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A Novel Design of ARM based Automated Medication Dispenser

Better Medication Leads to Better Life

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***Abstract*— In this busy scheduled life, people usually tends to forget to take their medicine on time due to forgetfulness or memory loss due to aging. In rural India most of the people are unable to follow the physician's prescription, which causes over dosage or wrong dosage due to misunderstanding of physician's direction. It may cause negative consequences for patients. Sometimes it results to severe impact on their health.**

This paper presents the design and implementation of "A Novel Design of ARM based Automated Medication Dispenser" for those who take medications without continuous professional supervision. Automated dispensing systems are eHealth drug storage devices that electronically dispense medications in a controlled fashion and track medication use. Monitoring of medication has been given the highest priority. Automated pill dispenser can track the missed medications doses. It notifies the patients through buzzing an alarm, or throgh a phone call or flashing data on the server. Live data is updated in the server for each dose at the scheduled time with help of IoT. Sometimes even after the alarm, if the patients did not take any medicines then it will alert the care takers/ nursing staff through sending messages to server or making phone calls. Caretaker can acces the details anywhere using mHealth.

Keywords*— *Automated Pill Dispenser; eHealth; mHealth; IoT; Medication

I. INTRODUCTION

Proper medication adherence determines the success rate of treatment. Failure to adherence causes severe problems which not only affects the patient health but also the health care system. Medication non adherence in patients causes worsening of disease, death and increased health care costs [3], [7]. A survey conducted by Nation Community pharmacists Association (NCPA) shows that only 24% of patients strictly adhere to the medical prescription, which proves that more than 75% of the patients fail to follow their medication due to various reasons [4]. Most common reasons for medication non adherence are forgetting to take medicines, wrong dosage, over dosage, taking old pills without consulting doctors and stopping the prescription early. Non adherence results to severe negative consequences of the health and increases the health care cost. For the non adherence health care system costs an estimated cost of $290 billion annually [4].

In the rural parts of India most of the patients fail to take medication on time. Therefore taking right medication at the right time is essential for the patients, which helps in betterment of their life. There are few medication reminder devices available but they do not provide the feedback for medication adherence. Cost of such devices is also very high for rural India to afford [8]. No central monitoring system is available with the existing devices. The cost of such devices varies from US $80 - $500 approximately 5000 to 45000 in Indian rupees [5].

Proposed Solution

A Novel Design of ARM based Automated Medication Dispenser is a proposed solution for medication non adherence. It is designed on cost constraints so that people in the area can afford to buy it or can take it for rent for fewer amounts. It keeps track of the medication adherence and gives the highest priority for notifying the patient in all channels. Here the channels are Buzzer, phone call, flashing on Server. With their existing mobile phones they can able to get all the updates and notification alerts.

Automated medication dispensing systems are drug storage devices that electronically dispense medications in a controlled fashion and track medication use [6]. Automatic medication dispenser can track the missed medications doses. It alerts the patients by beating alarm and through a phone call to the patient at the scheduled time. Sometimes even after the alarm, if the patients do not take any medicines then it will notify the care taker/ nursing staff through messages, phone calls and by displaying live data on the server. There are two applications of the Automatic Medication Dispenser. 1. In-house patients and 2.In-hospital patients.

In the In-house mode the family member receives the dosage details and missed doses list through messages, phone calls. In the In-hospital mode the nursing staff receives the dosage details and missed doses list on the central server. It can be used for either of the applications.

II. PROPOSED DESIGN

A. Design overview

Automated Medication Dispenser has three major units: microcontroller based dispensing unit, mobile notification unit and server remote monitoring unit. The Figure 1 represents the overview of the Automated Medication Dispenser. Microcontroller based medication dispensing unit plays a vital role in tracking the medication list and is responsible for notifying the patient during the scheduled time. This unit consists of a keypad, LCD, GSM/GPRS, DC motor, mini servo motor and buzzer. Keypad is used for setting an alarm and updating the details like mobile number.

