

IoT Based Sanitary Pad Vending Machine

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Abstract: The idea behind this machine is to have an online payment for customers, as no one is carrying cash with them, and has access to an inventory of the product to the vendor so that he can monitor the machine online. This vending machine is fully automatic with a touch display, it includes an online payment gateway like UPI, Debit Card, Credit card, Net Banking payments. This machine uses a spring and free-falling mechanism to dispense napkins. This machine contains a total storage capacity of 80, with 40 individual slot capacities.

The whole machine is controlled using Raspberry Pi, which is being programmed to connect the razor pay server for online payment gateway and MongoDB server for vendor inventory.

This machine is simple to operate, it has QR based UPI payment option. Once the online payment is successful, then one can collect a napkin. Once the product is dispensed it will update the inventory with all the details like type, quantity, price, payment ID, etc. to the database.

KEYWORDS: Sanitary napkin machine, Raspberry pi, free-falling mechanism, Razor pay, MongoDB



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INTRODUCTION

In today's world, women's cleanliness or hygiene is very important and to be taken care of by them. Women are still afraid or shy of buying napkins from outdoor shops, pharmaceutical stores, and other stores. A permanent solution to this particular problem is by installing a napkin dispensing system in different places like schools, colleges, and public places. Talking regarding menstruation is offensive in many demographics and this contributes to ignorance and illiteracy during menstrual management. The result is that they have to miss out on work, schools as well as their daily other commitments. So there is a need to make availability of sanitary napkins to them, which can be achieved by employing vending machines with digitalized online payment.

PROBLEM STATEMENT

Coin acceptors often jam up, especially if a bill or other foreign object is inserted into the coin slot. When the coin box is full with the coins, no more payment can be accepted thus preventing another purchase, for vending machines using notes as a method of payment, the notes must be in good condition. The term the good condition refers to the good shape of the notes, not folded, and the original one. When using notes with a bad condition such as crumpled or dirty, the vending machine cannot read the note and then reject the payment, and the vendor won't have clue when the coin box will be full, whether it's a dummy note and when the items need to be refilled, this is the serious problems of coin-based vending machines.

Nearly 23 million girls drop out of school annually due to a lack of proper menstrual hygiene management facilities. A common and significant challenge they face is the ability to manage their menstruation safely, comfortably, and with dignity. In many emergency contexts, women and girls lack access to basic materials, such as sanitary pads.

OBJECTIVES

The main objective of this sanitary napkin machine is to overcome coin-based mechanisms and provide access to sanitary napkins at working places like offices, shopping malls, etc with digital online payment. Maintaining vending machines is difficult due to the maintenance of inventory and refilling the items in it.

This machine provides the vendor to monitor inventory through a dashboard and sends a notification to the vendor when the items in the machine are less i.e when items are less than 5 it will notify the vendor to refill the machine.

This vending machine is designed to solve

- Lack of access to sanitary pads
- Inventory management system
- Payment method

METHODOLOGIES

There are few mechanisms that we have tried.

Case 1: Implementing rack & pinion mechanism-based sanitary napkin dispenser by taking input from the serial monitor.

Case 2: Implementing a Horizontal spring mechanism-based sanitary napkin dispenser by taking input from the HDMI Touch display.

Case 3(Final design & implementation): Implementing vertical spring free falling mechanism-based sanitary napkin dispenser by taking input from HDMI Touch display with net banking and vendor inventory.

Case 1:

In this case, we followed the rack and pinion mechanism for pushing the sanitary pad to dispense out. Compatible with high accuracy servo with a torque of 9kg to 16kg is taken as per available in the market. Once the Atmega328p receives command through the serial terminal it will rotate servo from 0 degrees to 90 degrees, the rack and pinion gear mechanism pushes the pad outside.

During the testing of Case-1, we faced an issue in pushing out the pad when it is filled (50pads). The servo could not push the pad as the torque of a motor is not sufficient to push it out. And we also used a Bluetooth module with an Atmega328p controller to receive data to the controller from Tablet. In some cases, the Bluetooth connection of the controller from the tablet is lost making the model unsuccessful, which made us research another mechanism.

s.no	Components used in Case1
1	Servo motor
2	Atmega 328P Controller
3	Bluetooth module
4	Servo clamp
5	Gear Box

Fig 1: List of components used in Case - 1



Fig 2: Case -1 Prototype

Case 2:

So, as per Case 1, we faced some bugs like data transfer between the controller and tablet due to malfunction of Bluetooth module some time fails and some wear off with the gear mechanism, so to overcome all these issues we have chosen the Horizontal spring mechanism and serial communication directly from the application, which we have developed.

