AUTOMATED DRUG DISPENSER USING ARDUINO MICROCONTROLLER

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Abstract

Today, automation plays an important role in human life. People always look for convenience even in handling commodities and other basic needs in life such as food and medicine. Automation not only refers to reduced human effort but also energy efficiency and time saving.

The main objective of the study is to develop an Automated Drug Dispenser using Arduino Microcontroller. The proposed project uses electrical and electronic materials such as sensors, bill/coin validator, servo motor and inverter.

This concept is composed of a microcontroller. It is a computer on a chip that is optimized to control the electronic circuitry. It also acts as the brain of the system. A sensor converts a physical parameter into a signal that can be measured electronically. It sends a signal to a microcontroller when a specified condition is encountered. The study focused on the design and development of automated dispensing of medicine. However, the loading of medicine inside the machine and the detection of expired drugs will be in manual operation. The system focused only on the technological concept.

Keywords*: Automation, Bill/Coin Validator, E*nergy Efficiency, *Microcontroller*, *Servo Motor*

Introduction

As people continue to seek for convenience, more and more technologies are invented. One of these technologies is the vending machine. Vending machines come in different types as they are made for different purposes. Vending Machines are rarely found in the market. They are a coin operated machine for selling merchandise. Vending machines provide various products such as snacks, beverages, water, tickets, and others products. They have many benefits as well.

The term ‘vend’ is defined as "to be disposed of by sale". Items that are capable of being vended are thus referred to as ‘vendibles’. This means that items or services that can be sold are considered as possible vendibles. Groceries, snacks, fuel, ATMs, bookings for almost any kind of service and orders for almost any kind of good: could all be considered "vendibles" for a type of retail store centrally featuring a pharmacy that dispenses prescription medication and sells over-the-counter medications.

Drugstores are very valuable to the community especially to those who are under medication. The usual problem that consumers encounter is that, some medicines are out of stock. In other cases, the service counter is slow in dispensing the medicine. Some drugstores also dispense the wrong number of pills.

The development of a microcontroller can hopefully minimize these problems. The primary purpose of this new technology is to automate drug dispensing. The microcontroller is designed to save space and has the capability to operate with human intervention.

PROJECT DESIGN

This chapter presents the development including the design project perspective; the steps and procedures in the fabrication of the frame with the source of electricity, electric motor; and incorporation of different sensors, microcontrollers, and actuators to be used. Evaluation procedures and techniques to determine the performance of the automated drug dispenser are also discussed.

Project/Research Design

The study will be using developmental research design. Developmental research is often initiated for complex, innovative task for which only very few validated principles are available to structure and support the design and development activities. Since in these situations, the precise design and performance of the machine to be developed is often still unclear, the aim of the design project is to make a prototype that will increase the innovative aspirations and requirements.

Project Development

Before developing the machine, identification of the supplies and materials to be used will be first determined and these were broken as follows;

Table 1. Materials to be used in the Design Project

Quantity	Item	Specifications
2 pcs	Aluminum frame	1” x 1” x 40’ x ¼”
1 pc	Arduino UNO	32 pins/ 14 I/O path
3 meters	Battery Connectors	Size 8
1 unit	Battery Control Unit	24v/12v- 30A
2 units	Battery	12V-150Ah
1 pc	Ejector	40 pins/ 33 I/O path
1 unit	Inverter	1000 watts
1 pc	LCD	4 x 20 Characters
1 pc	Optocoupler	5000 vms/ 0.5 Pf
1 pc	Power Supply	12V, 250 watts
10 pc	Sensor	12C
1 pc	Start-Stop Switch	30A at 6-12V DC, 15A at 24-36V DC
1 pc	Toggle Switch	30A at 6-12V DC, 15A at 24-36V DC
1 pc	½ HP Electric motor	220volts, 0.37 KW

Design and Fabrication of Automated Drug Dispensing

The automated machine frame will be made up of four major raw materials: galvanized steel, Lexan or other plastic, acrylic powder coatings, and polyurethane insulation. The bulk of the machine is constructed from galvanized steel. Lexan, a tough polycarbonate plastic, is used in the front panels of the machine. Acrylic powder coatings are colored powders used to "paint" the surfaces of machines. This coating withstands the rigors of weather and abuse better than paints that are applied wet. Polyurethane foam provides the insulation for the inside of the vending machine. The acrylic metal sheet holds all its components and is composed of a microcontroller, sensors, a keypad, an LCD display, a money feeder, a money changer, motor and a power supply. The microcontroller serves as the brain of the whole project; this is where all the decisions and calculations happen, a sensor stands as the triggering inputs to microprocessor.