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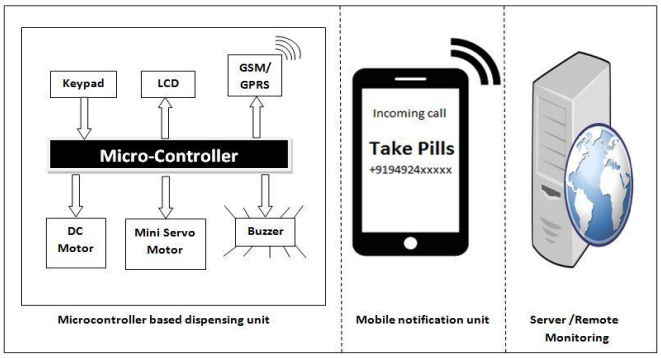

Fig. 1: Overview

LCD is used to display all the information like present time, next dosage details etc. GSM/GPRS module is used to notify the mobile unit and for updating the live data on the server through GPRS. DC motor and servo are used to dispense the medications in a controlled fashion. The Mobile unit gets the notifications from the microcontroller through GSM during the scheduled time. The server gets data from the microcontroller through GPRS.

The working process is split into three steps for the ease way of implementation.

1. Patient gets the prescription from the physician and the medications are loaded with help of prescription details and the alarms set for those schedules.

2. Device will always show the present time and next dosage time and also keeps on monitoring the medication schedules. If the present time matches with the alarm time then it will notify the user with help of buzzer and a call via.

3. If the patient still does not take medicine then it will be added to missed-out dosage list. The details of dosage will get uploaded to sever. The alarm gets updated to the next dosage schedule.

These three steps are repeated until patient gets completely recovered.

B. Keypad Functionalities

In the design of Automatic Medication Dispenser, following functionalities are available: SET, LIST, HOME, ENTER, PRE DOSE, Backspace and numbers from 0 to 9. SET is used to configure alarm and update the mobile number; LIST is used to show the list of dosages and its corresponding dosage time. ENTER used to commit the changes and also used as dispense switch. Pre Dose is an additional feature to the Automated Medication Dispenser.

III. IMPLEMENTATION DETAILS

Automated Medication Dispenser has one NXP LPC2148 ARM controller, one 20X4 LCD, one GSM/GPRS SIM 900a, one 4X4 keypad, one Buzzer, one DC motor of 30 RPM and one mini servo motor. The Microcontroller along with keypad, LCD, motors and GSM/GPRS together forms the dispensing unit.

A. Hardware implementation

A NXP LPC2148 ARM controller is the back bone of the dispensing unit. Dispensing unit consists of MCU (Microcontroller unit), keypad, LCD, GSM/GPRS modem, DC motor and mini servo motor. When no activity is requested the MCU displays the RTC (Real time clock) and next dosage time on LCD. During the scheduled time the MCU will raise an event for beating buzzer and notifying the patient's mobile through the GSM modem. Medication box is ready for dispense as shown in the inner view of the dispensing unit Figure 2. In the inner view of the dispensing unit there are three pipes which are used for the storage of medication boxes. Each pipe stores medication boxes of corresponding dosage schedule. Three pipes are placed on the top of DC motor shaft. In the middle there is shaft for pushing the medication box.

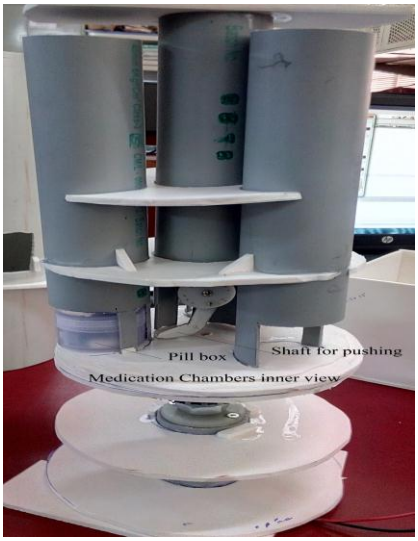

Fig. 2: Inner view of the dispensing unit

There are few dedicated keys on the key pad. One is the ENTER key which incorporates two functionalities: as a submit button during the configuration settings and as dispense button during the scheduled time. During the scheduled time before notification are turned on, the base of the dispensing unit rotated to scheduled dosage. Start notifying the patient via all channels. Upon pressing the dispense button, the mini servo motor will push the will box into the dispense space.

Pre Dose key is an additional feature to the Automated Medication Dispenser, as the dispenser ever time show the next dosage time, if in any case patient knows that he is not available at the home then they can request for pre dose by pressing this key. It will dispense the medication box and it reminds the patient in the scheduled time.

