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SMART SHOPPING WITH SMART TROLLEY

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ABSTRACT

The Internet of Things (IoT) is changing human lives by connecting everyday objects together. Nowadays, shopping at big malls is a daily activity in metro cities. One can see a huge rush at malls on holidays and on special discount days. People purchase different items and put them in trolleys and go to the billing counter for payments. During that time, they have to wait in a long queue to get their products scanned using an RFID reader with the help of a barcode scanner and get them billed. To modify that, customers have to purchase in a smart way in shopping malls. Each and every product is attached with RFID tags, which, when placed into a smart shopping cart, can be automatically read by a cart equipped with an RFID reader, so that the billing can be conducted from the shopping cart itself. In this way, customers can avoid waiting in a long queue at the checkout points. For this system, additional smart shelving can be added and equipped with an RFID reader to monitor stock, updating the central server. The server knows the status of the items in the store. Inventory management also becomes much easier because all items can be automatically read by an RFID reader instead of manually scanned by laborers.

Keywords: Smart Trolley, RFID Scanner, Arduino Uno, Shopping Malls, ESP32.

I. INTRODUCTION

The overall electronic system of the trolley is operated on a small 8-bit ATmega328P AVR microcontroller, and an advance 32-bit NodeMCU ESP32 which enables wireless/RF communication. After linking the trolley to the android device , user get access to the database of the product so they can find the location of the product by just searching the product name in the application. The system uses various sensors and I/O devices which are interfaced and controlled by the AVR microcontroller. For RFID tag/card detection and identification an RFID reader is interfaced with the microcontroller via UART, SPI or I2C serial communication. The trolley uses Neo-6M GPS module which will give the location co-ordinates with the help of satellite communication. This GPS is also interfaced with the microcontroller through UART communication. By fetching and processing the location co- points the system will share the location data to the staff management system in order to track the trolley. The system uses Low-Energy Bluetooth communication to link the users Android device for trolley management. For motion/movement detection the trolley system uses an analog accelerometer sensor which will give x-y-z motion/momentum data to the microcontroller so that it can detect and identify if the trolley is in use or not after a certain timeout. For lid opening and closing the trolley uses servo/stepper motors along with some feedback sensors which will help microcontroller to identify the position and state of the lid. The system also consists of 16x2 LCD display which is interfaced with the microcontroller. With the help of display system is able to show useful information to the user/staff about the status/state of the system and product. Apart from LCD the system also uses few tactile switches/buttons to configure/control the system. For indication purpose the system will have few LEDs which will indicate various status such as Low-Power, Linked/not-linked, out of range, Heart-beat, etc. It will also have a buzzer for security and identification purpose which will buzz/beep on burglary event detection or out-of-range, or low- power, etc.

OBJECTIVE

1. To give products summary and add/log the item amount into the trolley system.
2. To make an easy interaction for user and staff.
3. To identify or locate the trolley within the shopping mall/market area.
4. To detect UPI payments securely and grant access to the user to take out their products/goods.

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5. To communicate with the trolley wirelessly over a WiFi-LAN or BLE.

II. METHODOLOGY

The Smart Trolley is a shopping trolley which is based on electronic and embedded system for automatic billing and management. It uses various electronic devices and sensors in order to interact with users and automatically identify events. The overall system is controlled by the 8-bit AVR microcontroller ATmega328P to which all the I/O devices and sensors are connected. The trolley uses RFID reader which is used to detect and identify information about the product/goods added in the trolley which helps system and admin to identify the cost and name of the product. It also uses various photo sensors just to ensure that only a single product is added at a time in order identify frauds. The trolley is having automatic lid opening/closing mechanism which secure it more from frauds. The lid will only open is case if product is place above and scanned properly. For user interface a 16x2 LCD, switches, and few LEDs are used which helps users to identify the total bill and product details. Apart from all these the system is also deployed with NEO-6m low-power GPS module which identify the LLA coordinates (Latitude, Longitude, & Altitude) in order totrack the trolley's location within the shopping market area. To wirelessly monitor various parameters of trolley it uses a ESP32 MCU which is having a wireless/RF BLE and WiFi stack. This ESP32 is connected to AVR through UART serial communication.

