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Smart Medicine Kit using Embedded IoT for Visually and Hearing-Impaired Patients

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Abstract
Health is one the most important aspects that can be considered by most of the human beings. Nowadays, Diseases keep on increasing day by day and people keep on taking tablets and certain medications to control those diseases. Missing to take tablet on time causes severe health problems to some of sugar patients etc., but people now a days keep on missing to take tablet on their regular life that causes health problems. Some people alter the tablet by mistake when tablets are mixed in the cover. Many uneducated people as well as visually and hearing impaired patients are not even know which tablet have to take. According to many medical surveys many heart patients are died because of forgetting to take essential tablets. To avoid such ill effects, we have developed a smart device which can act as automated medical assistant to the patient. An alarm with visual indication will be given using buzzers with LED at tablet taking time and the single button will be used for open or close the tablet rack on at that time of the alarm. A rack will be pushed, and that contains tablets to be taken at that time to avoid confusions on altering of the tablets. The medicine kit configuration also done using eight buttons with multiple options like morning, afternoon, evening, night, snooze, emergency open etc., and an immediate action will be taken by sending SMS to guardian with the help GSM module when the patient missed to take tablet. For further clarification how many times patient missed the tablet with date and time will be updated to hospital through IoT for the corresponding patient ID. These details can able to view by the doctor which helps to diagnose the patient. Process of this medicine kit was controlled by using 8-bit Microcontroller.

Keywords: Health, Diseases, Tablet, medical surveys, buzzer sound, GSM/GPRS module, IoT, visually impaired, hearing impaired, 8-bit Microcontroller.

1 INTRODUCTION

1.1 Tablet Remainder

The main responsibility of the “Smart Medicine Kit” is to act as medicine indicator. So, the buzzer was used for different beep sound with distinguish use of operating time delays. Most of the patients forget to take tablets on time and on the actual time to take them as per the prescription [1, 2]. Sugar patients, heart patients, blood pressure and very elder peoples and for many reasons people take tablets regularly [3]. In some cases patients may forget to take the tablet, this may cause many side

effects to them, tablets should be taken in correct time without any delay in order to make sure that they have an enough amount of antibiotic in your body at all times.

To avoid this we ensure the remainder in the kit in which real time clock is interfaced in order to match the patients prescribed timing and to alter them for taking pills and we can set the time for the different prescribed timing as per the consultant [4, 5]. Auto snooze (snooze time is to be set as per the user wish) option is also available for the convenience of the patient when patient unable to take the tablet while intimation time and can take the pills later on.

1.2 Rack System

Rack system is used to bring the tablet out of the kit automatically using the DC motor with pulse gears [6] .These DC motors are controlled by the PIC controller for the open and closing of the rack system. We used the rack system for the protection of the tablets from the chemical degradation as in the kit the tablets are kept with the covers closed, so the external factors like temperature, moisture and oxygen will not affect the tablet's chemical composition. For opening and closing of the tablet racks automatic system according to the time that was set already and push buttons are available for the opening and closing of racks this will be helpful for the illiterate and the aged people for taking tablets in the ease way. This system was incorporated with LCD display and push buttons and controller this helps to maintain the tablet routine on time and to get the proper medicine without any confusion [7, 8]. Here four separate push buttons are used (emergency buttons). This emergency buttons for various period indication morning before eating, morning after eating, afternoon and night respectively. We provide options for fixing the times for different kind of tablets initially.

1.3 GSM/GPRS

Here, when the patient misses the tablet routine GSM/GPRS Module is used to send an intimation through SMS to the care taker/Guardian of the patient that they missed to take pills at a particular period of time. This helps to maintain patient health regularly and to maintain chemical composition of the drug in blood in order to control the diseases [8]. The SMS is controlled by PIC controller, real time clock is interfaced with the kit in order to match the patients prescribed timing and to alter them for taking pills. If patient does not pick the tablet while alerting, controller snooze the timer automatically. Also, after the snoozing, they don't take the tablet after 3 continuous snoozes then automatically SMS alert is sent to the care taker/Guardian and also update to hospitals through IoT via GSM/GPRS module present in the kit [9]. Then they can manually advice the patient to take tablet.

