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IoT based smart cart using RFID and NodeMCU

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Abstract:

The advent of Internet of Things (IoT) technology has revolutionized various industries, including retail, by enabling the development of innovative solutions to enhance customer experiences. In this project, we propose an IoT-based smart shopping cart system utilizing Radio-Frequency Identification (RFID) technology and NodeMCU microcontroller.

The primary objective of this project is to streamline the shopping experience by automating the process of item identification, tracking, and payment. The smart shopping cart is equipped with RFID readers and sensors that detect and record the items placed inside the cart. Each product is tagged with an RFID tag containing relevant information such as product details and pricing. The NodeMCU microcontroller, acting as the central processing unit of the smart cart, communicates with the RFID readers to capture the data of the scanned items. The collected information is then transmitted to a centralized database or server via Wi-Fi connectivity for further processing. Additionally, the system incorporates a user-friendly interface, accessible through a mobile application or web portal, allowing shoppers to view their current cart contents, receive product recommendations, and facilitate seamless checkout. Furthermore, the smart shopping cart system offers features such as real-time inventory management, personalized promotions, and analytics to retailers, enabling them to optimize their operations, enhance customer engagement, and increase sales revenue. In summary, our IoT-based smart shopping cart system offers a convenient, efficient, and immersive shopping experience for consumers while providing retailers with valuable insights and tools to improve their business processes. Through the integration of RFID technology and NodeMCU microcontroller, this project demonstrates the potential of IoT solutions in revolutionizing the retail industry.

Keywords:

RFID, ESP8266 NodeMCU, Internet of Things (IoT), Smart Shopping cart, WiFi

1. Introduction:

Over the past few years, IoT has become one of the most important technologies of the 21st century. Now that we can connect everyday objects kitchen appliances, cars, thermostats and many more to the internet via embedded devices, seamless communication is possible between people, processes, and things. By means of low-cost computing, the cloud, big data, analytics, and mobile technologies, physical things can share and collect data with minimal human intervention. In this hyperconnected world, digital systems can record, monitor, and adjust each interaction between connected things.

The physical world meets the digital world and they cooperate with one another in an interconnected fashion, thus this IOT based Smart shopping cart will not only provide fast and efficient alternative for conventional shopping but can revolutionize E- commerce Domain. The sensors and actuators have a significant job in IoT that empowers us to speak with the actual world. It comprises of three terms physical, keen and availability. Which defines how adroitly the sensors, microcontrollers, chip and actual gadgets, for example, actuators which interface remotely or wired to manage information with other electronic gadgets. IoT enables people to deal with their lives, business in powerful manners and give key changes to the world that can completely change business and industry. The potentialities offered by the IoT make it conceivable to create numerous applications that have a place with the business of aviation and aviation car, telecom, clinical, healthcare, independent living, Pharmaceutical, Transportation, Manufacturing, Retail, coordination and inventory network the board.

The main goal of IoT is to monitor individual items and environment remotely. This introduces electronic labels appended to singular items. When these labels become in the scope of peruses it peruses the stored information of article remotely which is known as RFID innovation. RFID assumes a vital part in the applications of IoT. It comprises of three segments such as RFID labels connected to the item that contain personality or data about an article, RFID peruser that read the information from the tags and focal preparing framework that perform communication between RFID frameworks to other electronic gadgets. Item urging a progressive impact on a wide scope of applications like airplane up keep, medical care, things taking care of, and inventory network the board.

2. Block diagram:

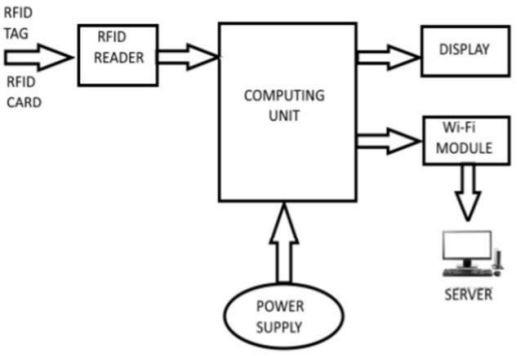

Figure. 1: Block Diagram

3. NodeMCU:

The NodeMCU ESP8266 development board comes with the ESP-12E module containing the ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi- Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.

NodeMCU can be powered using a Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface.

