ENHANCING MALL SHOPPING WITH REAL-TIME IOT-INTEGRATED TROLLEY TECHNOLOGIES

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ABSTRACT:

In the evolving landscape of smart retail, enhancing customer experience and operational efficiency has become essential for shopping malls. This paper presents a real-time Internet of Things (IoT)-integrated smart trolley system designed to modernize the conventional shopping experience. The proposed system leverages embedded sensors, RFID technology, and wireless communication modules to automate billing, track inventory in real time, and provide shoppers with live cart data. By reducing checkout time and enabling dynamic store interaction, the system aims to improve customer satisfaction while assisting retailers in streamlining in-store operations. A prototype developed using microcontrollers, RFID readers, and cloud-based analytics demonstrates the system's feasibility and effectiveness. The integration of IoT into shopping trolleys paves the way for smarter malls by bridging digital intelligence with physical retail infrastructure.

I.INTRODUCTION

The rapid advancement of Internet of Things (IoT) technology has significantly influenced various industries, including healthcare, manufacturing, and transportation. Retail, particularly brick-and-mortar shopping, is now leveraging IoT to overcome inefficiencies and enhance customer engagement. In traditional malls, shoppers often face inconveniences such as long billing queues, product misplacement, and lack of real-time spending visibility. These limitations not only impact customer satisfaction but also create operational bottlenecks for store management.

To address these challenges, the concept of IoT-integrated smart trolleys has emerged as a promising solution. By embedding IoT modules such as RFID readers, load sensors, and wireless transmitters into shopping carts, it becomes possible to transform trolleys into intelligent systems that interact with both the customer and store infrastructure. These smart trolleys can track items placed in or removed from the cart, calculate running totals, and facilitate automatic checkout—eliminating the need for manual scanning at billing counters.

This paper explores the design and development of a real-time IoT-based smart trolley system tailored for mall environments. The system is engineered to improve the shopping journey by offering automated billing, real-time cart tracking, and in-app notifications or assistance. Moreover, it benefits retailers by enabling real-time inventory updates, data-driven customer insights, and improved staff allocation. The research focuses on the technical architecture, user interaction flow, and the operational benefits of implementing such a system in a retail setting.

II.LITERATURE SURVEY

Dr. Suryaprasad J [5] in "A Novel Low-Cost Intelligent Shopping Cart" proposed to develop a low-cost intelligent searching aid that assists the client to go looking and select product and inform the client on any special deals out there on the product as they move around within the shopping complex.

Amine Karmouche [6] in "Aisle-level Scanning for Pervasive RFID-based Shopping Applications" proposed to develop a system that's ready to scan dynamic and static products in the shopping space using RFID Reader antennas. Instead of conducting the RFID

observations at the level of individual carts, aisle-level scanning is performed.

Satish Kamble [7] in "Developing a Multitasking Shopping Trolley Based on RFID Technology" proposed to develop a product to help someone in everyday searching in terms of reduced time spent while purchasing. The main aim of proposed system is to produce a technology oriented, low- cost, easily scalable, and rugged system for assisting shopping in person

Mr. P. Chandrasekar [8] in "Smart Shopping Cart with Automatic billing System through RFID and ZigBee" proposed to develop a cart with a Product Identification Device (PID) which will contain a microcontroller, a LCD, an RFID reader, EEPROM, and ZigBee module. Purchasing product information will be read through a RFID scanner on cart, meanwhile product information will be stored into EEPROM attached to it and this EEPROM information will be send to Central billing System through ZigBee module. The central billing system gets the cart data and EEPROM information, it access the product database and calculates the total amount of purchasing for that particular cart.