All these I/O devices, and sensors are interfaced with AVR microcontroller through its GPIOs and special function pins. The user interface section is having 16x2 LCD display, few switches and LEDs. The 16x2 LCD is interfaced with AVR microcontroller in 4-bit mode which requires 2 control pins and 4 data pins. The control pins are Register-Select (RS) and Enable (EN) which is used to select between command or data and latch the signal into LCD's register. The 4 data-lines are used to transfer command/data byte in 2x nibbles (4-bits in 1-cycle). The LCD is having a specific flow of initialization and display which is given is user guide of LM1602 LCD. It is having a 16 characters per line and 2 such lines so in total at a time it can display 32 characters. Apart from LCD few Push-to-ON tactile switches are used in order to navigate through the LCD pages or to control the system. The LEDs are used for indication purpose which indicates the Heart-beat of the system, or if fraud is detected. A buzzer is also used in order to indicate various things such as if product is scanned, if there is any problem in the system, or in case if fraud is detected. For product detection it uses RFID and light sensors. The light sensors used are the pair of LDRs and laser diodes placed in-front of each other. In case if RFID detects a product and lid opens then the light sensor is used to detect a single-fall event just to ensure that a single product is added. It also uses a snap-action switches to ensure that the lid is properly open/close and stops the lid motor.

The LCD uses 6 GPIOs from SIPO-SR. The switches use 2 GPIOs which are configured as inputs. The RFID is interfaced to the AVR through SPI & I2C serial communication interface. The GPS module and ESP32 are interfaced with AVR microcontroller through a UART serial communication port but as the AVR is having just a single UART it uses a CD4051 Mux/Demux to multiplex the UART. Also, the GPIOs of AVR are limited so it uses a 74HC595 SIPO (Serial-Input Parallel-Output) Shift-register which uses 3 GPIOs pins of AVR (latch, clock, & data) and gives/expands-to 8 outputs. The buzzer and LEDs use 2 of the outputs from SIPO-SR.

The overall system is powered through a 3x 3.7v Lithium-Ion batteries. The system requires 3 different power supply as 3.3v, 5v, and 11.1v. The devices such as ESP32 requires lower voltage of 3.3v to operate. Most of the devices uses 5v for their operation such as AVR microcontroller, LCD, sensors, etc. The motor and motor driver requires 11.1v (~12v) to drive the motor with higher torque. In order to get 5v regulated DC system uses a DC-to-DC buck converter which converts a 11.1v from battery pack to 5v regulated supply. The ESP32 dev-kit is having on-board LDO regulator which converts a 5v input supply to 3.3v regulated DC.

The AVR microcontroller is programmed in Embedded-C with the help of Microchip Atmel Studio 7.0 and AVR-GCC toolchain. The ESP32/12E is programmed in Arduino platform. The Android application is programmed in Java in Android studio. The admin application is web based so just requires a connection to the system.

III. BLOCK DIAGRAM

1. RFID (Radio Frequency Identification)

RFID (Radio Frequency Identification) is a wireless technology that uses radio waves to read and capture information stored on an RFID tag. The functioning of RFID technology involves the following steps:

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- An RFID tag is attached to an item. The tag contains a microchip and an antenna, which transmit itsunique identification number to an RFID reader.
- As the tagged item passes within range of the RFID reader, the reader sends out a radio signal, whichpowers the tag and prompts it to send its identification number back to the reader.
- The reader captures the identification number and sends it to a computer or other system, where it isused to identify and track the item.
- The computer or system can then access any information stored on the RFID tag, such as item name,price, or quantity.
- The use of RFID technology can improve efficiency and accuracy in various applications, including inventory management, supply chain management, and retail checkout processes.