The diagram below shows all the requirements needed in order to configure the system and process the different hardware components to output an automated drug dispenser.

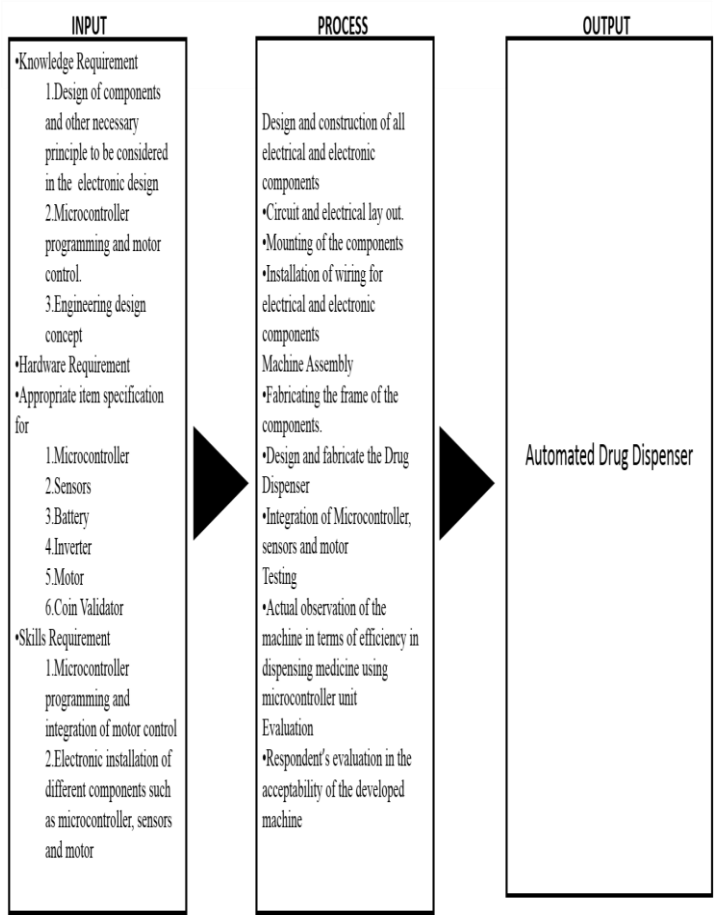

Figure 1. Conceptual Model of the Proposed Automated Drug Dispensing

RESULTS AND DISCUSSIONS

The study would have an impact among drugstores because it can reduce human labor as well as increase the speed of servicing the consumers when it comes to utilization and selling of medicine. The

machine has two functions; selling the product and sell the service to the customers.

The study will also be beneficial to the community, especially to those who are living in the rural and remote areas where access to the hospital or health center is difficult. The machine can operate 24 hours every day.

A. Project Description

The proposed project uses electrical and electronic materials such as sensors, bill / coin validator, servo motor and inverter. This concept is composed of a microcontroller. It is a computer on a chip that is optimized to control the electronic circuitry. It also acts as the brain of the system. A sensor converts a physical parameter into a signal that can be measured electronically. It sends a signal to the microcontroller when a specified condition is encountered. The study is focused on the design and development of an automated drug dispenser. It can only accept 5- and 10- peso coins and prepaid card. It can only dispense the number of pills and doses based on the type o medicine and brand selected. The machine automatically detect if the container of medicine is empty. But loading of medicine inside the machine and detection of expired drugs will be in manual operation. The system will focus only on the technological concept.

B. Project Structure

The prototype is made up of the following major parts: Electrical and Electronic Components; Microcontroller Unit; Power Supply for Microcontroller; Power Supply for the Relay; Circuit Board Switching the Sensor and Motors.

1. *Automation.* The term automation refers to a wide variety of systems and processors that operate with little or no human intervention. In modern automation systems, control is exercised by the system itself, through control devices that can sense changes in such conditions as temperature, rate flow and volume. It then commands the system to make the adjustments to compensate for these changes. Most modern industrial operations are too complex to be handled manually or even machines under manual control.

   Automation developed as a result of advantages in the design of a machine. According to the International News Organization, although early machines were often complicated, most were designed to operate under a specific set of conditions. When these conditions changed, a manual adjustment was necessary to assure proper operation. This was not a major shortcoming since machines operated at relatively low speeds. During the Industrial Revolution (between 1700s and the 1800s), however, more sophisticated machines were developed and applied to situations requiring a faster response that was possible with manual adjustment. This led to the concept of automation.

