Smart Tool Chest

Project Proposal

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1. Introduction

1.1 Statement of Purpose

Frequently, when working at a lab or workshop, there is a community tool chest. Many times, tools are misplaced or lost and some employee must then spend company time tracking down these tools. This product would allow automatic tracking and accountability for missing tools, by managing tool inventory, logging user identity, and even monitoring frequency of use. This system would be integrated into a tool chest, rather than being installed separately.

1.2 Objectives

1.2.1 Goals & Benefits

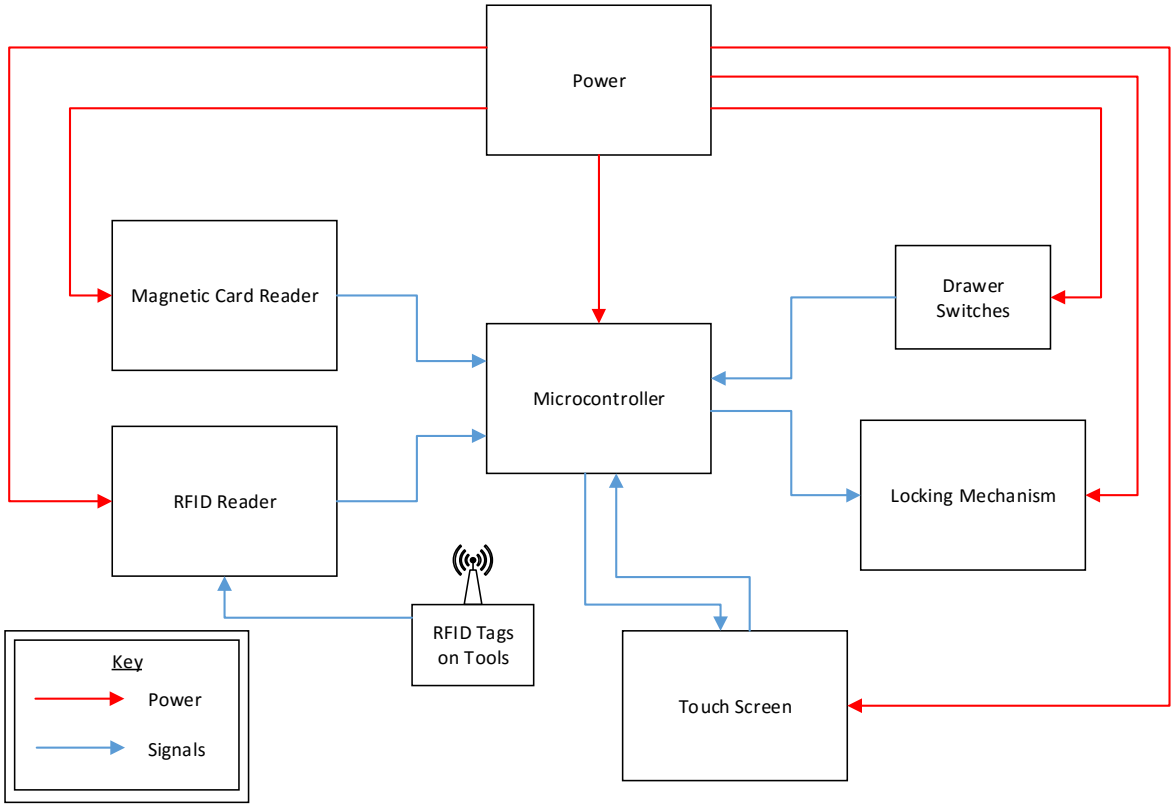
- Automatically monitor tool chest inventory
- Provide system of accountability for removed tools
- Frequency tracking statistics allow better company allocation of tool budget
- Less time required to track down missing tools

1.2.2 Functions & Features

- Sense tool availability with RFID tags
- Touch screen for tool organizing and tracking
- Magnetic card reader for unlocking and user tracking
- Controller mounted atop chest as central hub for system and IO
- Powered via standard wall socket

2. Design

2.1 Block Diagram



2.2 Block Descriptions

2.2.1 Power

The power source will use a wall outlet. We will convert the 120V AC source to 5V DC using a standard power adapter.

2.2.2 Microcontroller

The microcontroller serves as the central hub for IO as well as the decision making part of the system. It receives input from the switches, the card reader, and the touch screen to make decisions about what tools are present in the tool chest, whether to lock the chest, and what data to display on the touch screen.

2.2.3 RFID Reader

We will use an RFID Reader to track which tools are currently within the tool chest. The reader will sit on the inside of the tool chest at the top of the casing. The reader will be a chip mounted on our controller board and will use ultra-high frequency radio waves for the best reception inside the tool chest.

2.2.4 RFID Tags on Tools

The RFID Tags will be attached to the tools with some adhesive. The tags must come with an antenna attached and must be flexible to adhere to the curved surfaces of different tools. They will also be thin enough to not interfere with the use of the tool. They will be passive tags so they do not require an extra power source attached to the tool.

2.2.5 Magnetic Card Reader

The magnetic card reader will serve as an authentication tool to indirectly control the locking mechanism on the tool chest, through the microcontroller. It will also track the user's identity as they add and remove tools from the tool chest.

2.2.6 Locking Mechanism

The locking mechanism will accept input from the microcontroller to lock and unlock the tool chest. The mechanism itself includes a servo, which will rotate a bar to unlock the chest drawers, using parts of a built in key-lock. The magnetic card reader will provide the information necessary for the microcontroller to decide the state of the lock.

