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Intelligent Blood Management System

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***Abstract*—This paper presents an efficient method for a smart blood management system, called Intelligent Blood Management System (IBMS) that intends to provide a efficient and a real time coordination of blood management within a blood bank as well as to establish great communication amongst multiple blood banks. This system uses an unique and a economical concept of using the weight detecting sensors along with image processing that can efficiently track the quantity of the different blood groups (using colour coding mechanism) in all the associated blood banks, using Cloud connectivity. It uses an internal management analytic that always takes care of the availability of blood and using predetermined logic that can pre populate a blood bank based on the highest frequency of the need of a certain blood in an area. This system has an integration of user interaction also, where users and even hospitals can make requests for blood through the app (including app verification). The mobile application helps users to connect with the system including the fastest way to reach the blood bank and even live tracking if the blood is to be delivered from the bank to the hospital and more.**

***Index Terms*—Smart blood management, Image Processing, Blood bank, Cloud Database, Color Coding.**

I. INTRODUCTION

Blood - Life Force of every creation that lives on this planet has its only source from the people who donate blood on voluntary basis. Blood transfusions are used for trauma victims - due to accidents and burns - heart surgery, organ transplants, women with complications during childbirth, newborns and premature babies, and patients receiving treatment for leukemia, cancer or thalassemia [1]. The blood bank plays a crucial role in maintaining the blood supply chain. Their major responsibility is to supply the blood in order to meet the rising demand from the hospitals [2]. The current blood bank management consists of a number of manual steps making it difficult for the blood banks to maintain a high level of accuracy and reliability thereby the need for automating the blood storage and management system arises to smoothly tackle an emergency situation, if the stock of blood is insufficient or unavailable. Availability of blood is of utmost importance is any situation of emergency [3]. To improve the functionality of the current system which is designed to store, retrieve and analyze information concerned with the administrative and inventory management within a blood bank, we intend to automate the blood management system in a blood bank which shall be beneficial in case of an emergency situation [4]. Moreover, Intelligent blood management system is aimed at providing a great connectivity between the needy patients and the nearest blood banks so that the patients have a hassle free experience. Internet of things is a part of the upcoming and booming concept, Industry 4.0. It talks about how machines/devices are connected and are communicating with one and another ultimately without human involvement. The features of IIoT (Industry 4.0) are key standards for creating the pathway, better and faster decision making, people empowerment is essential, cybersecurity will be a major issue, a new generation of sensors will be coming and cloud computing and big data will play an important role. This paper also has a major role in the Internet of things, where devices are expected to communicate with each other.

II. PROBLEM STATEMENT

According to the World Health Organization, Southeast Asia's estimated blood requirement is about 16 million units per year, but it collects just about 9.4 million units annually, leaving a gap of 6 million units. India with its huge population of over 1 billion is lagging behind in blood collection. India has 2,433 blood banks that can collect 9 million units of blood annually, but collects only 7 million. And the two main reasons are management and awareness. Considering the blood management side, theres lack of uniformity, consistency and up-to-date regulation and policies of the blood banks.This makes the data susceptible to errors and human mistakes which in turn puts human lives in danger [5]. In addition, theres inability to transfer blood units between blood banks which sometimes leads to units expiring on shelf. And there is no centralized database to big a mass track. A hospital may have its own system and blood bank but co-ordination between neighbouring blood banks is practically impossible [6].

Blood donors in India, are divided into three categories - voluntary donors, replacement donors and professional donors. Most donations are because of replacement donations, which are non-remunerated donations, provided by the relatives of patients who need blood either on urgent basis or for an-

ticipated transfusion during planned surgeries. Professional donors are those who donate blood in exchange for money. There has always been blood shortage in most of the blood banks because the blood banks fail to organize voluntary blood donation camps on a regular basis and depend mainly on replacement donors. As a result, there is always pressure on patient to procure blood when needed. According to the protocol specified by National AIDS Control Organization (NACO), 25% of all blood collected by a blood bank has to be kept aside as buffer stock, to be used only in the case of an emergency. However, according to NACO out of India's 2433 blood banks, only 20% are able maintain the buffer stock.