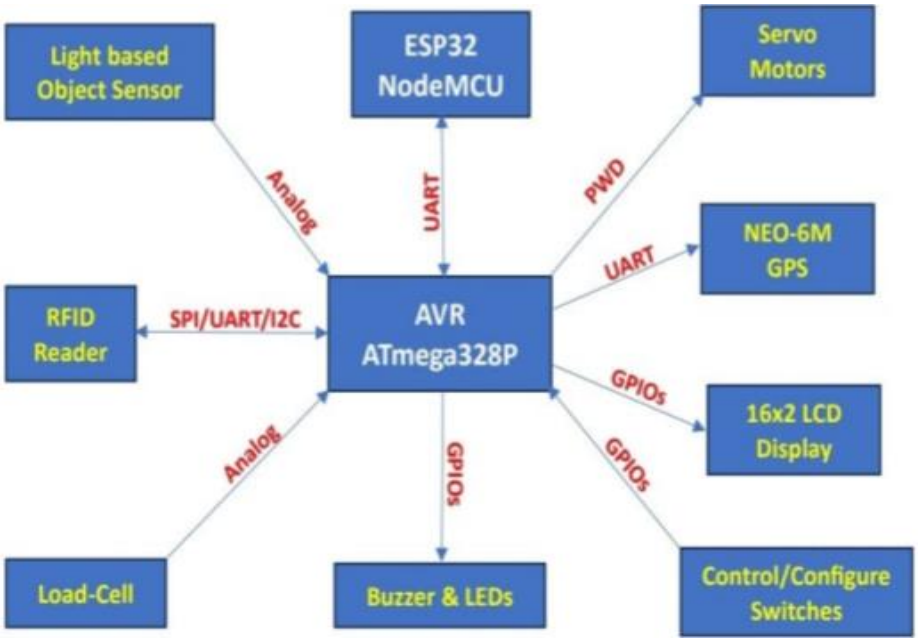

Fig 1: Block Diagram Of smart shopping with smart trolley

2. NODEMCU ESP32

The ESP-32 System-on-Chip microcontroller supports Wi-Fi 802.11 b/g/n, dual-mode Bluetooth 4.2, and a variety of peripherals. The 8266A, is essentially a two-core processor that can be clocked upto 240 MHz Additionally, it has a 4MB flash memory, an increase in the number of GPIO pins from 17 to 36, and 16 additional PWM channels. The processor comprises a total of two central cores (the Extensa LX6 processor, made with 40 nm technology). Individual CPU cores can be manipulated. Data and instructions can be stored in the 520 KB of on-chip SRAM. For example, the ESP32- Wrover SOC module has 4 MB of external SPI flash and an extra 8 MB of SPI PSRAM for use in custom applications (Pseudo-static RAM). Depending on the board type, we can employ varying amounts of SPI, I2S, I2C, CAN, UART, Ethernet MAC, and IR. A temperature sensor and a touch sensor are also included as standard equipment.

3. LOAD CELL

A load cell is an electro-mechanical sensor used to measure force or weight. It has a simple yet effective design which relies upon the well-known transference between an applied force, materialdeformation and the flow of electricity.

4. NEO 6M GPS

It can track up to 22 satellites on 50 channels and achieves the industry's highest level of sensitivity i.e.-161 dB tracking, while consuming only 45mA supply current. Unlike other GPS modules, it can do up to 5 location updates a second with 2.5m Horizontal position accuracy. The u-blox 6 positioning engine also boasts a Time-To-First-Fix (TTFF) of under 1 second. One of the best features the chip provides isPower Save Mode(PSM). It allows a reduction in system power consumption by selectively switching parts of the receiver ON and OFF.

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This dramatically reduces power consumption of the module to just 11mA making it suitable for power sensitive applications like GPS wristwatch. The necessary data pinsof NEO-6M GPS chip are broken out to a 0.1″ pitch headers. This includes pins required for communication with a microcontroller over UART. The module supports baud rate from 4800bps to 230400bps with default baud of 9600.

5. SERVO MOTOR

As servomotor provides precise angular precision, which means it can rotate as per the desire of the user and then stop and wait for the succeeding signal to take further action. Servomotor is a very versatile and a special kind of motor whose operation is automatic up to a certain limit for a given command in order to correct the performance with the help of error sensing feedback. Hence for applications where rotation of motor is required for just a certain angle, servomotor is used which has special arrangement which makes it to rotate at a certain angle for a given electrical input. It's just a basic engine that can work with a servo mechanism. It's called dc servo motor if the drive isused for DC control. And when the Ac engine is driven, the AC servo motor is named. It consists of three elements, Output Sensor and Feedback System.

6. MICROCONTROLLER ATMEGA8A

In 1996, AVR Microcontroller was produced by the “Atmel Corporation”. The Microcontroller includes the Harvard architecture that works rapidly with the RISC. The features of this Microcontroller include different features compared with other like sleep modes-6, inbuilt ADC (analog to digital converter), internal oscillator and serial data communication, performs the instructions in a single execution cycle. These Microcontrollers were very fast and they utilize low power to work in different power saving modes. There are different configurations of AVR microcontrollers are available to perform various operations like 8-bit, 16-bit, and 32-bit.

7. 16*2 LCD

An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.

8. L298N MOTOR DRIVER

The L298N is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A.

9. LDR

Photoresistor (also known as a Photocell, or light-dependent resistor, LDR, or photo-conductive cell) is a passive component that decreases resistance with respect to receiving luminosity (light) on the component's sensitive surface. The resistance of a photoresistor decreases with increase in incident l intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits and light-activated and dark-activated switching circuits acting as a resistance semiconductor. In the dark, a photoresistor can have a resistance as high as several megaohms (M?), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices. Moreover, unique photoresistors may react substantially differently to photons within certain wavelength bands.