1.4 IoT

All the medical details are collected in the daily basis and verified once in a month and are stored in cloud (database) and these information are maintained by the hospitals where the patient is consulted .The database contains missing tablet routine of a patient in that month, keeping this information hospitals can easily compare the test records with the previous month records and can distinguish patient health improvement than the previous month. This helps the Doctor to increase or decrease the dosage of medicine or to change medicine in respect to patient's health condition [9-12].

The database is maintained in the thingspeak database account where we finally get the CSV file as the output file which is easy to interpret the document. This document is obtained from the internet and then sent to respected hospitals through python code via “pythonanywhere.com” cloud computing [13].

2 PROBLEM STATEMENT

2.1 Missing Tablets

Day by day diseases become stronger and the number of people who take tablets increases enormously due to the long-term diseases for all age group peoples. Sugar patients, heart patients, blood pressure and very elder people taking tablets regularly for many reasons. But in many conditions, they miss taking the tablets on time, this causes many side effects, tablets should be taken in correct time without any delay in order to make sure that they have an enough amount of antibiotic in their body at all times. When the tablet intake is irregular the antibiotic in the blood becomes too low which helps the virus to get multiplied and becomes non-resistant to the disease. For example, the people who take pills for the blood pressure they should maintain the tablet cycle on time otherwise it may cause major problem of having the heart attack and stroke risk at the high blood pressure level [14].

2.2 Tablets Mismatch

Some of the patients get confused and alter the tablets due to the lack of knowledge about the tablets and the elder people cannot maintain the identification of tablets all the time also illiterates unable the pick the right tablet on the daily basis as they lack in knowledge about the tablets. This causes major health problem and the risk of getting allergic to pills [15].
Also, a cause for the mismatching of pills is due to the enormous number of brands available in the market. Chemical composition of each tablet brand will vary which may cause the side effects on the patients. Allergic effect may cause when the brands get changed due to different compositions. Poor people go for the cheap tablets but this cause the major effect on diseases. Sometime on the severe cases instead of controlling the disease, it increases the risk of diseases [16].

3 PROPOSED WORK

To avoid such health problems caused by avoiding or missing tablets we need to continuously monitor the patients. Remind them to take tablets and provide some extra time when they got work and remains again. We should avoid human work or separate medical assistant to continuously monitor them. Without any human interface this device will monitor the patient and sends SMS to guardian or relative trigger them to take action. It will continuously collect data which contains date and time and corresponding Patient ID will be updated on hospital server.

3.1 Block Diagram

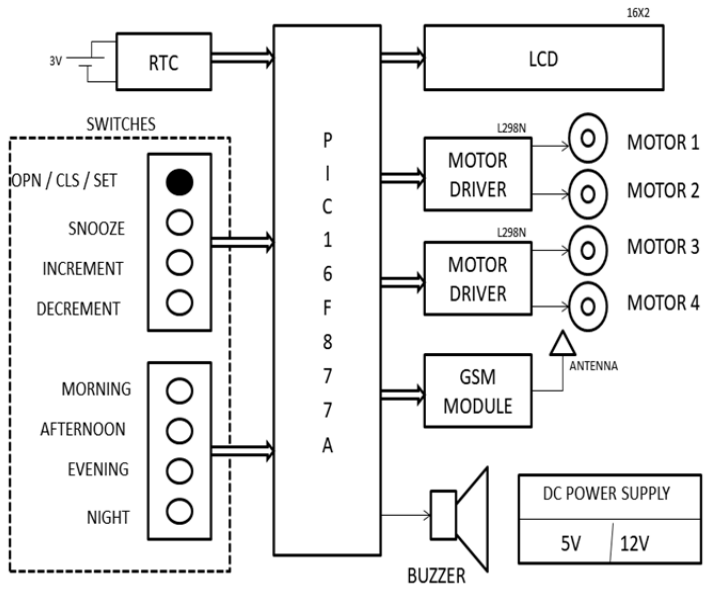

Fig. 1. Block Diagram of Initial Process

Fig. 1 shows the initial work of tablet remaining that will take the timing threshold given by the patient through push buttons and real time from the RTC and keep on comparing the two times. Alarm will be given on match through buzzer with LED blinking for visual indication and corresponding rack will be open by controlling DC motors through drivers. SMS will send through GSM module when missing of tablet found.

