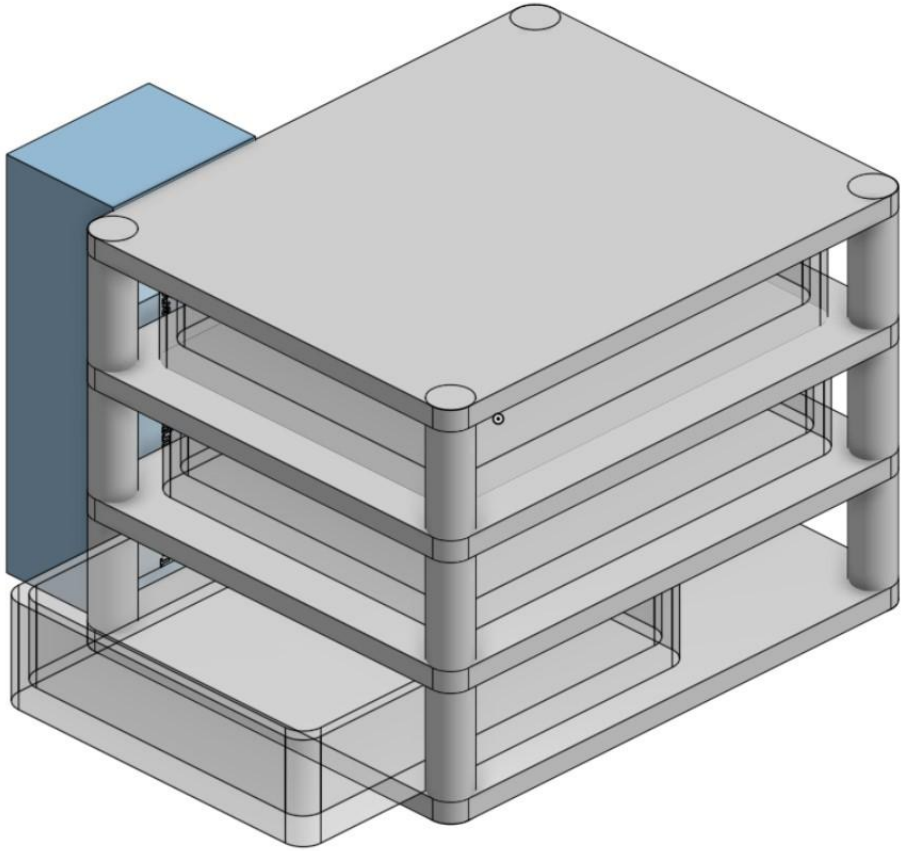
Notable Hardware Components

- MOSFET connected with Arduino Uno to direct current -> allow Arduino to control and lit up the correct LED