10. SWITCH

Push buttons, also known as tactile switches, can be found everywhere: from phones to elevators to large industrial machines. They are the simplest type of input device. Learn what is push button, how do they work, how to interface them with evive and program them in PictoBlox – our Scratch blocks-based graphical programming platform with advanced hardware interaction abilities, and finally what exciting DIY projects you can make using the push buttons available in the evive Starter Kit.

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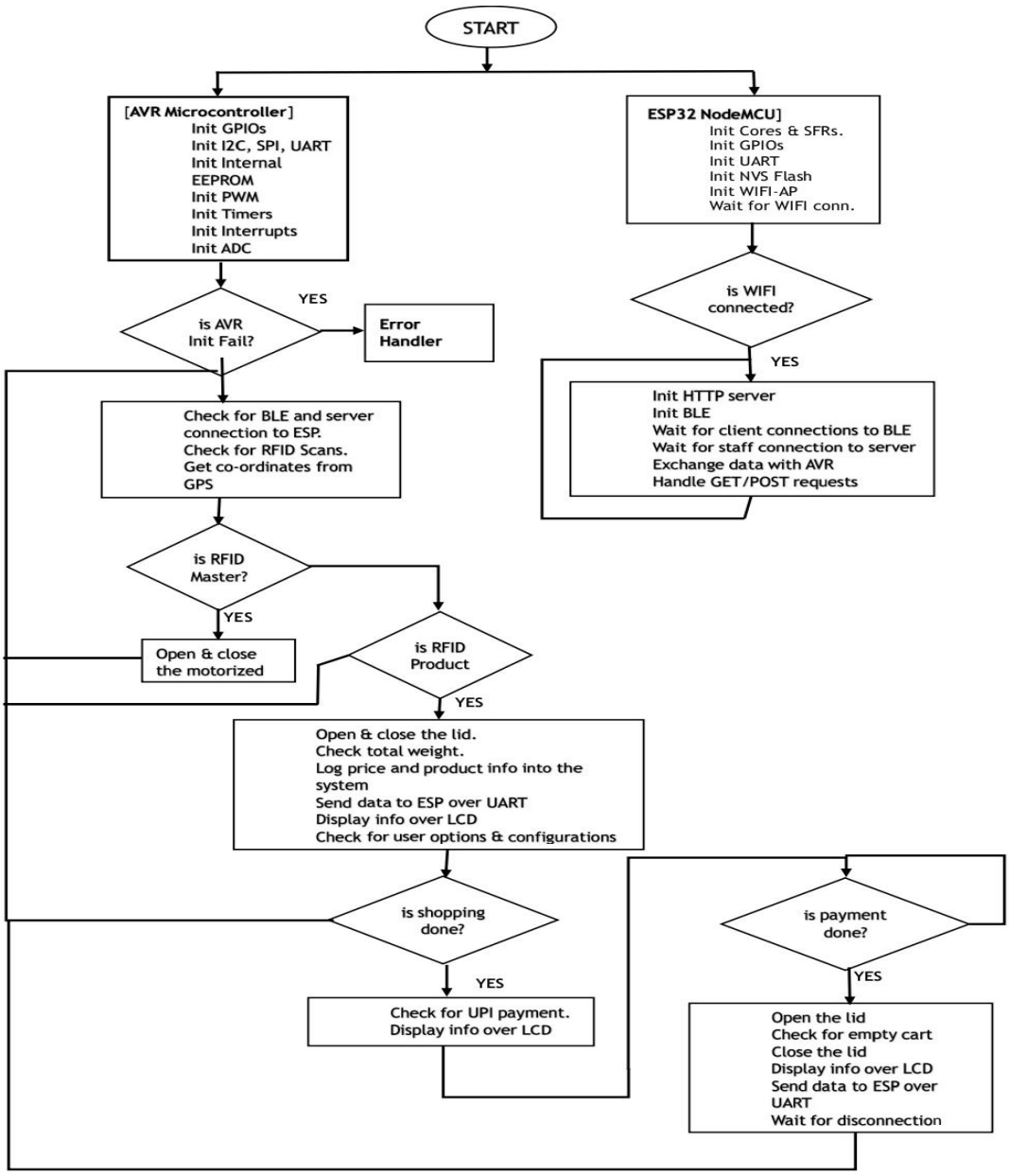
11. LED

Light-emitting diode (LED) is a widely used standard source of light in electrical equipment. It has a wide range of applications ranging from your mobile phone to large advertising billboards. They mostly find applications in devices that show the time and display different types of data.

