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Design and Construction of an RFID Based Drug Prescription Management System

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Abstract

This paper presents a device that may be used in hospitals to validate prescriptions and preserve patient data while keeping patients' identities confidential. This paper employs RFID tags to track patient databases via a web server. This system can not only capture accurate and up-to-date information about patients' prescriptions, but it can also limit prescription drug abuse. Patients' real-time data can help doctors reduce medication mistakes and provide the best services possible.

1.0 Introduction

Recently, information technology has been widely utilized in a variety of economic activities, with the healthcare industry being particularly important in terms of economic development [1]. Healthcare services are complicated and life-critical, and one error in any operation can have irreversible effects [2]. Radio frequency identification, or RFID, is an emerging tool that can help with the current challenges. In recent years, medical institutions have begun to employ RFID to manage and track medical equipment, monitor and identify patients, guarantee the proper drug administered to the right patient, and prevent the use of fake medications [2]. RFID systems include small chips known as tags, which carry and send identifying information to an RFID reader, a device that may connect with computers [3]. RFID systems' capacity to offer precise and reliable data about tagged objects will enhance efficiency and bring various benefits to both the corporate sector and consumers in the not-too-distant future [4]. According to current World Health Organization studies and surveys, millions of people are injured or die as a result of inadequate medical treatment (WHO). Misdiagnosis of illnesses and the patient's most recent medical history

have been identified as variables contributing to the growing mortality rate [5]. Our major aim, as revealed in this paper, was to develop an RFID-based system architecture and data model capable of properly handling crucial information for emergency treatment across hospitals and national boundaries. According to [6], medication errors are a significant contributor to patient morbidity, death, and escalating expenses, hence creating an aiding information system is essential for effective health care delivery. A system for maintaining drug information and interacting with pharmaceutical delivery devices was created by [7]. The system comprises software for usage in hospital pharmacies and biomedical contexts [7]. Additionally, [8] built and created a medication error control system that was a prototype RFID-based piece of software that may be used to track and deliver medication in a hospital setting. One issue with the system is that it only covers the control of drug errors and not pharmaceutical monitoring and management.

2. Methodology

The complete circuitry of the RFID-based medication prescription management system has been analyzed in this section, with the various modules in focus. To create a successful medication prescription management system, the proper components that will interact with the medicine process must be chosen (ordering, administration, transcribing and dispensing). The following are the primary components of our suggested system

2.1. Power supply unit

This is the circuit that supplies power to the full system. It obtains power from a 220volts as AC power supply source, to deliver a 5 volts and a 3.3volts DC output.

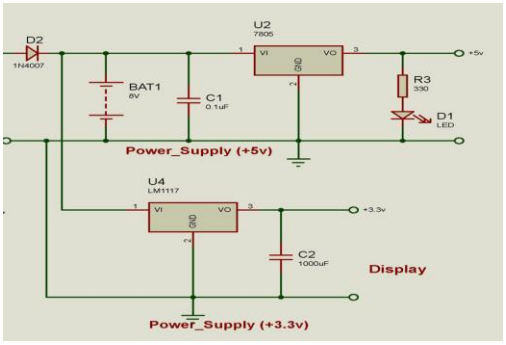


Fig 1: The Power Supply unit.

The calculations of the power supply are as follows;

Component List

1. Voltage regulator
2. Capacitors

3. Diodes

Let's get into detail of rating of the devices :

Voltage regulator :

As we require a 5V we need LM7805 Voltage Regulator IC.

7805 IC Rating :

- Input voltage range 7V- 35V
- Current rating $I_{c\,=}$ 1A
- Output voltage range $V_{max=5.2V}$, $V_{Min=4.8V}$ (1)

Rectifying circuit :

The best is using a full wave rectifier

1. Its advantage is DC saturation is less as in both cycle diodes conduct.
2. Higher Transformer Utilization Factor (TUF).
3. 1N4007 diodes are used as its is capable of withstanding a higher reverse voltage of 1000v whereas 1N4001 is 50V

Capacitors:

Knowledge of Ripple factor is essential while designing the values of capacitors It is given by

$Y=1/(4\sqrt{3}fRC)$ (as the capacitor filter is used)

1. f= frequency of AC (50 Hz)

2. R=resistance calculated

$R= V/I_c$ (2)

V= secondary voltage of transformer

$V=6\sqrt{2}=8.4$ (3)

R=8.45/500mA=16.9Ω standard 18Ω chosen

3. C= filtering capacitance

We have to determine this capacitance for filtering

$Y=V_{ac\text{-}rms}/V_{dc}$ (4)

$V_{ac\text{-}rms} = V_r/2\sqrt{3}$

$V_{dc=} V_{Max}-(V_r/2)$

$V_{r=} V_{Max-} V_{Min}$

$V_r = 5.2-4.8 = 0.4V$

$V_{ac\text{-}rms} = .3464V$

$V_{dc} = 5V$

$Y=0.06928$ (5)

Hence the capacitor value is found out by substituting the ripple factor in $Y=1/(4\sqrt{3}fRC)$ Thus, C= 2314 µF and standard 2200µF is chosen

Datasheet of 7805 prescribes to use a 0.01µF capacitor at the output side to avoid transient changes in the voltages due to changes in load and a 0.33µF at the input side of regulator to avoid ripples if the filtering is far away from regulator.