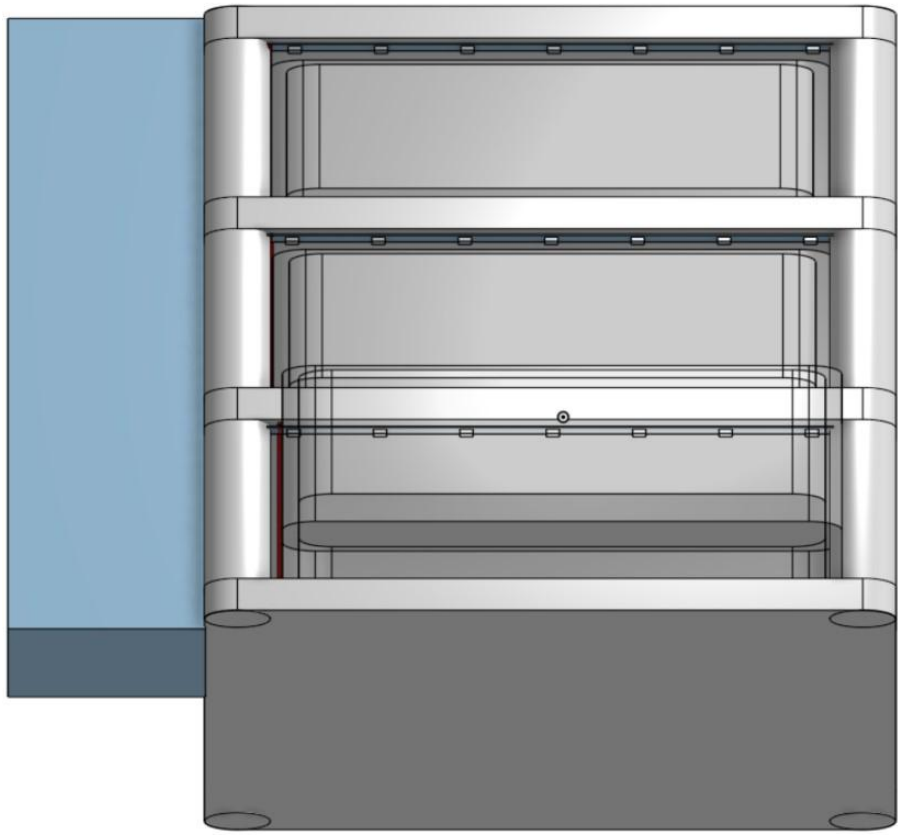


Product Visualization

Arduino/electrical housing



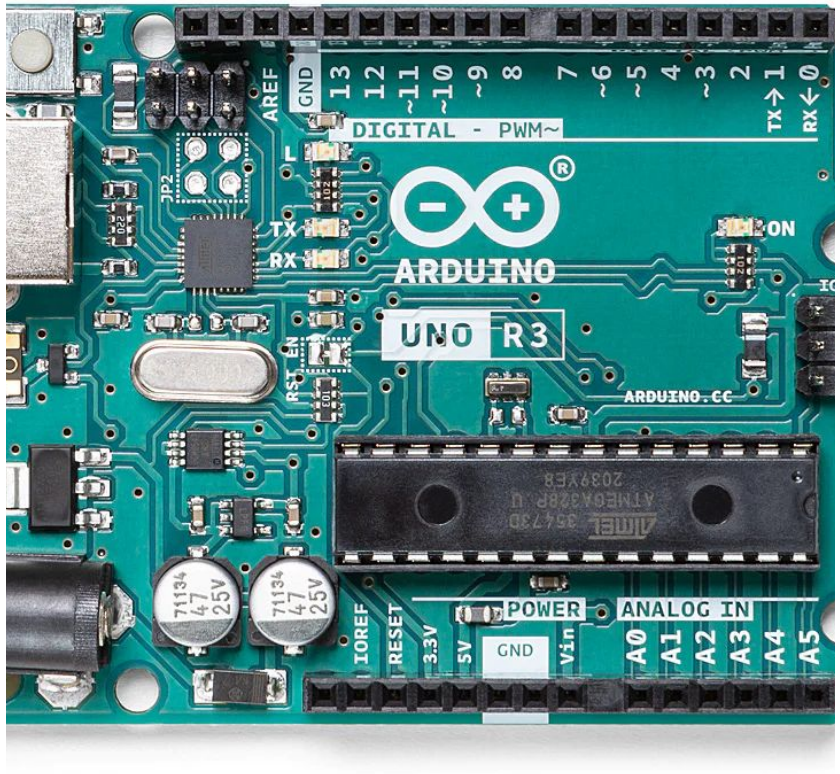
Overhead View



View of LED Strips

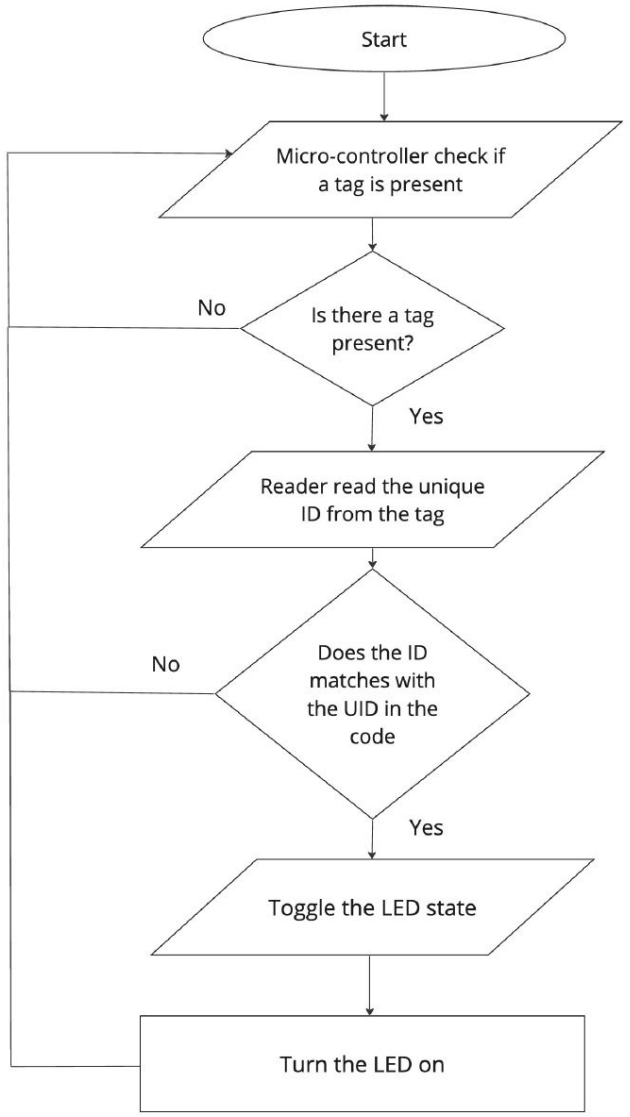
Software/Programmable Components

- Arduino Uno:
  - Microcontroller with digital and analog pins.
  - Programed/coded through the Arduino IDE.
  - Powered using a battery or through USB cable.



Software/Programmable Components

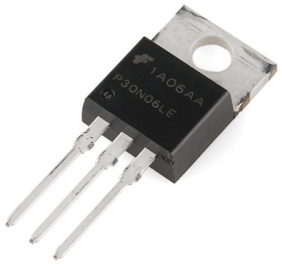
- Outer while loop to continuously check for a tag present
- Simple if-else logic to handle the ID of the tag detected