   Automation was quickly recognized as a valuable way to assure efficiency and accuracy in manufacturing processes. The chemical industries developed the technology of automation to regulate variables such as pressure and temperature that are involved in the production of chemicals. The food industries found that packaging, bottling, and sealing operations as well as the production of food products could be accomplished more efficiently by the use of

automated systems. The methods of automation were refined with the development of aircraft guidance systems and automatic pilots. The development of digital computers, which can monitor external conditions and make appropriate adjustments to a system, added further impetus to the application of automation. Today an entire oil refinery can be operated by just four persons through automation. Industrial robots perform numerous functions on assembly lines and automated spacecraft on deep space probes are programmed automatically to make adjustments in operation.

2. *Microcontroller Unit*. A Microcontroller is a stand-alone single-chip IC that contains a CPU, read-only memory to store the program; RAM to store variables used in the execution of the program and various I/O buses to connect to the outside world such as SPI, I2C, and UART. It has to be programmed via an external interface to a PC.

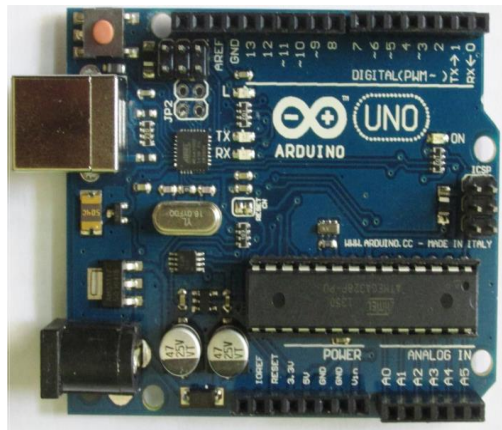

Fig. 3. Arduino UNO R3

Arduino is a small microcontroller board with a USB plug to connect to the computer together with a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeakers, microphones, etc. They can either be powered through the USB connection from the computer or from a 9V battery. They can also be controlled from the computer or programmed by the computer and then disconnected and allowed to work independently.

Arduino Uno, a microcontroller board based on the ATmega328 is used in this project. The hardware consists of a simple open hardware design for the Arduino board with an on-board input/output support. The software consists of a standard programming language compiler and the boot loader that runs on the Arduino Board. The Arduino hardware is programmed using a Wiring-based language (syntax and libraries), similar to C++ with some slight simplifications and modifications, and a processing-based Integrated Development Environment (IDE). The Arduino Board is where the code is written and executed. Arduino senses the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors and other actuators. The microcontroller on the board is programmed using the Arduino programming language and the Arduino development environment (based on Processing).

Arduino projects can be stand-alone or can communicate with software running on a computer (e.g. Flash, Processing, MaxMSP and Megunolink). The hardware reference designs (CAD files) are available under an open-source

license which is free to adapt to our needs. The open-source Arduino environment makes it easy to write the code and upload it to the I/O board. It runs on Windows, Mac OS X, and Linux. In addition, the Uno now uses an ATmega8U2 instead of the FTDI chip. This allows for faster transfer rates and no drivers are needed for Linux or Mac (in file for Windows is needed), and the ability to have the Uno show up as a keyboard, mouse, joystick, etc. (https://en.wikipedia.org)

Fig. 4. Coin Validator

3. *Coin Validator*. A currency detector or currency validator is a device that determines whether bills or coins are genuine or counterfeit. These devices are used in many automated machines found in retail kiosks, self-checkout machines, gaming machines, transportation parking machines, automatic fare collection machines, and vending machines.

   The process involves examining the currency that has been inserted. By using various tests, they help in determining if the currency is a counterfeit. Since the parameters are different for

each coin or bill, these detectors must be programmed for each item that they are to accept.

In operation, if the item is accepted it is retained by the machine and placed in a storage container for later collection. If the item is rejected, the machine returns the item. If a coin is rejected, it usually drops into a container for the customer to take back. If a bill is rejected, the machine pushes the bill out and the customer must remove it from the slot in which it was placed.

Fig. 5. Stepper Motor

4. *Stepper Motor*. A stepper motor is a brushless, synchronous electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely without any feedback mechanism. A Stepper Motor works on the principle of electromagnetism. There is a soft iron/magnetic rotor shaft surrounded by the electromagnetic stators. The stator and rotor have poles which are teethed. When the stator are energized the rotor moves to align itself along with the stator.