Fig 2 shows the updating the date, time and Patient ID to the cloud by using thing speak website when the patient misses to take any tablet. It is done through a GPRS module and will be updated in IoT server. By using thingspeak web link, CSV file is processed and update to hospital servers through python script. Then the doctor can view the data which contains all patients date and time details when they missed to take tablet along with their Patient ID.

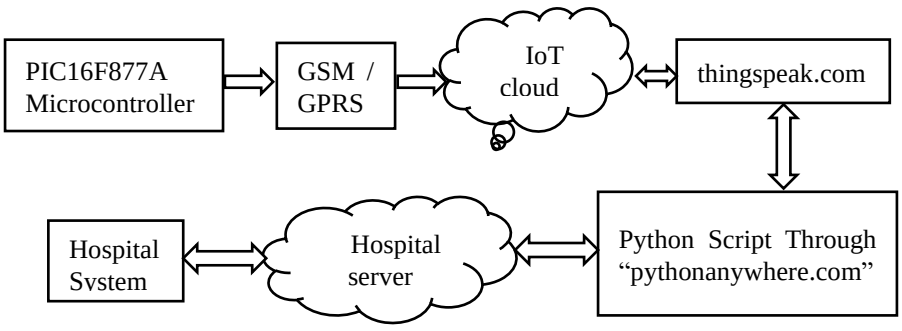

Fig. 2. Block diagram of data update in cloud

3.2 Medicine Box with Rack

Fig. 3. Medicine Box

This is a physical setup that having four racks to hold four set of tablets which are planned to taken by the patient in Morning, Afternoon, Evening and night. The motors are attached in the medicine box in the respective position [17]. Gear pulley (Gear track) is attached in each rack and that is attached to the Gear which is hold by motors. When the motor gets rotated due to the high friction between gear and gear track the rack will open smoothly. Sample medicine box shown in Fig. 3.

3.3 Software Requirements

Simulator

Simulator is used to check the working flow of the program. We can visualize the working in a simulation in all modules like motors, microcontroller and all used electronic components can be attached to the simulator. The components are properly connected and the hex file which is generated by the CCS compiler from the written program. The Proteus design Suite is software program used often mainly through electronic layout engineers and technicians to design or create electronic schematics and electronic prints for production PCB (printed circuit boards).

It use of either a hex report or a debug file to the microcontroller component on the schematic for micro-controller simulation. Its application in a vast spectrum of prototyping in areas which includes automation motor manage, temperature control and user interface layout.

Process Flow

The proposed process flow was split into two phases: the first one is to remain the tablet routine and is to send to SMS through GSM and second is to update the data in the cloud through Thing Speak.