III. NEED FOR THE SYSTEM

Currently, the blood banks are operated manually where the blood bags are handled by the assigned medical staff [7]. Looking at the problem which is broadly talking about the awareness, shortage of blood management comprising of communication and network connectivity among multiple blood banks, Intelligent Blood Management System is an effective application, to solve such a problem. In order to increase connectivity among multiple blood banks, this system has a common centralized database that is able to mass track the management and mobility of the different parameters like movement of the blood units, volunteering blood donor details and more [8] . It does real time assessment and provides instant alerts within the blood bank whether the blood units are available or not. This is done with the help of smart colour coding mechanism. Machine learning algorithms help in making a smart judgment in determining the requirement of blood units for a particular area. With this method, the blood units can be circulated before the occurrence of an emergency, from one blood bank to another which actually would require more than other. The application also does an extensive awareness effort by displaying different info pop ups and insights of how important it is to voluntarily donate blood. An additional source of blood units is that the blood banks can request for the required units online to the other blood banks who are capable of giving. This decision is automated as well. With a communication among the blood banks but there also is connect among the hospitals that might need blood during their critical surgeries. This is mainly for those hospitals that dont have their own blood bank. The application also connects the normal users to the special features of the IBMS [9]. If the user wants to donate blood, he/she will know where to go and whom to approach.

IV. OBJECTIVE

There will always be a high risk to the medical requirements like blood due to manual intervention and management of the blood packets and lack of inter and intra communication [10]. Hence the main objective is to make sure that the system is automated so as to reduce or nullify this risk. IBMS intends to keep a smart count of the various blood groups and to establish a strong network between all the blood banks, hospitals and the customers. It gives a time to time alert to the system that a certain blood group is needed at certain blood bank before hand. Prime objective is to devise a system which will automate all the counting of blood bags for each blood group, thereby, eliminating the need of human intervention. It's futuristic objective is to work hand in hand with a machine learning algorithm that will predict which blood bank requires more number of a particular blood group as compared to other regions with respect to the type of population living near that blood bank. Hence an effective communication is established.

V. SYSTEM DESIGN

In the current system, labels are attached to blood bags. The blood group identification is done using the blood group specified on this label. Now, in the IBMS, these blood group identifying labels are replaced using color codes. When these bags are kept in the refrigerator, the camera scans for the different color codes and gives a count directly, involving no human efforts. Hence, the chance of error in counting manually reduces. Also in the conventional blood bank systems, database of the donors is not always maintained [8]. But IBMS keeps the data of all the donors with the help of a cloud server. Hence, penalization of data is easy. Users, as well as the blood banks, can keep a track of all the donations. This information stored in a database can reveal blood management shortcomings and identify opportunities for improvements. The Intelligent blood management system consists of a number of hardware and software components which are interconnected. Following are the components used in the said system:

A. MSP432P401R LaunchPad

The MSP432 is a LaunchPad manufactured by Texas Instruments based on the 32-bit ARM Cortex-M4F CPU. In the system the MSP is used to control the motors. For controlling the motors even a motor driver is interfaced with the MSP432.

B. CC3200 LaunchPad

The CC3200 is a Texas Instruments based LaunchPad based on Cortex M4 MCU. This launchpad has built in WiFi connectivity created for the Internet of Things(IoT) applications. The OV7670 camera module is interfaced with the launchpad which carries out colour identification of the colour code on the blood pouch. The launchpad will be connected to the WiFi and also the colour code will be send on the ThingSpeak cloud. ThingSpeak is an Internet of Things(IoT) platform used for storing and retrieving data on or from the channels created on the registered ThingSpeak account.

C. OV7670 Camera Module

This camera module is used to scan the blood bank and detect the colour code on the blood pouches. Image processing will be carried out on the captured image to identify the colour. Then the colour code will be sent to ThingSpeak database and then all the acquired data will be processed.

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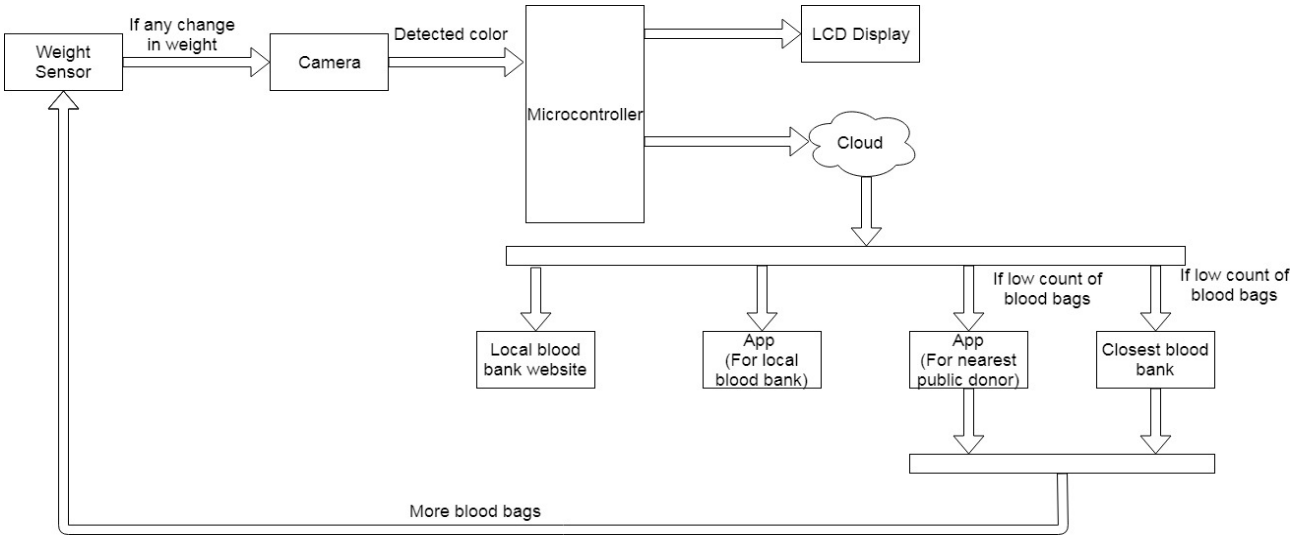