B. Software implementation

Software implementation has two parts 1) Various functionalities of Automated Medication Dispenser 2) Server side programming.

The most common functionalities on microcontroller side are setting an alarm, notifying the patients, running RTC and displaying it on LCD (Home), updating the live data on server. The flow chart shown in below gives all the functionalities incurred in software flow of implementation.

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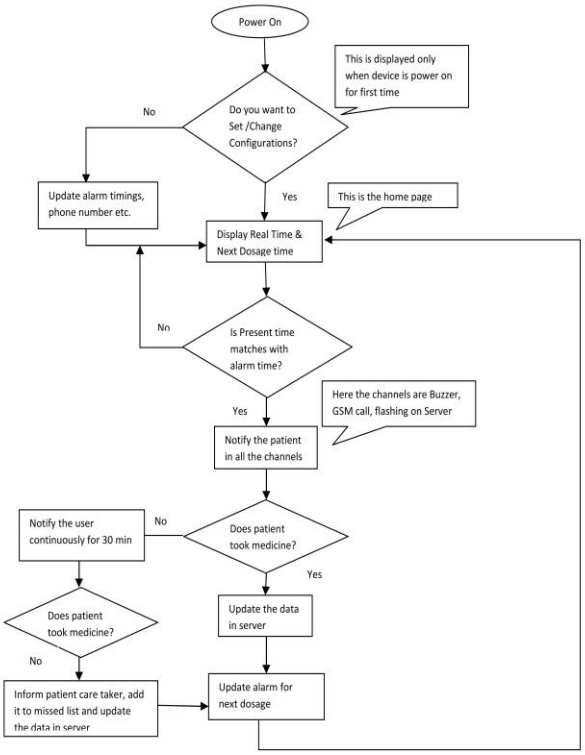

Fig. 3: Software Flow Chart

When the device is turned on for the first time it will ask to configure the list dosage schedules (alarms) and contact details for notifying the patient during scheduled time. The Software functionalities of each block are given below.

Home: By default, the device is displaying the RTC and next dosage details on LCD. Compare the present time with the scheduled time. In this mode the MCU accepts the interrupts from the 4X4 keypad. If there is any event raised by the keypad then interrupt service routine is executed.

Notify Mode: If the scheduled time matches with the present time then the notifying mode is activated. In this mode the patient gets notified via channels. Here the channels are buzzer, a phone call and a message. MCU will poll the dispensing switch continuously.

Dispense Mode: In this mode the microcontroller pushes the medication box to the dispense space. The position is identified with help of limit switch.

Update Mode: In this mode, status of medication is updated to the server from MCU. Also it updates the alarm for the next dosage and moves back to the home screen.

Server accepts the data from the Automated Medication Dispenser and monitors the usage of the medication which helps central nursing staff to maintain all the patient medication details. Server maintains the missed dosage list and also the medication status on the user profile.

IV. EXPERIMENTAL RESULTS

We validated the effectiveness and the advantages of our proposed design by testing both hardware and software. We have divided the validation process in two steps: 1) validating the Microcontroller based dispensing unit and 2) Tracking patient's adherence to the prescribed medication from the server in two ways a) tracking by central nursing stuff when used within hospital b) tracking by patient's care taker when used within house.

The reason for choosing LPC2148 is because it has inbuilt RTC which plays the key role in the functioning of device. The 20X4 LCD is chosen to display the following parameters like present time and next dosage time in an effective way. The 30 RPM DC motor is chosen because it provides the required speed i.e a single rotation in 24 hours. We verified the functionality of each module individually and thus obtained the required result effectively. The Automated Medication Dispenser is demonstrated in attached Figure 4.

Fig. 4: Prototype of Automated Medication Dispenser

Tracking patient's adherence to the prescribed medication from the server is demonstrated in the attached in Figure 5 and 6. Tracking of medication from server gives the patient details and live tracking status.

The cost of the existing medication reminder varies from 6000 to 50000 INR. We incorporated both In-house and In-hospital functionalities in the same device for approximately 5000 INR.

Taking into consideration of existing medication reminder we added new features to the device like pre dose and central monitoring. Thus people can get the adherence medication report from any part of the world.