So in this case we used Raspberry Pi for the payment process with the Stonedge vending application running in Kiosk mode. In this model the customer can directly select the size and quantity, using a touch display and pay for it, on successful payment Pi sends data through UART which is received by the Atmega328p controller, and dispense the selected item from the machine. Motor rotation is monitored using a Hall-effect sensor, in this, the motor consists of a Hall effect sensor and the spring holds a magnet, once the rotation is complete the hall sensor reading goes from Low to High and High to Low. In the Atmega328p controller, it's coded in such a way that it will rotate single rotation for High-Low-High logic.



Fig 3: Magnet attached to the spring and Hall sensor attached to the Motor

s.no	Components used in Case2
1	Geared motor with holder
2	Hall sensor with magnet
3	Springs
4	Raspberry pi with display
5	L293d motor driver IC
6	Atmega328p controller

Fig 4: List of components used in Case – 2

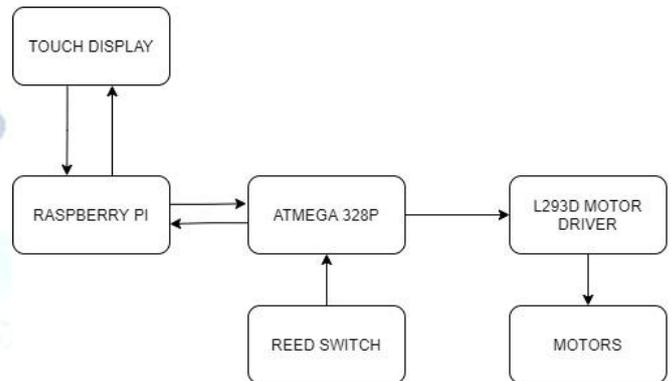


Fig 5: Block diagram of Case – 2

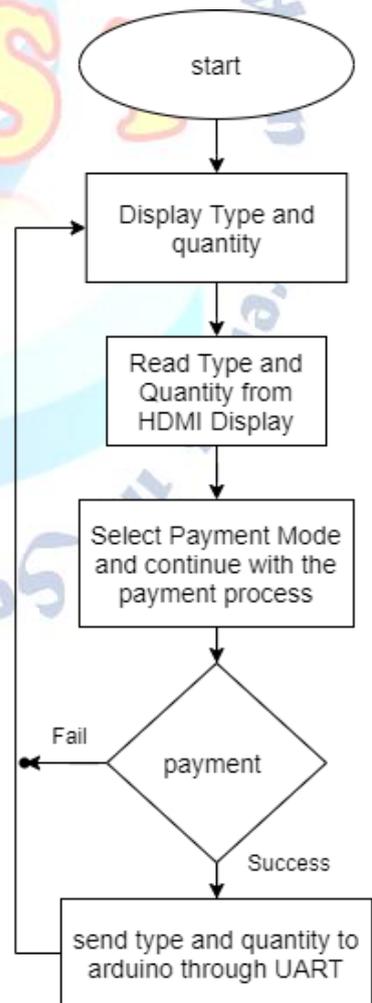


Fig 6: Raspberry pi Flow chart

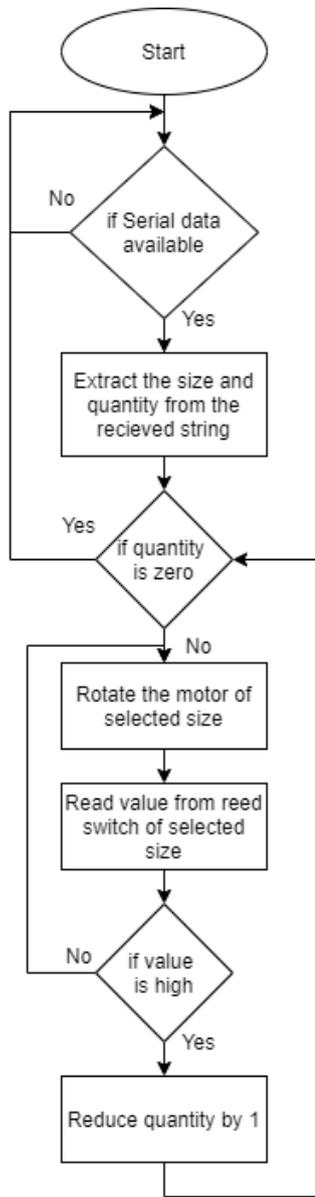


Fig 7: Atmega328p controller Flow chart



Fig 8: Case – 2 Prototype

Case-3(Final end design&implementation):

In Case-2 design, we faced few more issues with the Hall Effect sensor, a magnetic field depends on environmental conditions, so detection of motor rotation was not accurate,

instead of sensors we used a limit switch that gives 100% accuracy.