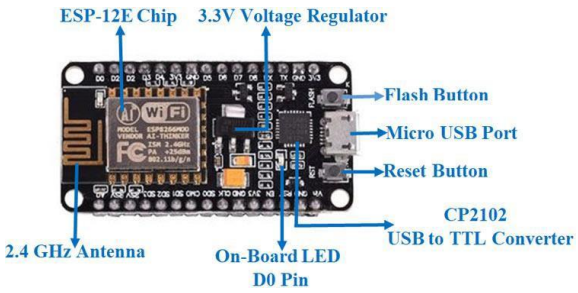

Figure. 2: NodeMCU Development Kit

4. EM18 reader:

EM-18 is used like any other sensor module. First we choose the mode of communication between MODULE and CONTROLLER. Next we will program the controller to receive data from module to display. Next power the system. When a tag is brought near the MODULE it reads the ID and sends the information to controller. The controller receives the information and performs action programmed by us.

Step1: Establishing a mode of communication. EM- 18 can provide output through two communication interface. One is RS232 and another is WEIGAND. The form of communication is selected by SEL pin. If SEL pin is selected HIGH then form of communication is RS232 and if SEL pin is pulled LOW then form of communication is WEIGAND. Usually the RS232 is selected because it's popular so SEL pin is pulled HIGH.

Step2: The output of MODULE bit rate is 9600bps (bit per second). The controller should be programmed to receive information from MODULE at this rate. If bit rate of controller mismatches then the system will not work correctly.

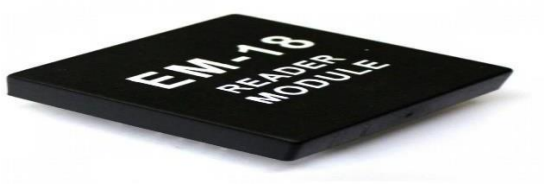

Figure. 3: EM18 Reader Modul

5. RFID cards:

RFID, short for Radio Frequency Identification, is a technology that uses radio waves to wirelessly identify and track objects or individuals. It involves the use of RFID Tags, which are small electronic devices that contain a unique identifier and can be attached to or embedded within various items. These RFID tags can be read and scanned by RFID readers or antennas, enabling the transmission of data between the tag and the reader.

Figure. 4: RFID Cards

6. LCD display:

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots. A Single character with all its Pixels is shown in the below picture.

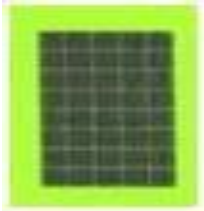

Figure. 5: LCD Display Pixels

Now, we know that each character has (5×8=40) 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an Interface IC like HD44780 is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the Commands and Data from the MCU and process them to display meaningful information onto our LCD Screen.

7. Tactile switch:

Push-Buttons are normally-open tactile Push buttons allow us to power the circuit or make any particular connection only when we press the button. Simply, it makes the circuit connected when pressed and breaks whenreleased. A push button is also used for triggering of the SCR by gate terminal. These are the most common buttons which we see in our daily life electronic equipment's.

Figure. 6: Pin Tactile Switch

8. Hardware connection:

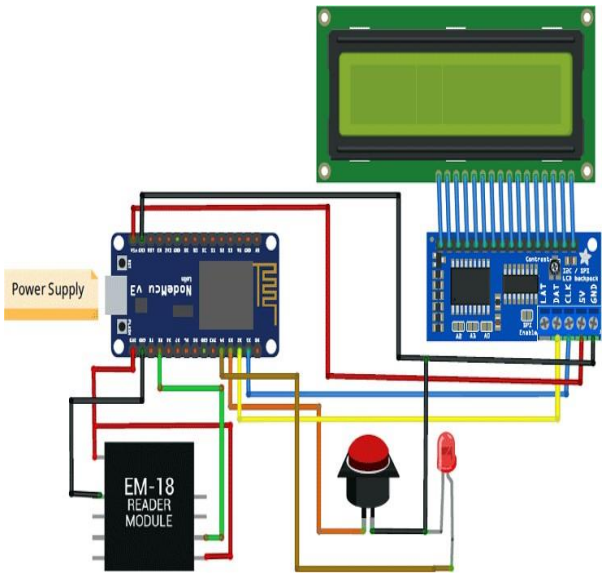

Figure. 7: Circuit Diagram

9. Working principle:

The IoT-based smart shopping cart system, powered by NodeMCU and RFID technology, revolutionizes the traditional retail experience by seamlessly integrating hardware, software, and cloud connectivity. Upon initialization, the NodeMCU microcontroller establishes a connection to the Wi-Fi network and initializes the RFID reader module. Continuously scanning for RFID tags within its range, the system automatically identifies products as they are placed in the cart, eliminating the need for manual scanning at checkout. This data is transmitted to a cloud-based server application, where real-time inventory management and personalized customer interactions take place. With its ability to streamline the checkout process, optimize inventory management, and increase customer engagement, the IoT-based smart shopping cart system represents a significant advancement in retail technology, poised to transform the retail industry and redefine the future of shopping.