2.2. Microcontroller Unit

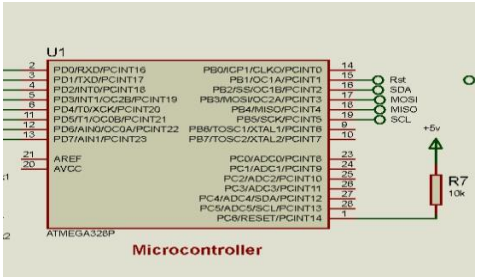


Fig 2: The microcontroller unit

It is an 8-bit microcontroller by Microchip [9] with a high performance and low power controller. Engineers can use the ATmega328P IC for a variety of tasks thanks to its inherent safeguards and many programming options. Embedded systems, motor control systems, display unit peripheral interface systems, SMPS and power regulation systems, industrial control systems, and ARDUINO UNO, ARDUINO NANO, and ARDUINO MICRO boards are just a few of the applications for the ATmega328p [9].

2.3. The RFID Module

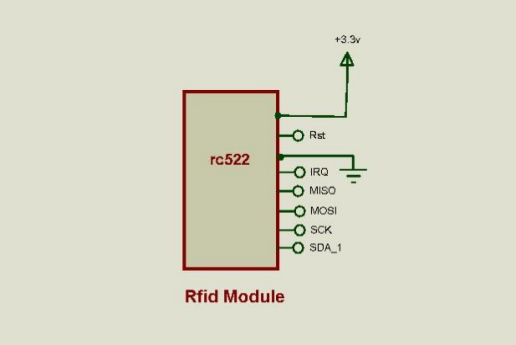


Fig 3: RFID module

It features an RFID reader and RFID tags with an antenna and serves as an input device. When a tag is swiped over an RFID reader, radio waves are used to read and collect the data stored on the tag. The Philips MFRC522 original reader circuit chip design is used in the MC522 RFID module, which is simple to use, inexpensive, and ideal for equipment development, the creation of cutting-edge applications, and the demand for RF card terminal design and manufacturing [10].

2.4. WiFi Module (ESP8266)

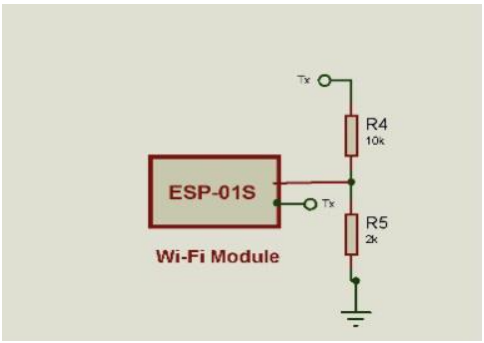


Fig 4: WiFi Module

By default, the ESP8266 has firmware that enables normal "AT commands" to be used to control it. It is also quite simple to write and submit your own code, which gives it a ton of power and flexibility.

2.5. LCD (Liquid Crystal Display)

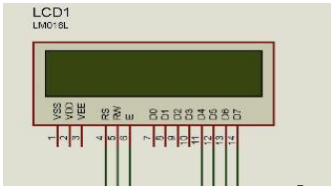


Fig 5: Liquid crystal display

There are several uses for LCD (Liquid Crystal Display) screens, which are electrical display modules. A 16x2 LCD is a very fundamental module that is frequently utilized in many different gadgets and circuits. These modules are preferable over multi-segment LEDs with seven segments and additional segments. The explanations are that LCDs are inexpensive, easily programmable, and have no restrictions on showing unusual and even customized characters, animations, and other content [11].