Fig. 6. IR Sensor

5. *IR Sensor*. It consists of transmitter and receiver LED to detect the object according to adjustment of sensitivity. Transmitted light is received by receiver after reflection through an object. It works based on the reflected light incident on reverse biased IR sensor. When photons are incident on reverse biased junction of this diode, electron hole pairs are generated. As a result reverse leakage current is found. This IR sensor is also used for detecting the motor rotation, according to selection of an item and also the amount of an item.

C. Principle Operation of the Automated Drug Dispenser

The state diagram mainly consists of four states (User Selection, Waiting for the Money Insertion, Product Delivery and Servicing (when product_not_available='1'). Initially when the reset button is pressed, the machine will be ready for the users to select the product. This state is the initial state of the design. After this, the user will select the product to be

dispensed. This state can be one of the select1, select2, select3 and select 4. The machine can accept coins with denominations of 5 and 10 pesos only. Suppose the user selects the 'sel1 input'. The machine will check whether the products are available in the machine or not. After this, the control unit will move to the waiting state, where it will wait for the money to be inserted. The coin is inserted then the machine will go to state_1, 2 and 3 then wait until the desired money is inserted. When the desired amount is inserted, the machine will go to the item state and the item will be delivered at the product output. If products are not available in the machine then the control unit will demand for servicing and after service the machine will get reset. This methodology is explained using a flow diagram shown in figure 7.

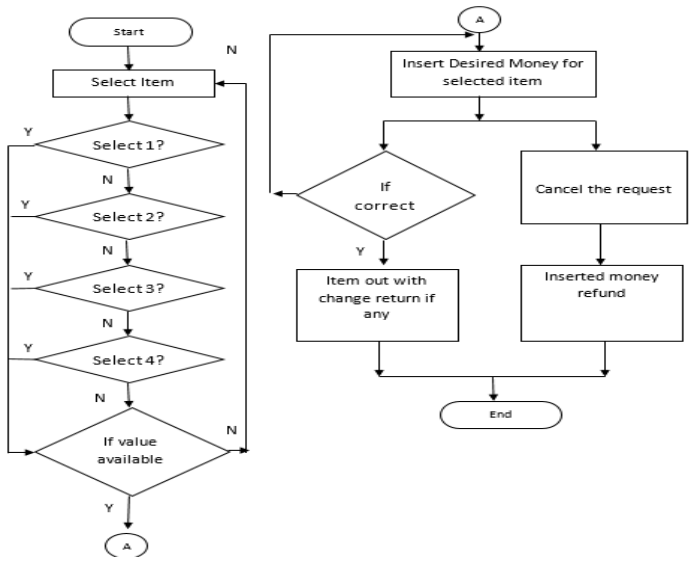

Figure 7. Flow Chart for Proposed Automated Drug Dispenser

D. Evaluation

The evaluation is composed of evaluation plan, evaluation procedure and evaluation criteria respectively.

Evaluation Plan

It involves the systematic collection of information about the activities, characteristics and outcomes of an activity or action, in order to determine its worth or merit. It is a major part of learning, and can provide a wealth of useful information on the outcomes of a project or action as well as the dynamics of those who undertook the work.

Figure 8. Evaluation Cycle

In this project, since it is IT infrastructure in nature, evaluation will analyze the output based on the six aspects as shown in Figure 8. The scope encompasses all the work progress in the different areas of activities. Quality measures the acceptability of the project to the end-users. Risk identifies the critical area of the project.

Resources deal with the labor and material supplies. Schedule involves the time table of the work in progress. Budget is the funding source for the project implementation.

Evaluation Procedure

Minimum of thirty (20) respondents with related expertise are the target clients who will evaluate the efficiency of the project design. Before the evaluation, the project design will be demonstrated to the panel of evaluators on how the machine will be operated. Moreover, the details and specifications of the project will be discussed and explained. After which, the evaluators will be requested to operate the machine for evaluation. Accomplished evaluation sheets will be collected and tabulated to determine the results.

Evaluation Criteria

The automated drug dispenser will be evaluated in terms of its efficiency and reliability using the scale provided in Table 2. Numerical values of one (1) to five (5), in which 5 is the highest and 1 is the lowest were set to obtain a descriptive equivalent of excellent (5), very good (4), good (3), fair (2) and poor (1).

Table 2. Rating Scale for the Evaluation of the Automated Drug Dispenser

Numerical Rating	Descriptive Rating Equivalent
5.00	Excellent
4.00	Very Good
3.00	Good
2.00	Fair
1.00	Poor

CONCLUSIONS

The proponent's main objective is to assist in the dispensing of medicine using a microcontroller.

Specifically this project will use an open source platform. The Arduino will control the whole operation of the system like triggering other embedded devices / sensors.

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