Fig. 1. Block Diagram of the Intelligent Blood Management System

D. Load Sensors and its ADC

The load sensors are used to detect the change in weight in any of the compartments of the blood bank refrigerator. These load sensors will be attached to every compartment of the refrigerator. The load sensors will be monitoring the weight of each compartment continuously. If there is any change in the weight of any compartment, the microcontroller will trigger the camera module to scan that particular compartment. HX711 is the high precision 24-bit ADC for the load sensors. It will be used to process the analog values sent by the load sensors. The ADC will continuously send the data from load sensors to the microcontroller but the camera will be triggered only if the weight is changed.

E. Stepper Motors

There are 2 stepper motors used in the construction of the system. The motors are used in a similar configuration to that of the CNC machine. One for the horizontal motion while other for the vertical. This combination of the motors will be used to maneuver the camera to the compartment where change is weight is detected. So even this system of the motors is activated when change is found in the weight.

F. Android Studio

Android Studio was used to design and build the companion app for IBMS. The front end of the app was designed using XML and the back end using Java, which was supported by Firebase.

G. Firebase

Since the main objective of the system is to achieve quick, smart and real time information movement to give dynamic alerts and remainders, we choose to use the Googles Real Time Firebase. Firebase is Google's web platform that helps you quickly develop high-quality apps and grow your business. Connecting Django project in python to Firebase and android application is very easy and flexible and it is hardly 5 lines of code for establishing connections.

VI. METHODOLOGY

The following steps are followed by the IBMS for a hassle-free working.

1) Initially, the camera counts the number of tags of the same color to get a count of the number of blood bags pertaining to that color code by processing the image of the colored tag.
2) The microcontroller then displays this count on a screen just outside the blood bag storage, as well as sends this count to the cloud database.
3) This data on the cloud is visible to the local blood bank on a website as well as on a mobile application, so as to keep a track while not being around the storage area.
4) If the number of blood bags of a particular blood group falls below a threshold value, a notification to the nearest bank will be sent to the nearest blood bank, requesting the blood bags of that blood group.
5) A version of the mobile application stated would also be available for the general public, on which the users will be notified about the shortage of blood in a blood bank, so that he / she can donate. The needy users can also search for the required blood group through this app. The app will navigate them to the nearest blood bank.
6) After steps 5 and 6, if there is a change in the number of blood bags, the weight sensor will detect it.It will again start counting only when there is a change in weight (implying a change in number of blood bags). If the camera starts counting, the above steps are repeated.

A summary of the methodology is shown in the form of a block diagram in Fig. 1.

The IBMS Companion mobile application (Figure 2) is available for android devices, having Android version above

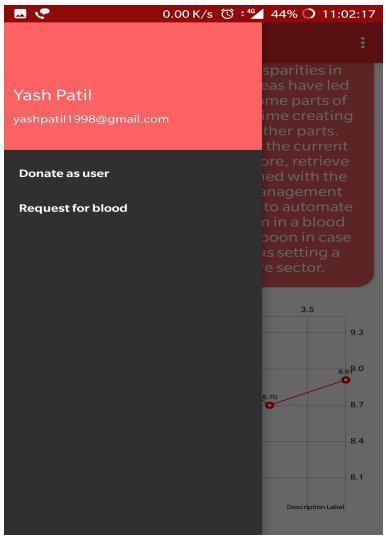

Fig. 2. IBMS Companion Mobile Application

6.0 (Marshmallow). The app has many functionalities:

1) A user can donate voluntarily as per the need of various blood banks or hospitals near him. The user can send a donation request via the app, and will be notified as per the requirements near him. The user can also specify the maximum distance he is ready to travel to donate blood. And using geofencing, he will be redirected to the nearest blood bank in the radius specified earlier.
2) A user can also request for blood pouches via the app. All he need to do is put the blood group details, quantity, and the user will receive a notification from the nearest blood bank, stating availability.

