Medical Kit Dispenser

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1 Introduction

1.1 Problem

There have been instances during which medical necessities have been in need but are inaccessible, either due to how far the closest drug store is or the time of day during which such necessities are needed. For example, cold medicine is something that you often do not have at home and will only need when you are having a severe case of the sniffles––but circumstances are that you likely would not get such drugs if they are not relatively immediately available. Another scenario is when sometimes, the straps in our mask would snap off. Most people do not carry around a spare mask in their bag, which requires them to get another one from a store. In the era that we are currently in, addressing our illnesses and the safety of others as soon and as effectively as possible is out of everybody's best interest.

1.2 Solution

What we would like to do to address such issues is to build a modular vending machine that is targeted towards UIUC students and can be placed around campus. Our implementation of this machine is unlike any other vending machine that you can find either at ECEB or anywhere else for that matter. We would like to make it modular so that it can be as small (so that it can be placed in low-traffic areas) or as large (conversely, in high traffic areas) as it needs to be. A consequence of the modular design is that the trays that store inventory can be expanded vertically or horizontally to accommodate for every product size––a feature that is not found in any vending machine.

In addition, as this product is intended to serve the user more than to benefit the owner, the design of such device will be focused on ensuring that the user is able to obtain whatever product it is that they have ordered through a series of motion detectors. The vending machine is intended to provide goods that current students are able to obtain for free, either from

McKinley or otherwise; however, such goods are often distributed to students on a quota. That is, students are able to dispense certain goods after some time period has elapsed. The software related to this device will thus serve two purposes: to track the user's past transactions to ensure that they are eligible to dispense a certain product, and to track inventory of the machine. Due to the required internet connection, an Arduino or Raspberry Pi will be used to make implementing the database-to-machine connection feasible for this project; however, the implementation of the actual machinery and any failsafe system will require at least 2 PCB boards; one to unify the BUS that connects to all the dispensing trays, the motion sensor, and the arduino so that the machine functions as intended, and the other to ensure that the individual trays dispenses an item when commanded.

Due to the modularity of the design and the implementation of the software, this machine can also serve as an all-in-one distribution center for goods that are often handed over to students as needed. While this machine is initially intended for distributing necessities, it can also be stocked with other items depending on where they are. For example, a machine at the ARC can also be used to vend sanitation wipes or some injury-related remedies.

