Smart Electronic Component Organizer

Kaiwen Zhao
Canlin Zhang
Yihao Deng

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TA: Yichi Zhang

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1. Introduction

1.1 Objective

As EE students, most of us have stored many electronic components such as resistors, capacitors and MOSFETs. Traditionally, we would store these components in storage organizers, a huge cabinet with many transparent plastic drawers. A small organizer may only have as few as 20 drawers. However, a larger one can have up to a hundred organizers. A big problem is that people usually cannot immediately locate the components they want. They have to look into the transparent boxes or at the tags one by one, wasting a lot of time.

We propose a solution to this problem by creating a logger with indicators for people to better store and find components. It would also consist of mechanical designs to push the drawers out from the back. People would use the logger to either assign a certain drawer to a certain component or command the automated stick to push out the drawer with the component they need. The logger would have a simple LCD screen and buttons (with labels of 0 to 9 and r, c, l, ic, value, number, enter, eject and clean). Users would be able to log new components and find logged components using the screen and the button. To find a certain component, users would use the buttons to specify the component they want. For example, if user types r, 0603, value and 200 and presses enter, the indicator (a LED) of the drawer which user registered before for this component would be lit. If the user presses the eject button, the specified drawer would be pushed out from the back.

1.2 Background

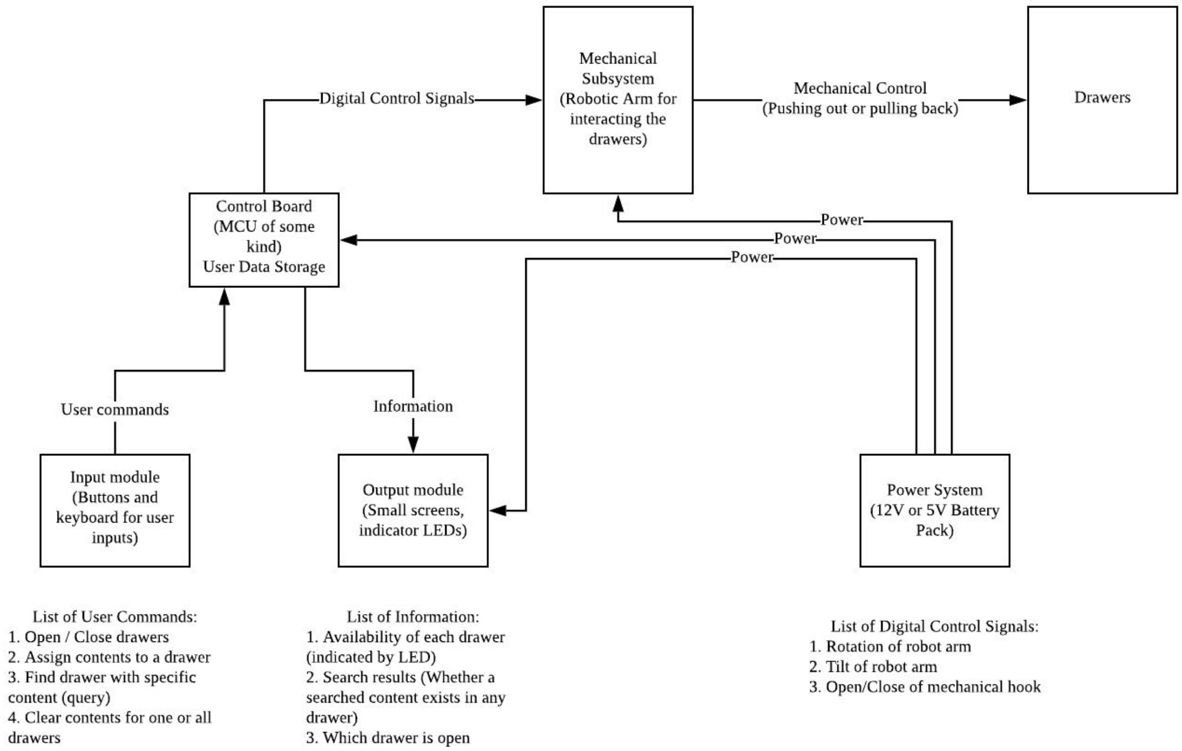
It is not a new idea to digitize boxes or lockers for better management. Though most of the lockers are accessed only by mechanical keys, many electronic lockers have been introduced to the market and deployed by mew department stores and apartments. However, hardly anyone considered bringing a digitized box management system to smaller instances, for example, an electronic components organizer. Although every experienced engineer would be used to find data in datasheets and lookup tables as well as to find a certain type of components out of hundreds of boxes, it would still waste much time. Because there is currently no widely-used and affordable digitized organizers on the market, the smart electronic components organizer is proposed to fill the white space.

1.3 High-level Requirement List

- Users are able to register new components into the system
- After users input relevant information of the electronic components they request, they should be able to quickly locate these components with the help of a prompt message on LCD screen, a LED in the corresponding drawer, and the opened drawer (most obvious).
- The organizer should be able to open and close the corresponding drawers for users by a mechanical structure resembling a robot arm (with three straight sections, two rotating nodes and one small clipper at the tip) behind the organizer.