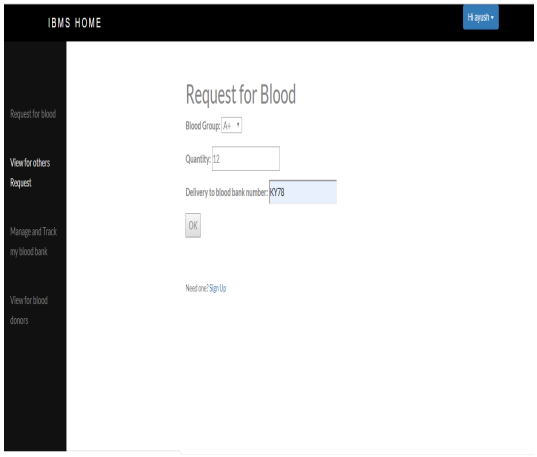

Fig. 3. IBMS Website

The need of the IBMS website (Figure 3) in this system is because the huge organisation like the blood banks and hospitals have a classic reception model where the system needs to keep a track of the entire database and needs to have a better view of the activities going on. Moreover these target organisations dont need portability. The website is personalized. This means that there are different features for the blood bank website and different features for the hospital website. The additional feature in the blood bank website would be that it would be connected to a smart blood tracking system that will automate the monitoring of the blood bank and display insights and alerts-reminders on the website.

One of the major processes of storing the blood bags is attaching a label on the bag. The conventional method involves attaching a sticker which bears the blood group and a barcode which encodes in it the expiry date of the blood. The IBMS aims to change this convention and introduce a more convenient method that ensures the certainty of the labelling by introducing colour coding. Basically, each blood group is identified by a different colour. The table 1 shows the blood group along with its associated colour.

TABLE I
ADOPTED COLOUR CODE FOR THE SYSTEM

Blood Group	Colour
A+	Red
A-	Blue
B+	Green
B-	Yellow
O+	Orange
O-	Brown
AB+	White
AB-	Magenta

Each blood bag is stored for 42 days in a blood bank after which it is dispose off. Hence to mark the expiry date of the blood bag, an expiry label is used. This label is simply attached on the blood bag and after a period of around 42 days the colour of the label changes to black or any designated colour indicating the expiry. This label is made up of two layers - the front layer and the back layer. The front layer comprises of self - adhesive vinyl sheet and the back layer is the ink printed layer. After a predetermined time, the ink from the back layer migrates to the front layer changing the appearance of the label. The time taken by the ink to migrate depends upon the adhesive used and the concentration of the dye in vinyl. For the IBMS we use black colour as the migratory colour. Hence, the expiry of the blood bag is indicated when the label turns completely black.

The colour coding is captured by the camera. Image processing is carried out on the captured image indicating the blood group. If the image is found to be black, it indicates the expiry of that particular blood bag. The colour identification is basically carried out by analysing the pixel values from the image. The RGB(red, green, blue) content in the particular pixel is calculated and based upon these values the colour is identified. The table 2 illustrates the pixel values for the colours which are used for colour coding.

There is a specified range of the RGB values and if the detected image has the values in that particular range, the colour will be identified and hence the blood group.

When weight sensors in a blood bank detect shortage of blood pouches, it should publish a message to all the

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TABLE II
PIXEL VALUE FOR IMPLEMENTING COLOUR CODE

Colour	Pixel Values
Red	(255,0,0)
Blue	(0,0,255)
Green	(0,255,0)
Yellow	(255,255,0)
Orange	(255,165,0)
Brown	(165,42,42)
White	(255,255,255)
Magenta	(255,0,255)

subscribed blood banks that so and so blood bank is facing shortage issues. Either help, it accepted and delivered or the blood bank has to set up timely donation camps. The earlier scope was based on publishing data on the Thingspeak IoT platform and then do scraping to obtain it. However, a better way of establishing communication between two IoT devices in this scenario would be using Messaging Queue Telemetry Transport (MQTT). It is a lightweight protocol based on the publisher-subscriber concept. The main broker or a server is maintained to keep a track of all the published data on their respective topics and to make sure this data is delivered to all the subscriber based on various levels of Quality of Service (0, 1 and 2).