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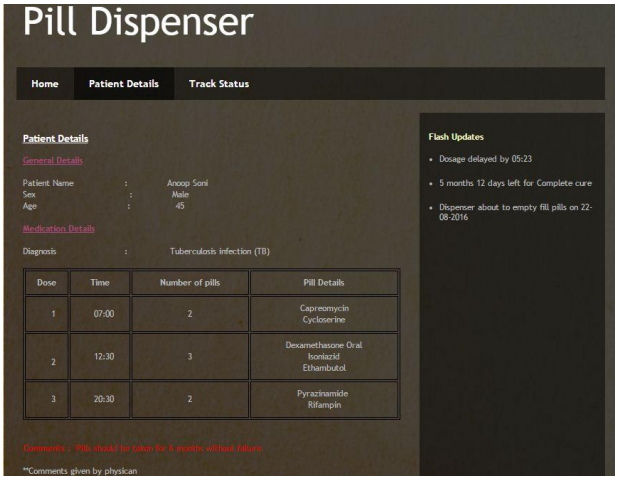

Fig. 5: Patient details as viewed on server

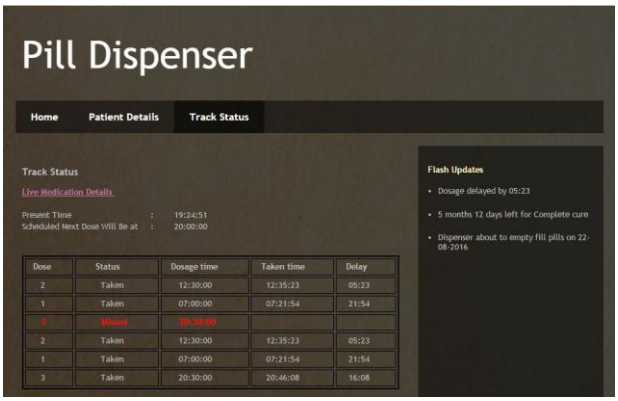

Fig. 6: Live tracking status as viewed on server

V. ALGORITHM

The proposed Dispensing system implements the following steps. Steps 1-3 are to be done by the user/technician.

1. Initialize the RTC (Real Time Clock).
2. Configure the list of scheduled doses (alarms) for medication.
3. Fill the medications according to the schedule.
4. Display present time on LCD.
5. Check whether RTC matches with dosage time.
6. If yes go to 7, if no go to 4.
7. Notify the patient by beating buzzer and making phone call to patients, display dosage time, dosage list.
8. Check whether Dispense button is pressed or not. If button pressed, go to 11.
9. If dispense button not pressed, Check if (RTC time>dosage time +30 min) if yes go to 10, if no go to 8.
10. Add the dosage in missed list. Go to 12.
11. Dispense the medicine, display next schedule time.
12. Update the data in server.
13. Update the alarm to next dosage schedule.
14. Go to 5.

VI. CONCLUSION

There are some automated medication reminder systems which are available, but they have some difficulties such as complex process, expensive and not being portable one. The proposed Automated Medication Dispenser overcomes the drawbacks of the conventional system. This smarter device is smaller in size, economical, has a better accuracy, it is compact and less complex in operation. A Novel Design of ARM based Automated Medication Dispenser is implemented for those who take medications without continuous professional supervision. The proposed system certainly would help all aged patients especially illiterate people to take their medicines on time. This system would also be a feasible solution for the elderly patients struggling to take medicines as per the prescription given by the physician.

VII. ACKNOWLEDGMENTS

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REFERENCES

[1] C. Crema, A. Depari, A. Flammini, M. Lavarini, E. Sisinni, A. Vezzoli "A smartphone-enhanced pill-dispenser providing patient identification and in-take recognition " Medical Measurements and Applications (MeMeA), 2015 IEEE International Symposium on .
[2] Pei-Hsuan Tsai, Tsung-Yen Chen, Chi-Ren Yu, Chi-Sheng Shih "Smart Medication Dispenser: Design, Architecture and Implementation" IEEE Systems Journal Year: 2011, Volume: 5, Issue: 1.
[3] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3191684
[4] https://www.ncpanet.org/pdf/reportcard/AdherenceReportCard_Abridged.pdf
[5] http://www.epill.com/dispenser.html
[6] http://archive.ahrq.gov/clinic/ptsafety/chap11.htm
[7] http://www.hindawi.com/journals/bmri/2012/381493/
[8] https://www.bindependent.com/pillidispensers.htm

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