2.2.7 Touch Screen

The touch screen allows the user to interact with an on-board application to change tool and user settings, check the inventory, and view tool statistics. The touch screen will communicate exclusively with the microcontroller.

2.2.8 Drawer Switches

The drawer switches allow the microcontroller to detect whether the drawers are open. In order to prevent multiple tool state changes while the drawer is open, the state of each tool will only update once the drawer has been closed. The switches will be located behind the drawers inside the case in order to be depressed when the drawers are closed.

3. Block Level Requirements and Verification

3.1 Requirements and Verification Table

Component	Requirement	Verification	Points
Power:	a. Supply 5V +/- 0.2V b. Supply 1A +/- 0.15A	a. Use a digital multimeter in parallel with the power supply to measure its voltage and verify it is 5V +/- 0.2V b. Use a digital multimeter in series with the power supply to measure its current and verify it is 1A +/- 0.15A.	10
Microcontroller:	a. Must be able to output high voltage greater than 1.155V b. Must be able to output low voltage less than 0.99V	a. Use a digital multimeter in parallel with the microcontroller pins to measure that high voltage is at least 1.155V b. Use a digital multimeter in parallel with the microcontroller pins to measure that low voltage is at most 0.99V	25
RFID Reader and Tags:	a. Must be able to read tags anywhere in the box b. Must not read items outside the box	a. Place RFID tags at the corners and bottom of case as well as underneath tools, test RFID readability b. Place tags near drawer openings to see if there is signal leakage into the case.	20
Magnetic Card Reader:	a. Produce consistent and accurate result when card is read	a. Scan the same card multiple times, make sure the data read is the same (and correct)	10
Locking Mechanism:	a. Servo must be able to rotate the tool chest's locking mechanism	a. Attach servo to tool chest's locking mechanism, should be able to unlock drawers	10
Touch Screen and Application:	a. Must display data from tool database b. Must allow user touch input	a. Check touch screen to see if tool data is displayed b. Verify proper signal feedback after touching display at multiple locations	20
Drawer Switches:	a. Must be able to sense when drawers are closed	a. Verify high input to microcontroller from switches when drawer is closed.	5

3.2 Tolerance Analysis – Power Supply

In order for our project to function correctly, the power supply must provide enough power for all of the component. We determined that the acceptable tolerance for the voltage output of this supply is 5V +/- 0.2 V since the servo motor cannot accept voltage input lower than 4.8V, and all other components have a maximum voltage ratings above 5.2V. The current minimum threshold was determined by summing all of the maximum current requirements of all of the components (refer to Table 3.2.1). The total current was 830.4mA, so we'll need to make sure our system always has that much power available. Therefore, the current supply must be 1A with a tolerance of +/- 0.15A.

Test Procedure:

When all the components are connected, use a digital multimeter in parallel with the power supply to measure the voltage around the supply and verify it is 5V +/- 0.2 V, then use the multimeter in series with power supply to measure the current flow to verify it is 1A +/- 0.15A.

Component	**Max Current Draw**
Microcontroller	0.4mA
RFID Reader	80mA
Magnetic Card Reader	100mA
Locking Mechanism (Servo)	500mA at stall
Touch Screen	150mA
Total	**830.4mA**

Table 3.2.1

4. Cost

4.1 Labor

Name	Hourly Rate	Total Hours Invested	Total Cost
Kevin	$31.00	150	$11,625.00
Devansh	$31.00	150	$11,625.00
Total			$23,250.00

4.2 Parts

Part Name	Part Number	Quantity	Total Cost
Tool Chest	HTA-102B12	1	$49.00
Microcontroller	ATmega324A	1	$6.15
RFID Reader	AS3990	1	$40.17
RFID Tags	AD-227m5	20	20 x $0.68 = $13.60
LCD Touch Screen	Adafruit HXD8357D	1	$39.95
Magnetic Card Reader	Hi-Co MSR90	1	$18.60
Servo Motor	Hitec HS-5055MG	1	$17.99
Push Button Switches	COM-00097	2	2 x $0.35 = $0.70
Power Supply	TSA1-050120WA	1	$5.00
PCB		1	$40.00
Total			$231.16

4.3 Grand Total

Section	Price
Labor	$23,250.00
Parts	$231.16
Grand Total	**$23,481.16**

5. Schedule

Week	Task	Member
Sept 20	Write design review	Kevin
	Draw schematics & diagrams, order parts	Devansh
Sept 27	Plan layout for components in chest	Kevin
	Layout PCB	Devansh
Oct 4	Set up microcontroller on breadboard/interface with card reader	Kevin
	Remove lock, install servo, case wiring	Devansh
Oct 11	Interface with servo	Kevin
	Finalize PCB, solder components	Devansh
Oct 18	Connect touch screen/ Add RFID Reader	Kevin
	Add RFID tags to tools, test signal strength inside & outside tool chest	Devansh
Oct 25	Finish RFID, begin UI	Kevin
	Prepare mock demo, solve RFID connectivity issues	Devansh
Nov 1	Continue UI development	Kevin
	Test entire system, begin debugging system	Devansh
Nov 8	Finish UI development, begin debugging	Kevin
	Complete system debugging, install housing for system components	Devansh
Nov 15	Continue application debugging	Kevin
	Install complete system in tool chest	Devansh
Nov 22	Complete application debugging	Kevin
	Prepare demo, debug	Devansh
Nov 29	Begin final paper	Kevin
	Finalize demo, finish debugging	Devansh
Dec 6	Finalize final paper	Kevin
	Finalize presentation	Devansh