2. Design

2.1 Block Diagram



- The user would enter the commands and information to the input module, and the user inputs would be transmitted to the control board for further processing.
- The user information would be displayed or indicated by the output module. The user information will be sent to the output module by the control system.
- All physical operations would be performed by the mechanical system, the control signals are sent from the control board to the mechanical system.
- All systems that need power to operate will be powered by the power system.

2.2 Functional Overview & Block Requirement

- Power system
  The power system is used to supply power for control board (MCU), output module (LEDs and the screen) and mechanical subsystem (robot arm). The power system would consist of a 12-volt or 5-volt battery pack or wall adapter.
  The power system mainly outputs 5V or 12V DC, and we estimate a total power usage of around 20 Watt (5 Watts for the MCU, 2 Watts for the screen and LEDs and 10 Watts for the mechanical system) should be sufficient for the system to function normally.

  Requirement 1: The power system must be able to supply power to the control system, output modules and mechanical system without any malfunction when the system is powered on.

- Control system
  The role of the control system is three-fold.
  First, the control system should be able to accept and process user inputs (user commands).
  Second, the control system should be able to store user data into its storage device and display appropriate information onto the output module.
  Third, the control system should be able to control the mechanical system (robot arm) to enable the mechanical system to open/close the drawers.

  Requirement 1: The control system must be able to recognize and process this list of user inputs.
  1. *Open/Close one of the drawers.*
  2. *Assign contents (content name) to one of the empty drawers.*
  3. *Find any non-empty drawers by specific content name.*
  4. *Clear contents (make drawer empty) of one or more drawers.*

  Requirement 2: The control system must be able to display the list of user information.
  1. *Availability of each drawer. (Indicated by each LED on every drawer)*
  2. *Search results when the user tries to search for specific contents.*
  3. *Which drawer is currently under mechanical control (Opening or closing)*

  Requirement 3: The control system must be able to store user information into its storage

  device. (SD card) The list of user information is:
  1. *Contents of each drawer.*
  2. *The list of drawers that are currently empty.*

  The input module consists of a small keypad and several buttons for user input. The user should be able to enter the list of commands, as indicated by requirement 1 of the control system, into the control system.

  Requirement 1: The input module must be able to let users enter content names for the drawers, including type of components (resistor - Ohms, inductor - Henries, capacitor - Farads and chip names (such as LM741).

- Output module
  The output module consists of small LEDs on each drawer and a small display. The information, including current user operation, overall drawer availability and drawer content information, should be displayed.

  Requirement 4: The control system must be able to control the mechanical system to interact with the drawers physically. In this case, this would be that the robot arm could reach the drawers accurately.

- Input module
  Requirement 1: The output module should be able to display or indicate correct information through LED and the display.

- Mechanical system
  The mechanical module consists of a robot arm which physically interacts with the drawers, including pulling (to close the drawers) and pushing (to open the drawers). The robot arm could open or close one drawer at a time, and the control system will command the robot arm to reach and either open or close the drawer.
  Requirement 1: The mechanical system should be able to reach the drawer accurately and quickly. Each drawer open or close operation should not take more than 60 seconds. (Moving robot arm to the position and opening/closing the drawer)

  Requirement 2: The mechanical system should have fail-safe protections (Over current, collision prevention, emergency shutdown, etc.) which prevent it from damaging other parts of the system physically or itself.

2.3 Risk Analysis

The microcontroller would be crucial to the successful completion of our project. As the "brain" of the whole logging system, it has to accurately interact with the user interface to receive correct messages from the user and send corresponding signals to the output module and mechanical system. It also has to save the correct data in the memory to keep track of each electronic component. In other words, if the microcontroller fails to serve the conditions above, then the whole logging system would not function at all. Besides the microcontroller, the mechanical structure is also important because it has to accommodate the size of the organizer. If the robot arm cannot reach some of the drawers, these drawers would become a waste of resources.

3. Ethics and Safety

One safety issue might occur in our project is handling the pack of lithium batteries that supplies for all of the other modules. We need to carefully determine the power consumption of each module, dedicate to safely distribute power in our power management design, and decide the working conditions of our organizer as a reference to our users.

Another potential safety issue is there is a possibility that the robot arm pushes one of the drawers with a large momentum so that the whole organizer might fall on the user. This could be prevented by setting a maximum current or voltage applied on the mechanical structure, conducting a series of testing about the force exerted by the robot arm when opening or closing a drawer, and making adjustments to the position of robot arm correspondingly.

Coming up with solutions for both of the statements above are to uphold the IEEE Code of Ethics #1, by disclosing any safety issues and also trying to prevent them during the development stage[1]. As a team of three people, we aim to collaborate with each other, support each other's idea, and make the best use of each one's strength as well as learn from each other. This would reflect the IEEE Code of Ethics #10[1].

Along the way to the completion of this project and to the future, staying active and positive to respond to any supportive criticism is essential to the development of our product. Making immediate modifications based on feedback and correcting mistakes without any delay is necessary for any project development. This is suggested by IEEE Code of Ethics #7[1].

4. References

[1] Ieee.org, "IEEE IEEE Code of Ethics", 2016. [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 12- Feb- 2020].