Tablet Routine

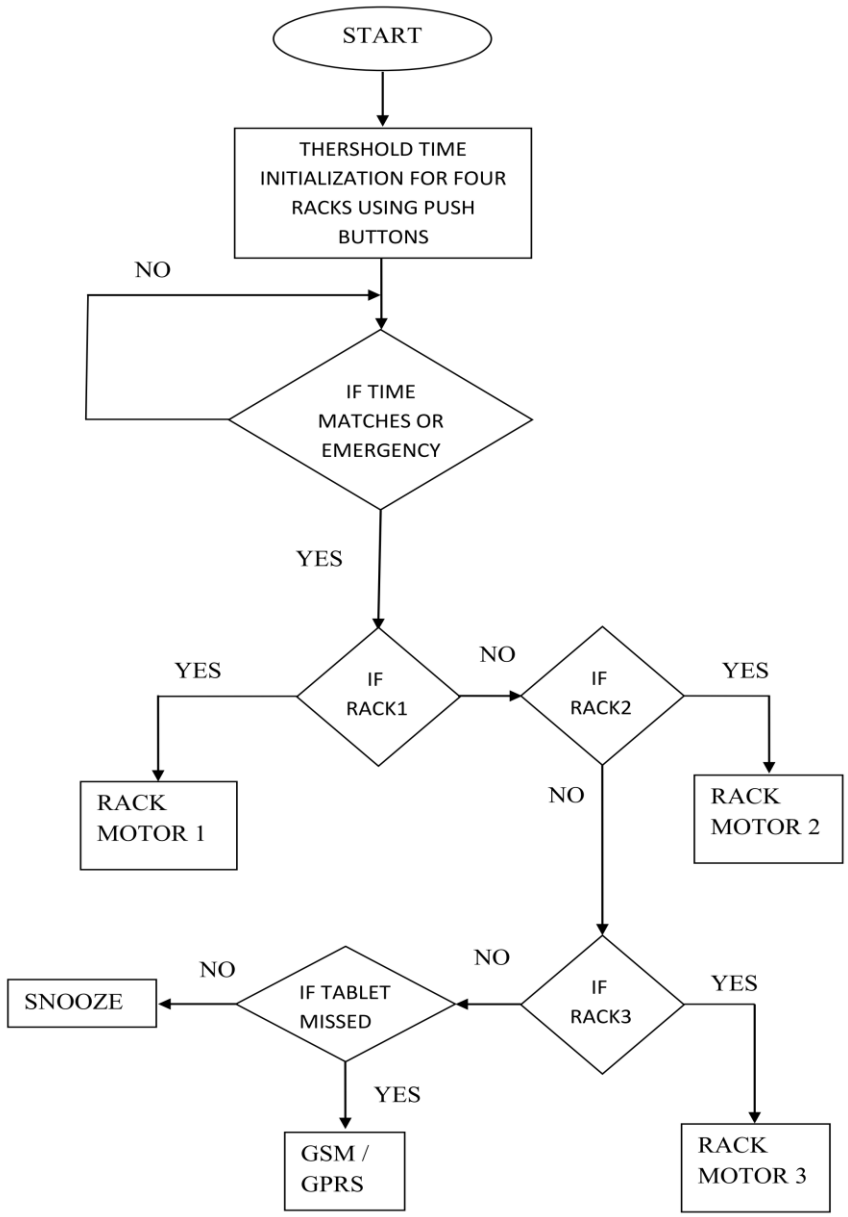

Fig. 4. Process Flow Diagram

Initially we want to set the threshold time before use it in the application. Because tablet taking time may vary according to the patient. So we need to provide a time adjusting facility. It is done in this paper by push button act as Increment and decrement buttons and that can visualize by LCD. The n micro controller takes current time in the real time clock and compares it continuously. When it gets matched it will give alarm using buzzer.

User can identify the sound. When user presses the open button, the corresponding rack will be open and it will be wait for the repressing of the same button to close the rack. Manual snoozing can be used to snooze it by one minute. Auto snoozing facility is also available that will be helpful when user not near the medicine kit. When three snoozes have be encountered the tablet will be automatically cancelled and SMS is sent to guardian of the patient through GSM using AT commands. Process flow diagram is shown in Fig 5.

3.4 IoT Through Thinkspeak

Thingspeak is an Internet of Things (IoT) application which is available at open source and HTTP protocol over the Internet via API to retrieve and store data.

