SPEC 2.0 Smart Pill Expert System

Vandana Rao Emaneni, JSS Academy of Technical Education, Bangalore, India*
P. Dayananda, JSS Academy of Technical Education, Bangalore, India
Amrutha G. Upadhya, JSS Academy of Technical Education, Bangalore, India
B.G. Nayana, JSS Academy of Technical Education, Bangalore, India
Priyam Poddar, JSS Academy of Technical Education, Bangalore, India

ABSTRACT

The article throws light on the implementation of an enhanced idea of the smart pill expert system. The proposed system is used to automate the capability of dispensing the right dosage of medicines at a given day-time interval. The spec 2.0 can be used at one's home, workplace, at hospitals by a user of any age group, and then possibly expanding the functionalities to a wider audience. It mainly focuses on providing access control and monitoring management functionality through a mobile app on a daily basis with no monthly subscriptions required. There will be alerts and SMSs sent across to the user based on the pill dispensing event's result. The spec 2.0 mainly focuses on providing an "over-dosage" functionality so that the user won't have to consume the medication if he hasn't taken them at the allocated time interval, to prevent over consumption. The system has been tested and the results have been formulated on a daily basis.

KEYWORDS

Dispensing System, Expert System, Health, Healthcare IOT, IOT Motorization Service, Medicine Dispenser Application, Medication Monitoring, Smart Medication, Smart Medicine Dispenser

INTRODUCTION

Advancements made in the field of smart healthcare technologies have provided people a better life situation in the present years. This would have been even more notable if the percentage of medication errors could be identified and corrected. Due to this negligence, there has been quite a lot of deaths and quite an enormous increase in the expenditures by millions each passing year. In the present-day scenario, since medical devices are incorporated on a network, due to its security issues, interoperability breaches are increasing in number day by day, resulting in enormous business losses. To curb this very risk, automation and consumer-based technologies are being adopted for the medical devices. Health care is at the heart of IOT, with applications varying from health monitorization to disease prognosis. These applications provide the visualization of identification, diagnostic study, treatment procedures

DOI: 10.4018/IJHIoT.337893 *Corresponding Author

and regular monitoring through the devices that are implanted in IOT. The main achievements are to reduce the cost and easy usage for its users by providing better user experience and easy operational customization. For seamless connectivity and better performance, a systematic scheduling scheme plays a very important role due to the availability of limited resources. In the healthcare domain, smart devices like a gateway, a server, and a database help in creation of data to be sent as medical services to the authorized organizations. In the upcoming years, IOT will play a huge role to address the above issues in the healthcare domain. Through IOT, various countries across the world, have adopted this new turnover in the field of medical health care, by designing and developing new frameworks and applications integrating services and security. The objective is to construct a device that is relatively small and light weight, that is developed as a software in such a way that patients receive their medication reliably and safely as prescribed by their physician. The device also provides alert messages which helps to take medicines in time as well as refilling the medications.