12. BUZZER

The buzzer is a sounding device that can convert audio signals into sound signals. It is usually powered by DC voltage. It is widely used in alarms, computers, printers and other electronic products as sound devices. It is mainly divided into piezoelectric buzzer and electromagnetic buzzer, represented by the letter "H" or "HA" in the circuit. According to different designs and uses, the buzzer can emit various sounds such as music, siren, buzzer, alarm, and electric bell.

FLOWCHART



IV. HARDWARE USED

1. **RFID (Radio Frequency Identification)**
2. **NODEMCU ESP32**
3. **LOAD CELL**

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4. **NEO 6M GPS**
5. **SERVO MOTOR**
6. **MICROCONTROLLER ATMEGA8A**
7. **16*2 LCD**
8. **L298N MOTOR DRIVER**
9. **LDR**

V. SOFTWARE USED

1. MICROCHIP ATM ATMEL STUDIO7

Atmel® Studio 7 is the integrated development platform (IDP) for developing and debugging SMART ARM®-based and AVR® microcontroller (MCU) applications. Studio 7 supports all AVR and SMART MCUs. The Atmel Studio 7 IDP gives you a seamless and easy-to-use environment to write, build and debug your applications written in C/C++ or assembly code. It also connects seamlessly to Atmel debuggers and development kits. Additionally, Atmel Studio includes Gallery, an online apps store that allows you to extend your development environment with native and third-party tools and embedded software vendor developed plug-ins. Atmel Studio 7 can also seamlessly import your Arduino sketches as C++ projects, providing a simple transition path from Makerspace to Marketplace.

2. ESPRESSIF IDF

ESP-IDF is Espressif's official IoT Development Framework for the ESP32, ESP32-S, ESP32-C and ESP32-H series of SoCs. It provides a self-sufficient SDK for any generic application development on these platforms, using programming languages such as C and C++.

ESP-IDF currently powers of devices in the field, and enables building a variety of network-connected products, ranging from simplelight bulbs and toys to big appliances and industrial devices.

3. PROTEUS

The Proteus Design Suite is a software tool suite which is used primarily for electronic designautomation. It is mainly used by electronic design engineers and technicians who create electronic prints and schematics for manufacturing printed circuit boards.Proteus Virtual System Modelling combines mixed mode SPICE circuit simulation, animated components and microprocessor models to facilitate co-simulation of complete microcontroller based designs. It makes it possible to test designsbefore construction of prototype. This is made possible by interaction with design using on screen indicator such as LEDs, LCDs, and actuators such as switches and buttons. (Labcenter Electronics).

4. PULSE VIEWER

Pulse View (sometimes abbreviated as "PV") is a Qt based logic analyzer, oscilloscope and MSO GUI for sigrok. It is licensed under the terms of the GNU GPL, version 3 or later.

Features:

- Fast O(log N) signal rendering at all zoom levels.
- Protocol decoder support.
- Trace groups support.

ADVANTAGES

- Reduces time spent at billing counter and increases customer satisfaction.
- This can reduce the expenses incurred by the management.
- Users can be aware of the total bill amount during the time of purchase which prevent them from overshopping.
- Increases overall efficiency. Allows quick checkout and eliminates waiting in long queues.

VI. APPLICATIONS

- Can be utilized in dress showrooms.
- Grocery store
- Use as common observatory system for owner as he/she can observe billing of all mall from anywhere.

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- Such smart shopping trolley can be used in shopping malls to minimize/reduce human efforts for proceeding with the bill and managing products.
- Used in various industries for tracking and tracing applications, such as inventory management, supply chain management, and asset tracking. Improve product authentication and prevent counterfeiting.

VII. CONCLUSION

The smart trolley summarizes products and seamlessly logging item amounts into a trolley system, users can efficiently manage their purchases. Additionally, incorporating features for easy interaction between users and staff fosters a smoother shopping process, promoting customer satisfaction. This smart trolley Integrates location tracking capabilities for identifying or locating the trolley within the shopping area ensures convenience for users and staff alike. This feature minimizes the time spent searching for trolleys, optimizing the overall shopping experience. The inclusion of secure UPI payment detection enhances transaction security and provides users with a seamless checkout experience. By granting access to users upon successful payment, the system ensures a smooth transition from shopping to product retrieval. The incorporation of wireless communication technology such as WiFi-LAN or Bluetooth Low Energy (BLE) facilitates real-time connectivity between the user's device and the trolley. This enables efficient data transfer, ensuring accurate logging of item amounts and providing a seamless shopping experience.

VIII. FUTURE SCOPE

1. The trolley itself contain an swapping machine for online transaction of payment.
2. Robotics arm also include in it for the picking and dropping of the product.
3. We can also include voice assistance.

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