Advancements in Case-3

- Vertical spring free falling mechanism instead of Horizontal.
- Used limit switches instead of Hall effect sensors which can work in any environmental conditions
- Removed Atmega328p controller, motors can directly be controlled by raspberry-pi
- Included vendor inventory

Block Diagram:

- Raspberry pi -4 will handle all the tasks in the vending machine
- Payment and machine data is updated and stored in the MongoDB database
- The motor driver is powered with 12 Volts DC supply to drive the DC motors

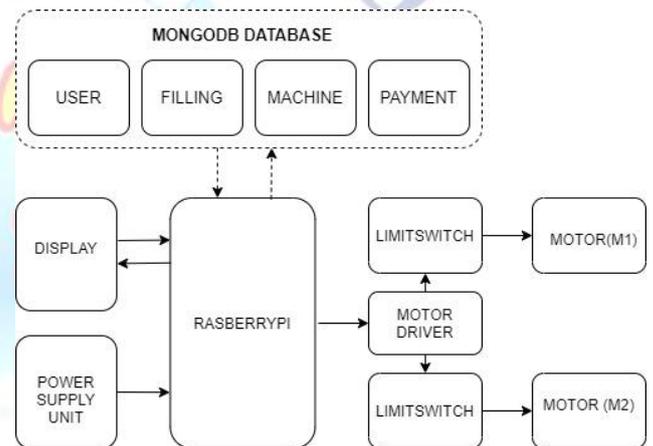


Fig 9: Case -3 Block diagram

Motor rotation using limit switch:

Initially, the limit switch will be in openmode (NO) and the value will be zero, so the motor will be off. The bore is designed in such a way that it closes the switch with a slight cut that opens the switch. Initially, the power supply is given to the common (COM) and motor to open the (NO) terminal. When a high pulse is given to themotor, it starts rotating making a closed circuit that rotates the motor. When the cut side of the bore is facing the switch, it opens (NO) the switch, so it stops the motor to rotate.



Fig 10: switch Normally Open (NO) with a motor shaft



Fig 11: switch Normally Closed (NO) with a motor shaft

Vendor Inventory:

- The line graph explains the sale of sanitary pads for the current month.
- From the graph, we can see two lines of different sizes plotted with the day-wise sale.



Fig 12: Xaxis – Days, Yaxis – Quantity of sale

- The bar shows the quantity present in the machine.
- The green bar represents no. of quantity present in the machine for size1 and the Blue bar represents no. of quantity present in the machine for size2



Fig 13: Quantity of each size in the machine

- The Doughnut graph shows the monthly sale of different sizes in sanitary pads.
- Red Doughnut graph represents the total no. of pads sold in the present month for size1 and Blue Doughnut graph represents total no. of pads sold in the present month for size2

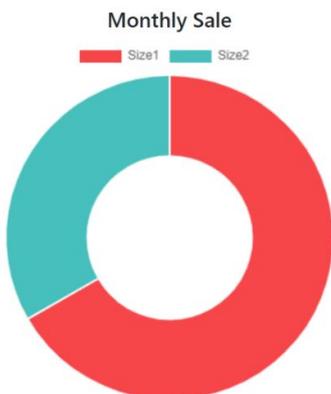


Fig 14: Monthly sale of different sizes

- The table payment shows the sales detail of that machine with the payment ID, date, and time of a particular transaction.
- The data here can be sorted by column and can be searched for particular statistics.

Payment ID	Date	Time	Purchase
pay_HU1GKcaVZreRl	03-07-2021	10:56	[Size1:1]
pay_HU1l1qDOn8KH	03-07-2021	10:57	[Size1:2]
pay_HU1MgtaU3TlomeU	03-07-2021	12:26	[Size1:1]
pay_HU1NboVt78X2BQ	03-07-2021	13:13	[Size1:1]
pay_HU1NcNG002jw2x	03-07-2021	13:14	[Size2:1]
pay_HU1N2XKXl884H	03-07-2021	13:01	[Size1:1]
pay_HU1NShwF1CtwW4	03-07-2021	13:05	[Size2:1]
pay_HU1Ntwd9RZl5p5	03-07-2021	13:06	[Size2:1]
pay_HU1NUsVWdmlMlx	03-07-2021	13:07	[Size1:1]
pay_HU1NvVvSNjstV2	03-07-2021	13:08	[Size1:1]

Fig 15: List of Payments

Notification to the vendor:

- Here is the mail that the vendor receives when the quantity in the slot falls below a threshold (in this case it is 5).
- It notifies the vendor, the quantity, and the slot that needs to be refilled.