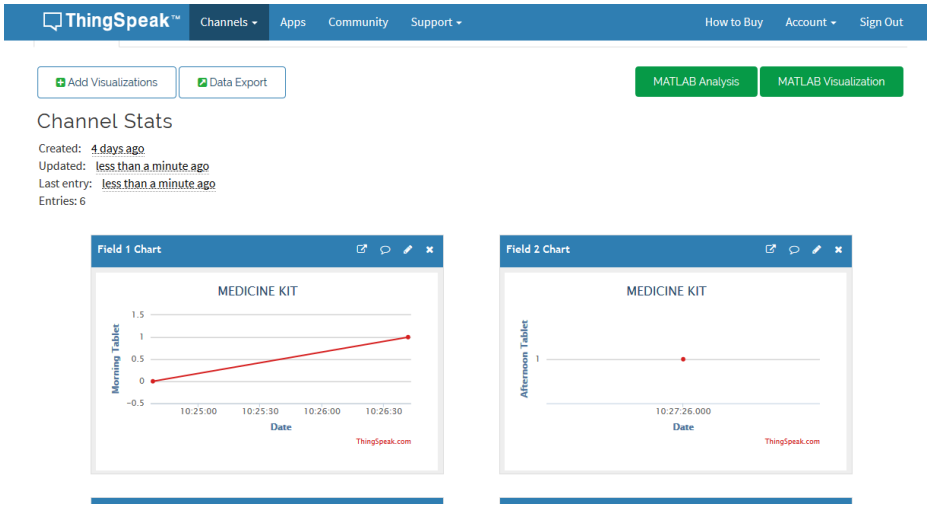

Fig. 5. Thingspeak visualization

An account should be created in Thinkspeak.com for a user and fields need to allocate for that user. A unique link will be generated for each user and using the link data can be updated anywhere in the world to cloud through IoT. A data for a particular field can be passed by changing fields in the link and all the data will be updated in the Thingspeak web site user account (see Fig 4). A CSV, JSON, XML files can be viewed for the performance of the data update to the user account. The account should be accessed by all so all the fields are marked as public access. MATLAB coding run on the background of the Thingspeak and that will show the process graph plotted for each field with date in the x axis.

3.5 Data Update to Cloud Through IoT

An account created in the ThingSpeak.com IoT web site and begins with a new user account. A new channel is created named Medicine Kit and that will hold values of 4 fields namely Morning, Afternoon, Evening and Night. This indicates tablet taking periods of a patient. Thingspeak automatically generate separate links for data update for each field. The link is used in the Microcontroller program and tablet information can be send to this URL that will be updated to Thingspeak server. The data can be retrieved by any person or Doctor and use the details for further processes [18]. Data can be sent to particular field that can provide a way to view Tablet missing time and date with respective type of the tablet. GPRS AT commands are used to send tablet details when patient miss the tablet. From Microcontroller to the cloud the data has been updated. Unique URL is there for each field to update the data.

Sample URL is “https://api.thingspeak.com/update?api_key=NMT32AO25VU32L75&field1=1”. Python script is written to consolidate and update thingspeak data to corresponding hospital server using cloud computing with “www.pythonanywahere.com”. Always run task was scheduled for continuous update of patient data.

The result has been viewed from the Doctor system as the graph or file format like CSV, JSON and XML document file.

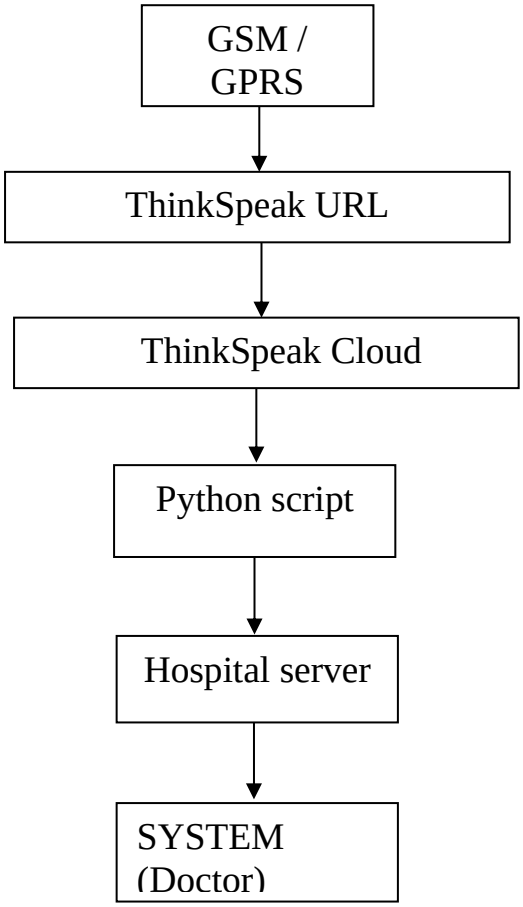

Fig. 6. Data Update on Cloud

Fig. 6 shows the flow of data update on cloud service.