2.6. Mode of operation

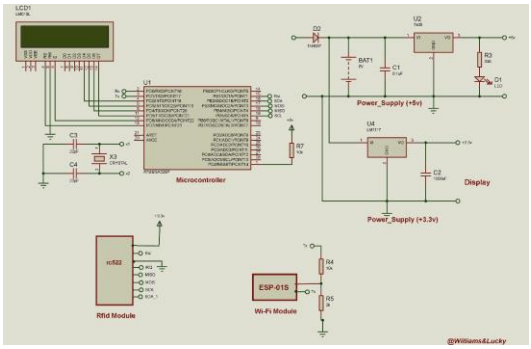


Fig 6: Circuit diagram of the design

The hardware is initialized when the system is turned on, starting with the LCD and moving toward the WiFi module (esp-01s). After initialization, esp-01s establishes a connection with a hotspot or router to enable internet access. The microcontroller will first show the message Swipe the card on the LCD display when the circuit is switched ON. When the ID card is detected by the RFID reader, it sends the specific card number via serial interface to the microcontroller. We must check the obtained card number with the numbers that are already recorded in the microcontroller or any database with the aid of appropriate programming. The microcontroller processes the data as soon as a card is recognized, shows the card ID on the LCD, and sends it to the online platform for processing.

3.0 Result and Discussion

3.1. Activating the website

The steps to connect the website to the circuit are as follows;

1. The user must first connect the WiFi to an hotspot named (hot) and a password (2020hott)
2. The user must open the website named (https://health-care-manager.herokuapp.com) on their smart devices (smart phones or laptop). The website works over the internet.

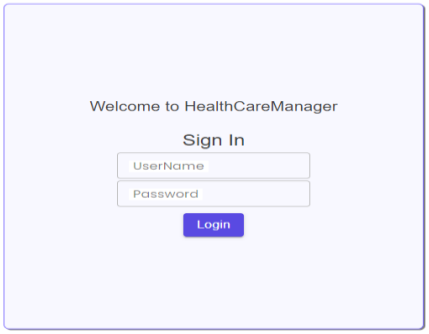


Fig 7: Sign in Account' page on HealthCareManager website Source: Ojo, Lucky and Williams

3. The first user which is the admin is to then create an account of the website. This enables the admin to create an account for the doctor and the pharmacist and patient also.

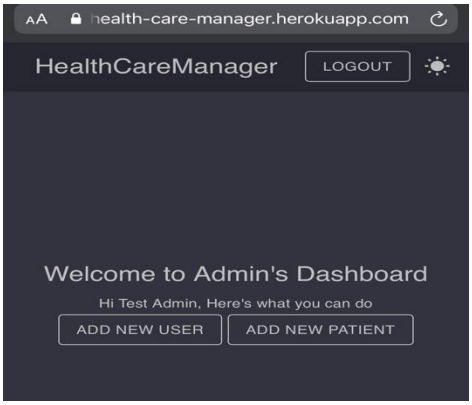


Fig 8: Admin Dashboard Source: Ojo, Lucky and Williams

4. To create an account for the doctor and the pharmacist, the full name, username and password is required.

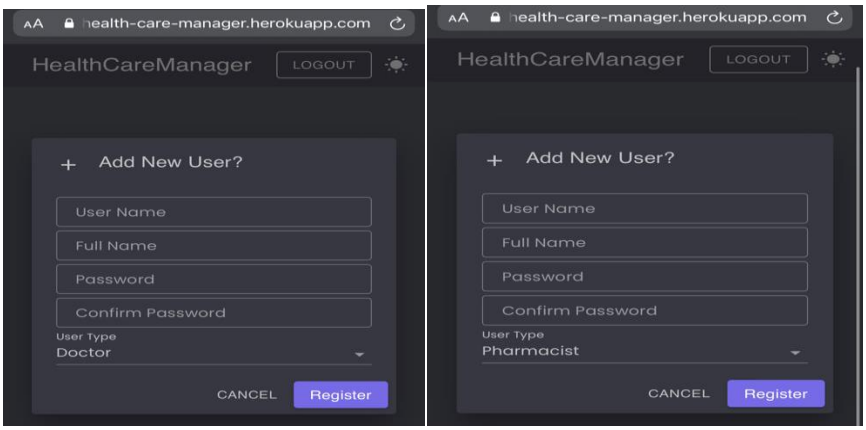


Fig 9: Doctor and Pharmacist Log in. Source: Ojo, Lucky and Williams

5. After creating an account for the user, the admin creates an account for the patient by swiping the RFID tag issued to the patient on the device.

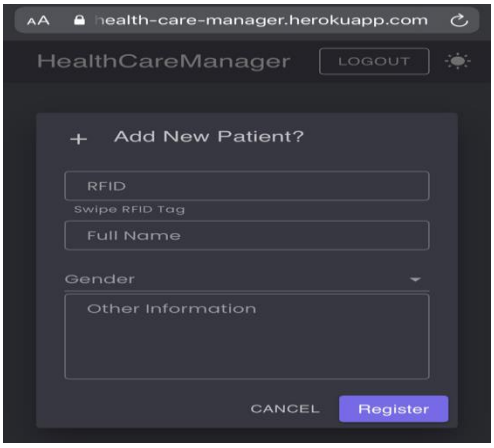
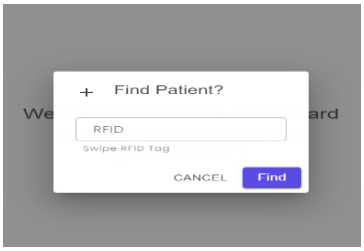


Fig 10: Add new patient dashboard. Source: Ojo, Lucky and Williams

6. Next, after all these processes is complete, Registered Doctor and Pharmacist can access patient's medical history through their respective dashboard.