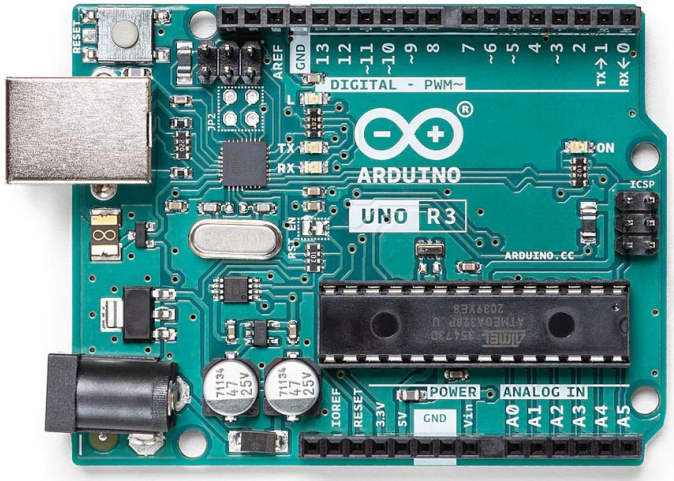


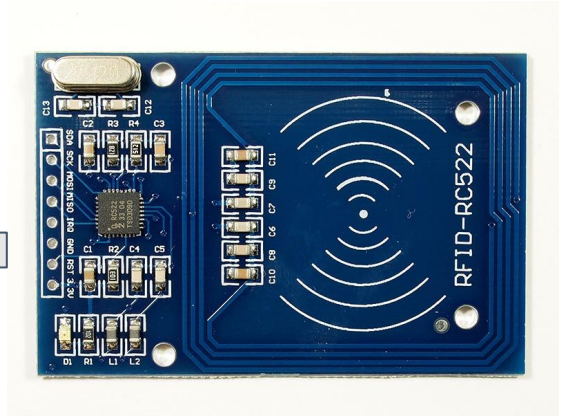
Full Design

2: Process signal/ID

1: Retrieves ID







3: Turns on LED

4: Repeat

Significance

- Efficient design: fast processing/delay time for software, hardware wiring efficiently wired to ensure fast and correct execution
- User-friendly design: intuitive user experience, modular code, software should work for every RFID key rings in design, etc.

=> In products, hardware and software are closely connected, important as both software and hardware engineers!