4 RESULT AND DISCUSSION

4.1 Simulation and Hardware Result

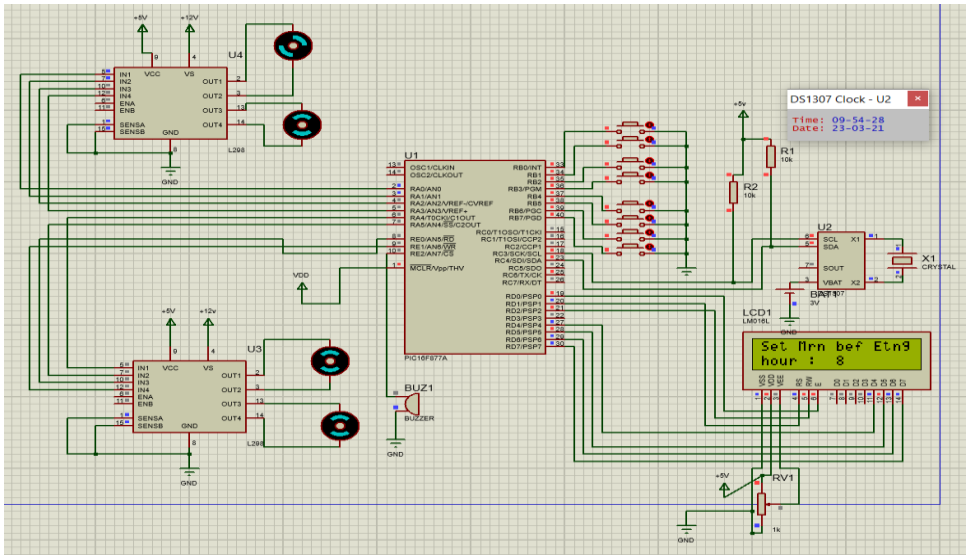

Fig. 7. Simulation output

Before coming into the application of the medicine kit initially we have to set the timer for tablet prescription time as given by the consultant. A real time clock is attached to the kit which is used to compare the real time clock with our timer kit for the intimation of the tablet taking time. For indication a buzzer is used. Open button is available for opening the respective rack to take the required tablet and close button is used to close the tablet rack which was open already. Fig. 7 shows the simulation output.

Snooze option is available when the patient is not available for taking tablet. Also, an emergency button is available for emergency conditions to pick up the tablet on required time other than the set time value. If the snooze is done for continuously three times then an SMS intimation is sent to the care taker or Guardian of the patient through the GSM/GPRS module. All these actions are controlled by the PIC microcontroller [19]. Fig. 8 shows the hardware implementation of the system.