Lets consider if the weight sensor detected a change that whatever is kept those pouches will be running low in a matter of some time. Hence this change will trigger the MSP430F5529 to drive the motor (that has an attached camera), to that area where the change was detected. Once the camera reaches that area, it will try to recognize the color coding and processing and conclude that the A+ blood pouches are running low. This Information is packed in a data packet and published onto the broker using MQTT and QoS (2- the highest level of transfer ensured).

VII. COMPARISON WITH OTHER EXISTING SYSTEMS

Table 3 gives a comparative study between some of the methods prevalent in handling blood. The table also depicts the differentiating factors that the proposed Intelligent Blood Management System has in comparison to the existing system.

TABLE III
COMPARISION WITH THE OTHER EXISITING SYSTEMS

Parameter	IBMS	TNGOV	Mediware	BirlaMediSoft
Automatic Count Detection	Yes	Yes	Yes	Yes
Automatic Expiry Detection	Yes	No	Unknown	Unknown
Connecting donors and Hospitals	Yes	No	Yes	Yes
Connecting Blood Banks	Yes	No	Yes	No
Mobile Application	Yes	No	No	No
Website Functionality	Yes	Yes	Yes	Yes
Colour Coding Based Detection	Yes	No	Unknown	Unknown

VIII. CONCLUSION

The intelligent blood management system can turn out to be a boon for blood banks and hospitals by helping them automate the blood management process. The system also provides with realtime analytics of the donations and requests of blood pouches. The color coding scheme to identify blood pouches based on blood groups is unique and makes it very easy to handle pouches since the pouches donot need to be in a sorted order based on blood group.

IX. FUTURE SCOPE

The smart automated IBMS pre-detects the need for a certain blood group based on both scenarios of drop/demand of the respective. Hence there would never be a situation that a certain blood group isnt available at the bank. Moreover, the IBMS mobile application is smart enough to guide the requesting user to the nearest blood bank based on the current location of the user. Before guiding to the nearest blood bank, it does a final check whether the required blood of requesting user is available or not. According to our system it is very unlikely however, the IBMS is caring enough to do a double check on this too. Lastly, the system will be able to analyse areas in a city where the demand of a certain blood group is high, based on which, will make sure that the number of blood pouches of that particular blood group is sufficient in a blood bank in that area.

REFERENCES

[1] Rehab S. Ali, Tamer F. Hafez, Ali Badawey Ali, Nadia Abd-Alsabour"Blood bag: A web application to manage all blood donation and transfusion processes", *International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET)*,Chennai, India, Mar 2017.

[2] Radha R. Mahalle, S. S. Thorat "Smart Blood Bank Based On IoT: A Review", *International Research Journal of Engineering and Technology (IRJET)* , Jan-2018.

[3] Amarjeet Singh Cheema, Siddharth Srivastava, P K Srivastava, B K Murthy"A standard compliant Blood Bank Management System with enforcing mechanism", *International Conference on Computing, Communication and Security (ICCCS)*, Pamplemousses, Mauritius, Dec 2015.

[4] N. Adarsh, J. Arpitha, Md. Danish Ali, N. Mahesh Charan, Pramodini G Mahendrakar"Effective blood bank management based on RFID in real time systems", *IEEE International Conference on Embedded Systems (ICES)*,Coimbatore, India, Jul 2014.

[5] Ibrahim Fawze Akar, Tukur Anas Mohammad, Mohamed Ismail Z "CBBR Centralized Blood Bank Repository", *International Journal of Information System and Engineering*, Apr 2015.

[6] Javed Akhtar Khan and M.R. Alony "A New Concept of Blood Bank Management System using Cloud Computing for Rural Area (INDIA)", *International Journal of Electrical, Electronics and Computer Engineering*, Feb 2015.

[7] Soo-Jung Kim1, Sun K. Yoo, Hyun-Ok Kim, Ha-Suk Bae, Jung-Jin Park, Kuk-Jin Seo, Byung-Chul Chang "Smart Blood Bag Management System in a Hospital Environment", *IFIP International Federation for Information Processing*, Jan 2006.

[8] Yulius Harjoseputro "Blood Transfusion Information System Design for Blood Transfusion Services Unit", *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, Sep 2018.

[9] Fitra Lestari, Ulfah Ulfah, Fitri Roza Aprianis, Suherman Suherman"Inventory Management Information System in Blood Transfusion Unit", *IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*,Bangkok, Thailand, Dec 2018.

[10] Abhijeet Gaikwad, Nilofar Mulla, Tejashri Wagaj, Raviraj Ingale, Prof. Bijendra Gupta and Prof. Kamal Reddy "Smart Blood Finder", *International Journal of Trend in Scientific Research and Development (IJTSRD)*, Nov-Dec 2018.