1.3 Physical Design

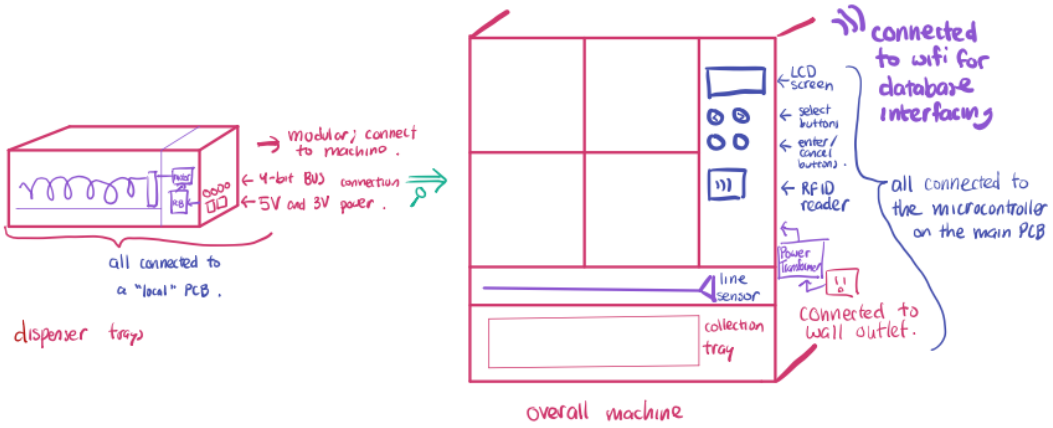


Figure 1. Physical Design of Medical Kit Dispenser

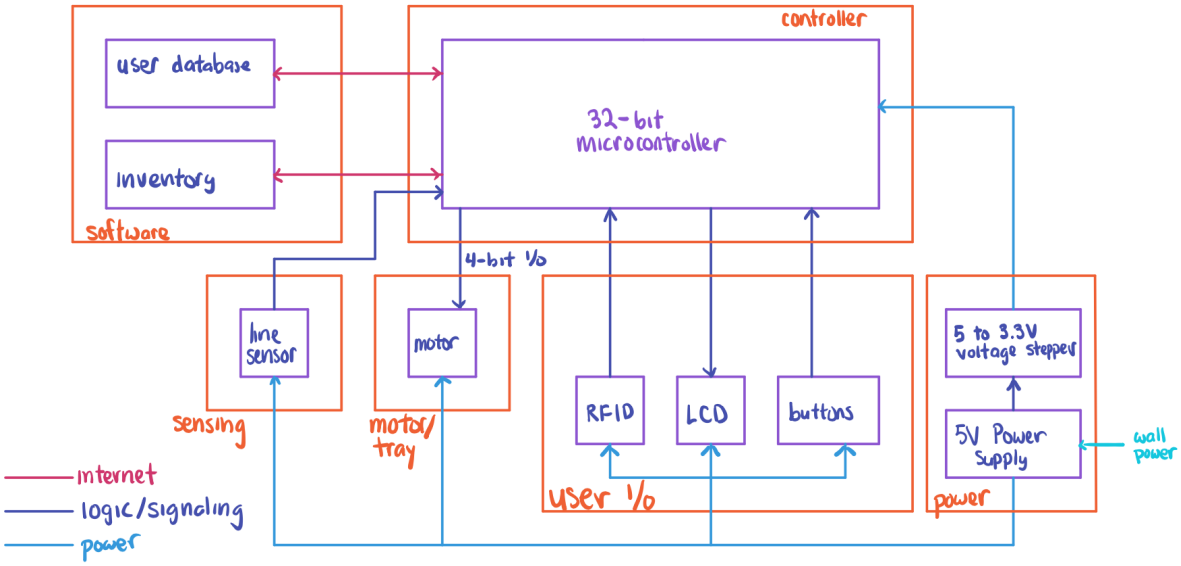
1.4 High-Level Requirements List

- ☐ The motion sensor should be able to detect if an item is dispensed, and should send a signal to the control module PCB and update the user and inventory database.
- ☐ The microcontroller should be able to read a user's identification using the RFID, which prompts the LCD screen to show what the user can dispense
- ☐ When a product is chosen, the correct signal should be sent by the microcontroller to the BUS, and the corresponding module should activate the motor to dispense a product.

2 Design

2.1 Block Diagram

For the project to be successful, the Medical Kit Dispenser will require two components: the hardware board and the software board. The hardware board will be divided into five main units: controlling subsystem, motor subsystem, sensing subsystem, user subsystem, and the power subsystem. The control unit will consist of a 32-bit microcontroller. The power subsystem consists of a 5v power supply and a stepper that will power the control, sensing, motor and user subsystem. The user interface unit will consist of an RFID, LCD, buttons, and a line sensor. The RFID, LCD, buttons and line sensor will be connected to the 32-bit microcontroller in the control unit through wires to be connected to the PCB. The dispensing unit will consist of a motor, which will be connected to the 16-bit microcontroller through a 4-bit BUS. The software board will consist of two items: user database and inventory. They both will be connected to the 32-bit microcontroller in the control unit through wires and connected to the internet through wifi.



(*) All our user I/O components will communicate with the 32-bit controller using generic I/O handling.

Figure 2. Block Diagram of Medical Kit Dispenser

2.2 Subsystem Overview and Requirements

2.2.1 Control Subsystem

This is the primary subsystem that ensures that the whole machine functions as intended. The microcontroller ensures that when a valid RFID signal is received, the user is able to select and receive products that they are eligible to dispense. This involves accessing the user database (subsystem 2.2.6) to ensure eligibility, and to display the eligible entries to the LCD screen (subsystem 2.2.4). When a valid input signal is received, a BUS signal is sent to the motors (subsystem 2.2.3) through a BUS, and when a signal is registered from the sensing modules (subsystem 2.2.2), the whole cycle repeats.

Requirement: The correct BUS signal should be emitted when a product is chosen; this can be tested by connecting leads from the BUS to a series of LEDs on a breadboard.

Requirement[*]: The correct products should be displayed to the LCD screen; can be tested by simply connecting the parts.

Requirement[*]: An RFID signal should be received and correctly interpreted by the microcontroller.

Requirement[*]: When a product is dispensed or indispensable, the microcontroller should update the inventory and user database correspondingly. Can be checked by tripping (or otherwise) the sensing module (2.2.2) and see if the database gets updated.