COMPARISON OF EXISTING AND PROPOSED SYSTEM

We are using the Arduino Uno microcontroller, which helps to control the sensors of the electronic circuit controlled by the Android mobile application. It integrates various technologies such as RFID sensor, Arduino Uno, Bluetooth, Wi-Fi, supermarket management application and Android mobile application. These proposed model technologies have never been incorporated into the relevant system. Most supermarkets use barcode technology instead of RFID technology, which is a time-consuming process that requires scanning every product in sight. RFID technology is used in related industries, but it is not a customer-friendly environment. The ZigBee module is also used to track shopping carts. Multiple shopping carts exchange shopping information, which increases security risks and system costs. Wireless communication, providing a variety of software modules, allowing customers to use more reliable and flexible supermarket.

III.DESIGN OF HARDWARE

This chapter briefly explains about the Hardware. It discuss the circuit diagram of each module in detail.

ARDUINO UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Arduino board has the following new features:

- 1.0 pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes.

- Stronger RESET circuit.

- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

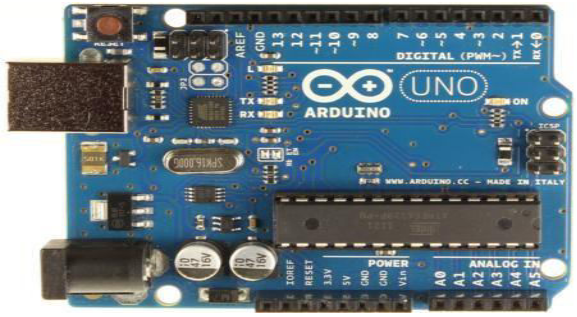


Fig: ARDUINO UNO

POWER SUPPLY:

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as "Regulated D.C Power Supply".

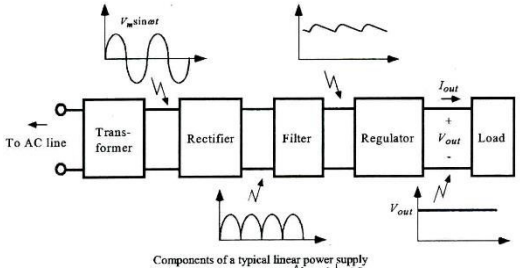


Fig: Block Diagram of Power Supply

LCD DISPLAY

A model described here is for its low price and great possibilities most frequently used in practice. It is based on the HD44780 microcontroller (Hitachi) and can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own. Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. are considered as useful characteristics.

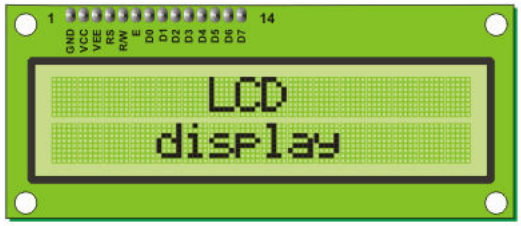
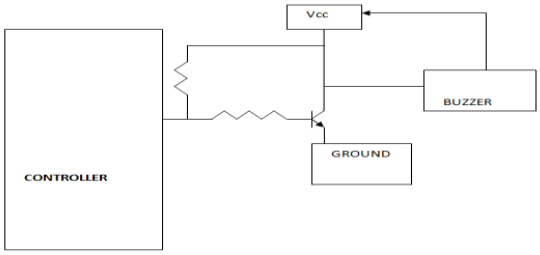


Fig: LCD

BUZZER

Digital systems and microcontroller pins lack sufficient current to drive the circuits like relays, buzzer circuits etc. While these circuits require around 10milli amps to be operated, the microcontroller's pin can provide a maximum of 1-2milli amps current. For this reason, a driver

such as a power transistor is placed in between the microcontroller and the buzzer circuit.