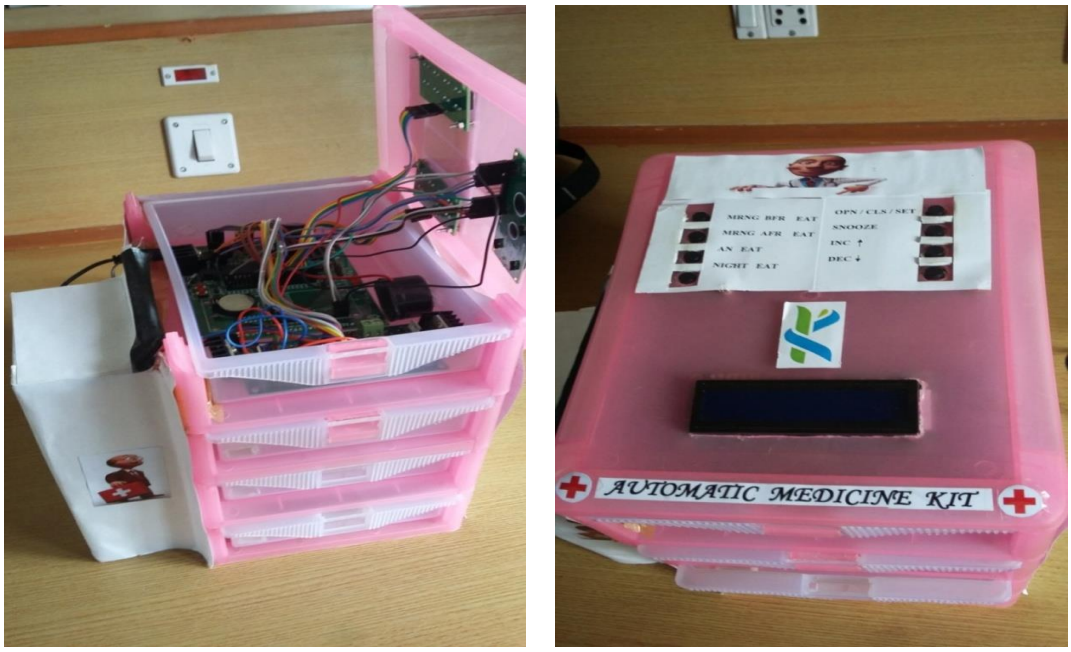

Fig. 8. Hardware implementation

4.2 IoT output

In IoT server the data can be viewed as .CSV file (see Fig. 9). This result can be viewed by doctor.

	A	B	C	D	E	F	G
1	created_at	entry_id	field1 (Patient ID)	field2 (Morning)	field3 (Afternoon)	field4 (Evening)	field5 (Night)
2	2020-09-23 08:30:34 IST	1	9A95G8X37123	snooze			
3	2020-09-23 08:40:40 IST	2	9A95G8X37123	before food missed			
4	2020-09-23 09:00:40 IST	3	9A95G8X37123	done			
5	2020-09-23 12:30:33 IST	4	9A95G8X37123		done		
6	2020-09-23 17:10:42 IST	5	9A95G8X37123			after food missed	
7	2020-09-23 20:30:58 IST	6	9A95G8X37123				done
8	2020-09-24 08:30:34 IST	7	9A95G8X37123	done			
9	2020-09-24 09:10:40 IST	8	9A95G8X37123	after food missed			
10	2020-09-24 12:30:33 IST	9	9A95G8X37123		done		
11	2020-09-24 17:00:42 IST	10	9A95G8X37123			done	
12	2020-09-24 20:40:58 IST	11	9A95G8X37123				after food missed
13	2020-09-25 08:30:34 IST	12	9A95G8X37123	done			
14	2020-09-24 09:00:40 IST	13	9A95G8X37123	done			
15	2020-09-24 12:30:33 IST	14	9A95G8X37123		done		

Fig. 9. CSV file output

5 CONCLUSION

The medicine kit is widely required and demanded. It avoids a separate person to take care a patient in every time. It will be a helpful medical assistant for user. This can be taken anywhere we needed and is ease to handle. As we can adjust the timings of the tablet routine usage will be more comfortable according the user's needs and convenient. Illiterate and aged people will not miss or confuse the tablet routine due to intimation and the snoozing options available in it. GSM/GPRS module helps to alert the patient's caretaker or guardian about missing tablet routine. Emergency push button is attached for emergency medical conditions. Database of patient taken in hospitals are very helpful for the doctors to achieve the patient's health condition. Collectively this medical kit will be very helpful

for the uneducated and aged peoples. This is the hands-free approach in which the patient has to do nothing other than appeal the device and retrieve his/her tablet.
In addition to this, ECG, live blood pressure and heart rate data are collected and connected to the doctor with present condition of patient's medical information. The proposed methodology of this paper is to diminish the problem of patient to meet doctor frequently in order to check their health condition. Due to the proposed methodology, the time saving is major advantage for both doctor and patients. Doctor can help in emergency scenario as much as possible.

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