2.2.2 Sensing Subsystem

The sensing subsystem will compromise all the sensors used. These sensors will detect whether an item has been properly dispensed. If an item has been properly dispensed, the object will pass through the line sensor and notify the microcontroller that the object has been dispensed, if not the microcontroller will know to retry.

Requirement: When motion is detected by the sensor, an active signal should be sent to the microcontroller. Can be tested by probing voltage under motion.

2.2.3 Motor Subsystem

The motor subsystem is in charge of dispensing items. A signal will be sent by the microcontroller through the bus to the motor and will push the object down for dispensing.

Requirement: When the correct signal is delivered across the BUS, the motor should activate for exactly one cycle on a rising edge. Can be tested by artificially sending a signal to the BUS connections on the PCB connected to the motor.

2.2.4 User Subsystem

The user subsystem comprises all the parts that the user will interact with including the LED screen, RFID and buttons. The LED screen is used so that users will be able to see what items they are able to dispense or choose what items to be dispensed. The buttons will be used for users to interact with the LED screen and choose which product they would like to be dispensed. The RFID module will be used to read the i-cards of users to identify who they are.

Requirement[*]: The correct products should be displayed to the LCD screen; can be tested by simply connecting the parts.
Requirement[*]: An RFID signal should be received and correctly interpreted by the microcontroller

2.2.5 Power Subsystem

The power subsystem will be plugged into a standard wall plug and convert it to a 5V DC power supply. This will be used to power the user subsystem, the sensing subsystem and also the motor subsystem. From there the 5V power supply will be stepped down to 3V to power the 32-bit microcontroller.

Requirement: The power system must take in 120V and output a 5V DC current
Requirement: The power system must transform the 5V DC current and step it down to a 3V DC current

2.2.6 Software Subsystem

The software subsystem will compromise two parts: inventory and user database. The inventory component will track the current items in the dispenser and will inform the microcontroller of what items are currently available so it will be able to display the correct information on the LED screen. The user database is to be used to identify users who are

currently using the dispenser and inform the microcontroller to display what items each user is able to dispense based on the quota they have on the item.

Requirement[1]: When a product is dispensed or indispensable, the microcontroller should update the inventory and user database correspondingly. Can be checked by tripping (or otherwise) the sensing module (2.2.2) and see if the database gets updated.

[*] Some subsystems may share the same testing requirements.

2.3 Risk Analysis

The greatest risk to a successful project is in the user subsystems. Testing the LCD screen is trivial; when wired correctly, an output transmitted by the microcontroller should be displayed correctly on the microcontroller. Any improper result would signal either an error in the connections or assigned pins, or error associated with the programming of the microcontroller.

Testing the RFID module will be more complicated; one will need to read the instantaneous output from the RFID to the microcontroller to ensure if the device is properly connected and implemented. Using Eclipse or similar IDEs to run the microcontroller program live should allow the testing of the RFID.

3 Ethics and Safety

Every piece of technology has its risks, and such risks can range from abuse of collected information or risk of injury to the user from unintentional misuse. While the implementation of our device requires us to collect some data regarding the user's vending history, none of the information should be considered sensitive. However, user information should not be divulged

unless absolutely necessary to ensure privacy, and as such the user information database and inventory database should be implemented independently to ensure that those who have access to inventory are not able to access user information without proper credentials.

In addition, as the project involves both moving components and electronic devices, the potential of self-injury from severe misuse will always be present. To mitigate any mechanical injuries, the motors used to dispense the products are low voltage and operate at low rotations-per-minute; this will prevent any injury from occurring if one were to misuse the machine while the motors are active. In addition, all exposed wires, whether that be from the PCB board or otherwise, are kept out-of-reach from the user, and the user interface are all made from insulating material (such as plastics) to prevent any electrical injuries from occurring.

In regards to the IEEE code of ethics, we are ensuring that we are going to follow the code of conduct, specifically in Article I, number 1 [1]. Our device is going to keep the privacy of others because we are going to only collect when a certain person has dispensed an item. Each user is going to be stored as an ID, not by their names, so user information is going to be ambiguous. Furthermore, the information is going to be held in the database, which is not accessible by anyone. Another article that we will follow is on the idea that we are not going to discriminate against others as stated in Article II number 7 [1]. We are following this by ensuring that we are not going to purposely hand out more supplies to certain individuals. Since we are ensuring that everyone will have a quota on supplies, no one is going to have more than the others, at least purposefully.

References

[1] “IEEE code of ethics,” IEEE, Jun-2020. [Online]. Available: https://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 10-Feb-2022].