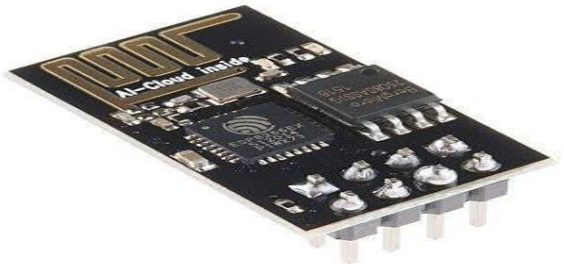
WIFI MODULE:

The **ESP8266** is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems.[1]

The chip first came to the attention of western makers in August 2014 with the **ESP-01** module, made by a third-party manufacturer, Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at the time there was almost no English-language documentation on the chip and the commands it accepted.[2] The very low price and the fact that there were very few external components on the module which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation.[3]

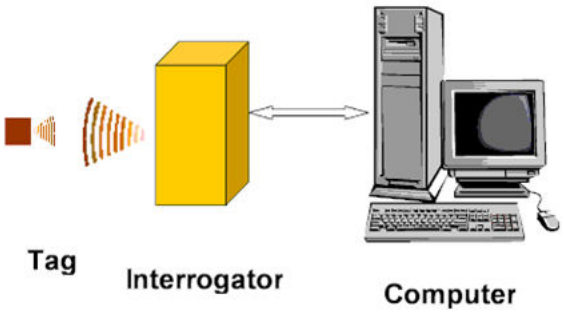
The **ESP8285** is an ESP8266 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.[4]

The successor to these microcontroller chips is the ESP32.

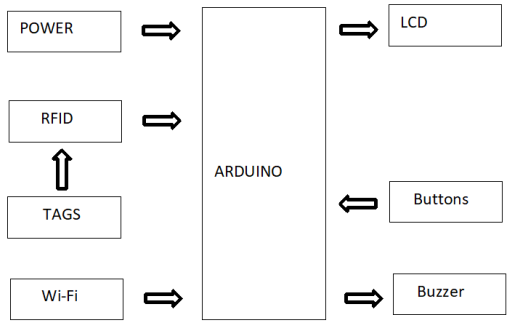


RFID (RADIO FREQUENCY IDENTIFIER)

Radio-frequency identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders. An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader. Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a (RF) signal, and other specialized functions. The second is an antenna for receiving and transmitting the signal. Chip less RFID allows for discrete identification of tags without an integrated circuit, thereby allowing tags to be printed directly onto assets at a lower cost than traditional tags.



IV. BLOCK DIAGRAM:



Working: The main aim of this proposed project is to develop a system which is used to solve the problem in the conventional trolley method and also provide child missing alert in that trolley itself .In this system RFID reader will be placed in each and every trolley in the mall and all the products will be equipped with RFID tags. When a person puts any products in the trolley, it"s code will be detected and price of those products will be stored in the memory ,its name and cost will be displayed on LCD and it will send to billing counter by wireless module. This trolley can be used to track the child „s location from the trolley when there is a big crowd in the mall. Which is possible by using RF transmitter and RF receiver. RF receiver is placed in corresponding trolley of the customers(parent"s)and RF transmitter is given to their child .so if the child moves far from their trolley then immediately that trolley generates alert message for customer(parent"s).

V.CONCLUSION

The implementation of real-time IoT-integrated trolley technologies offers a transformative approach to modernizing mall shopping experiences. By combining RFID, wireless communication, and sensor technologies within a smart trolley framework, the system automates essential processes such as billing, item tracking, and spending calculation, thereby reducing human intervention and enhancing shopping convenience.

The proposed solution demonstrates clear advantages in minimizing checkout times, improving inventory accuracy, and providing personalized shopper insights. From a business perspective, it supports efficient resource management and facilitates data-driven decision-making in retail operations. As consumer expectations continue to shift toward speed, personalization, and convenience, IoT-powered smart trolleys stand out as a practical and scalable innovation for future-ready malls.

Future enhancements may include integration with mobile payment gateways, indoor navigation systems, voice-assisted shopping features, and AI-driven product recommendations. Ultimately, this technology represents a key component in the development of smart retail ecosystems, bringing digital intelligence directly to the physical retail experience.

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