10. Advantages:

1. This system helps in achieving a faster billing system.
2. The innovation payment method avoid the long waiting time.

3. Helps the buyer to know the bill details in advance so that he can plan an affordable purchase.
4. Intimate the customers about thecurrent offers by showing pop-up in the trolley screen.
5. Helps in business promotions for the supermarkets by gaining more customers providing quick service.
6. Easy to use and does not need anyspecial training.
7. RFID tag and reader should not be inLOS to make the system work
8. Unlike barcodes, tags can store more information
9. Moreover it follows commands or instructions of reader.

11. Disadvantages:

1. Fraud and security concerns. Given the lack of ability to inspect merchandise before purchase, consumers are at higher risk of fraud on the part of the merchant than in a physical store.
2. Privacy.
3. Hands-on inspection.
4. Ensuring that the retailer has an acceptable privacy policy posted. For example note if the retailer does not explicitly state that it will not share private information with others with outconsent.

12. Future scope:

1. Integration with Inventory Management Systems: Enhance the system to integrate with inventory management systems used by retailers. This integration can provide real- time updates on product availability, restocking alerts, and efficient management of store inventory.
2. Personalized Shopping Experience: Utilize data collected from users' shopping habits to offer personalized recommendations and promotions. Machine learning algorithms can analyze purchase history and preferences to suggest relevant products to users, enhancing their shopping experience.

3. Payment Integration: Integrate secure payment methods into the system to enable users to pay for their purchases directly from the smart shopping cart. This can include options for contactless payments via NFC or mobile payment apps.
4. In-store Navigation Assistance: Develop features to assist users in navigating through the store aisles to locate products efficiently. This can include interactive maps within the mobile app or real-time guidance based on the user's shopping list.
5. Smart Promotions and Discounts: Implement dynamic pricing strategies based on factors such as demand, time of day, and user preferences. Smart promotions and discounts can be tailored to individual shoppers, increasing customer engagement and loyalty.
6. Environmental Monitoring and Sustainability: Integrate environmental sensors into the smart shopping carts to monitor factors such as temperature, humidity, and air quality. This data can be used to ensure optimal storage conditions for perishable goods and to promote sustainability initiatives within the store.
7. Social Distancing and Safety Measures: Enhance the system to support social distancing measures by providing real-time occupancy monitoring and crowd management features. This can help ensure a safe shopping environment during periods of high foot traffic or public health concerns.
8. Voice and Gesture Control: Implement voice and gesture recognition capabilities to enable hands-free interaction with the smart shopping cart. Users can add items to their cart, request product information, or navigate the interface using natural language commands and gestures.
9. Augmented Reality (AR) Shopping Experience: Integrate AR technology to offer an immersive shopping experience, allowing users to visualize products in their home environment before making a purchase. AR can also provide additional product information and interactive features to enhance engagement.
10. Global Expansion and Localization: Adapt the system for global markets by supporting multiple languages, currencies, and cultural preferences. Localization efforts can help retailers deploy the smart shopping cart solution in diverse regions worldwide.

13. Conclusion:

In conclusion, the development of an IoT-based smart shopping cart using NodeMCU and

RFID technology presents a promising solution to enhance the retail shopping experience. By leveraging the capabilities of IoT devices, real-time data processing, and cloud computing, this project addresses key challenges faced by retailers in managing inventory, improving customer engagement, and increasing operational efficiency.

Through the integration of RFID technology, the smart shopping cart system enables automatic product identification and tracking, eliminating the need for manual scanning and streamlining the checkout process. The use of NodeMCU microcontrollers allows for seamless communication with cloud-based servers, facilitating real-time inventory management and personalized customer interactions.

Overall, the IoT-based smart shopping cart system represents a significant advancement in retail technology, offering benefits such as improved efficiency, enhanced customer satisfaction, and increased profitability. With further refinement and deployment, this innovative solution has the potential to revolutionize the retail industry and set new standards for the shopping experience of the future.

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