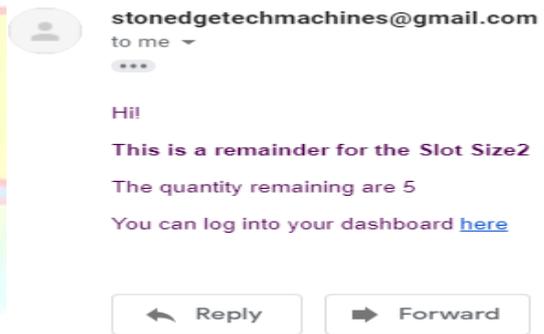


Fig 16: Notification mail to vendor

EXECUTION STEPS

Steps for Customer:

Step 1: Selecting the Size and Quantity

- The machine consists of two different sizes, customers can select any one of the sizes and the quantity from the touch display.



Fig 17: Size and quantity selection in the UI

Step2: Payment Gateway

- The payment gateway in the machine consists of different options like Credit/Debit card, internet banking, and UPI (UPI ID or QR Code scanning).
- As most people prefer using QR-based payments we too recommend the same method for the payment.
- Scan the QR code and pay using any of the banking apps.

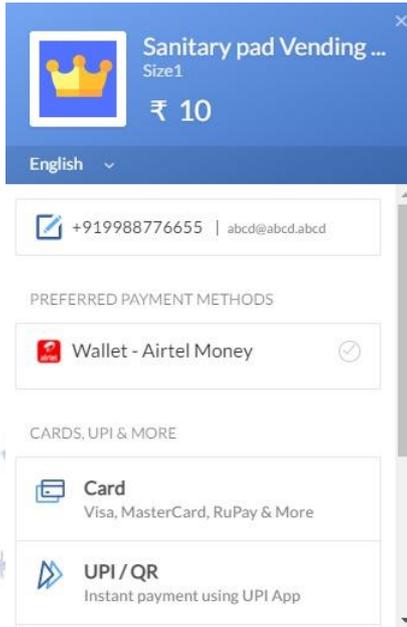


Fig 18: UPI based payments

Step 3: Collecting the Item

- Once the payment is successful, then the machine dispenses the selected size and quantity.
- Customers can collect them from the bottom collector unit.



Fig 19: Customer collecting the sanitary napkin

Steps for Vendor:

- Once the dispensing is successful database will be updated with quantity, sales, payment information.
- The vendor can log in to the dashboard.
- The dashboard contains all the details of the machine in a graphical way like the quantity present, total sales in the month, daily sales, and many more charts, graphs, and tables as shown in the vendor inventory section.



Fig 20: Case -3 Final End Design

SPECIFICATIONS

Voltage	220VAC
Power	45 – 50 Watts
Dimensions	380 * 160 * 830 mm (L*B*H)
Capacity	40 * 2 (Sizes)
Connectivity	WIFI/RJ45/GSM
Weight	15Kg
Display	7 inch TFT
Payment Mode	UPI QR / Internet Banking
Dispensing rate	As per user preference (max. of 3 at a time)
HMI/Interface	Touch Display

Fig 21: Specifications of Case 3(end)

APPLICATIONS

- The IoT-enabled feature ensures that real-time and detailed report is available online, regarding the number of dispensed sanitary pads and amount collected.
- The machine will instantly notify whenever there is a shortage of sanitary pads in the machine.
- Sanitary Napkin Vending machine can be wall-mounted at the Ladies' restroom facility at your premises for easy and private access.
- Online payment-based sanitary pad dispensing unit eliminates the risk of infection.
- Women can check the availability/unavailability of the sanitary pads from the display unit
- Napkin loading on a spiral; eases the process of dispensing or adding sanitary pads safely and securely.
- Contains QR-based UPI payment, can pay amount instantly using phone-pay or google pay.
- Vendor can have a complete inventory of the products in a vending machine
- UI, Database, and mechanism can be extended to other vending machines like snacks, general goods, baked goods, etc

CONCLUSION

The proposed system is the design of the finished model for an IOT based sanitary napkin machine with a digital payment method and vendor inventory system. The controller unit was tested and it's working as expected, it's able to dispense napkins based on user choice. Based on the results of the research, it can be concluded that this UI, database, and mechanism can be extended to other vending machines.

There are big opportunities for the entrepreneur to make a business of sanitary napkin using the vending machine at public places. Moreover, a good businessman not only has to be good at finding business opportunities with nice prospects but also, should be able to stand as a solution to the stipulation of society, including vital necessities.

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