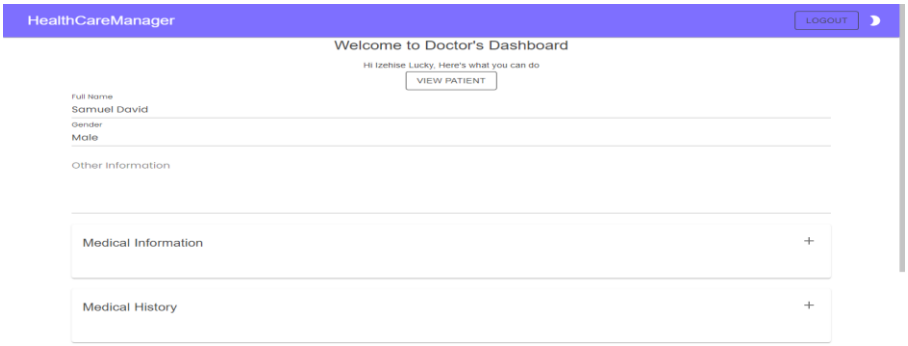


Fig 11. Doctor's dashboard Source: Ojo, Lucky and Williams

3.2 Hardware Assemblance

The following procedures were followed in the construction of the hardware circuit.

1. The design of the circuit was made. This involved the block diagram, it was essential as it served as a guide for the construction of the circuit.

2. The schematic diagram was drawn on the Proteus software and run to ensure the viability of the project.
3. All components were procured.
4. The Vero board was filed on its bottom with sandpaper in preparation for the connections.
5. The IC socked was soldered to the board.
6. The power supply unit, 5V, was connected to the voltage regulator using a wire soldered to its input pin and the output pin of the voltage regulator, L7805 was connected to the microcontroller (ATMega328P) through pin 01 (+VCC) to power the microcontroller was 5V coming from the voltage regulator. The power supply used for this project were 5V and 3.3V respectively. This was possible by connecting the two grounds of the power supply i.e the negative terminals together, while the positive terminals were connected to various components it powered.
7. A DC-DC converter was used to power the Wifi module. This is because the ESP32-01s requires a maximum of 3.3V and voltage regulator coming through other components was 5V. So using the divider rule, two resistors (2kohms and 10kohm) are used as the DC-DC converter to step down the voltage going to the ESP32-01s. The resistors are connected end to end to form a junction.
8. The RFID module, RC522 positive terminal was connected to the ATMega328P on pin
9. The LCD was connected to the ATMega328P on pin 05-13.
10. All the negative terminals are connected together and grounded.

Plate 1: Images of Construction of the Hardware Circuit

Photo Credit: Ojo, Lucky and Williams

3.3. Packaging

A plastic case of suitable insulation for electrical protection and simple use is utilized as seen in plate 2.

Plate 2: Packaging of the Hardware Circuit

Photo credit: Ojo, Lucky and Williams

3.4. Discussion

Although barcode labeling is widely used, economical, and dependable, it is a lengthy and labor-intensive procedure due to the limits of the technology, such as the need for line-of-sight and short-range reading distance [12]. This wireless technology will enhance and improve the efficiency and effectiveness of the procedures involved in receiving, storing, sorting, and shipping [13]. In the case of public hospitals, the suggested system aims to use Radio Frequency Identification (RFID) technology to handle and monitor medications in hospital environments. The suggested method can be inexpensive by using UHF RFID tags to identify the medicine that would be tracked. The system will have user/administration interfaces, an RFID network, and a central database. Another drawback of the drug management and replenishment system is that there are no computerized systems for patient data or prescriptions in Nigeria's public hospitals, making the deployment of such a system impractical. However, this solution overcomes this drawback by using an RFID module to decode the tag that holds the registered patient's information. This system can be utilized at any time because it has an 8V rechargeable battery. Additionally, a software website that permits a special identifying password is used.

4.0 Conclusion

In this paper, the effectiveness of the suggested RFID medication management system for enhancing patient safety and the medication process was established. Due to its scalability and ease of use, this system can be linked into a variety of drug planning and management systems. By scanning a large number of medications at once, our proposal can also improve medication-patient safety, speed up information flow, and eliminate human mistake in healthcare organizations. Our RFID medication management system was created to meet the needs of current medical trends.

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