LITERATURE SURVEY

(Al-haider et al., 2020) The system SPES provides expertise on the real-time analysis and support to every user relying on medication. Since Medicinal Nonadherence (MNA) is one of the huge factors for extended betterment, money issues, and sudden demises, SPES tries to curb these inconveniences by supporting several users, the option for controlling and monitoring their actions, simultaneously, to curb any misleading events. The SPES provides an easy UI and a trouble-free way of maintaining the physical dispenser system with an AI-Chat service that caters to the needs of the user's queries. (Batz et al., 2005) The medicine planner provides functionalities to pre-sort a prescription daily. This is especially catered to the needs of elderly and visually impaired personal to have a better management of their medicines. The planner has 2 distinct functionalities of providing a self-filling mechanism and an alert notification mechanism during the time of medicine intake. (Becker et al., 2009) The kit proposed can be programmed to provide a proposition to guide users to consume their correct medicine at the exact specified time interval through the employment of an alert functionality, buzzers, and LED. This is a small grant to improve life existence for a better healthy future for the world. (Bombarda et al., 2019) This IOT based intelligent medicine container houses several sensors and servers for frequent health monitoring check-ups. This allows wireless communication between the user and their caregivers regarding their monthly health check-ups and removes the burden of a physical meeting session. Since the main goal is to focus on the correct medication schedules, aged generations will be benefited the most as they require constant taking care off. The servers are used for embedding the time schedule along with the medication details. There is also an embedded temperature sensor for examining of the user's body temperature. (Casciaro et al., 2020) An automatic pet feeder has been constructed for allocation of the dry pet food for dogs and cats, with customization based on each pet owner. This provides an effective manner of taking care of the food patterns comfortably. (Chawla, 2016) The design facilitates easy monitoring and controlling functionalities via mobile app with no cost plans. The system is controlled by the user through his phone or through the buttons present on the machine itself for choosing his required number of medications for a given time interval. There are alert messages sent to provide an indication for whether the medication was removed from the container or not. (Diaz & Vepuri, 2012) The system has been built around prescription drugs which will assist in authenticating a patient's access of such medication based on their identity and prescribed schedule and simplifies the pharmacist or doctor to monitor this consumption. The system consists of intelligent reminders, caretaker reminders, and dosage tracking and notifies each time the container box is opened to provide a security feature that avoids stealing of medicines. Prescription drugs are sometimes consumed without any intent initiated by a doctor and sometimes the users may be forgetful to consume their medication, causing irregular consumption periods. To help curb these events, the system helps patients take their medication on time with value added safety measures, facilitating for a speedy recovery. (Hayes et al., 2006) The product improves the automation of functional modules through the usage of an existing mobile app "Blynk" to have a definite control over the feeder. Through the networks, the amount of feed will be controlled along with its duration of dispensing. This functionality is implemented by clicking the button provided on the app, that will in turn control the opening and closing of the hole in the dispenser cap. (Jadhav et al., 2020) A pill dispenser with alarm which is provided with a facility of notifying on the smart phones to help patients take right medicine at appropriate time that have been prescribed with several medicines. The existing systems have existing alarm modules present for indication of medication time. This could be a drawback for elderly patients to hear the alarm if the pill dispenser is placed at a lengthy distance from them or due to hearing loss concerned with age factor. There is not any dispenser system that provides in-built mobile alerts to remind the patients about medication thus far. Hence, the system is built using the Instapush application for the pop-up notifications and combination of infrared sensors and micro controller to control the medication dosage and time for consumption. (Mahmud et al., 2020) A different approach of abstract state machines has been introduced to develop this system. The development phase is very critical as even if one component fails, then it possesses great life-threatening injuries to the users who are diligently making use of the service. To prevent this situation, a precise procedure has been adopted to measure the probabilities of defeats. With this statistics, validation and verification modules are conducted in a well-documented incremental procedure. In addition, regulation (IEC62304) and guidelines are presented and by phase wise enhancement a fine model is attained which can be interpreted to code.

COMPARATIVE ANALYSIS STUDY

The following comparative analysis was conducted based on the kind of technology that was used and implemented in the products. There is also an analysis provided for the currently available dispensers in the market.

An overall conclusion can be brought after comparison of the features and limitations provided for each technology-based system.

(McCall et al., 2010) (Minaam & Abd-ELfattah, 2018) (Moise et al., 2020) (Mugisha et al., 2020) Sensor-based systems provide detection of opening and closing of medicine compartments, portability, antibacterial, mobile app integration, battery power and accuracy to detect the medication is very low (Nijiya et al., 2018) (Othman & Ek, 2016) Visibility- based systems provide detection of opening and closing of medicine compartments via an antenna, non-invasive, requires combination of sensors and devices for verification purpose and there a lot of assumptions made with respect to self-sorted medications. (Philips & Dibner, 2004) (Rao et al., 2020) Vision-based systems require

Table 1. Technology-based comparison

Sl. No.	Technology	Features	Limitations
1	Sensor-based	Alarm notifications, Alerts via Mobile, Scheduled dispensing, Middle-ware control, Medicine fidelity,	Single User, Limited security, No support services, No hands-on service, Not cost efficient,
2	Accessibility-based	Detection and Tracking	Assumption based, Limited security
3	Vision-based	Detection and Antibacterial	Security verification functionality
4	Existing Systems	Flexible, Alert notifications, Safety, Rechargeable battery, Mobile App, Alarm sounds, Automated tracking, Customization	Scalability Monthly payment, no power backup, Setup required, Quite expensive, Solid medications, Size dependent, Not portable

good camera resolution to recognize movements. The placement of the camera is very critical and is assumed to be monitoring the medication area. So, it detects and observes normal and abnormal medication activities through hand gestures. (Reddy & Chavan, 2020) Philips' Pill Dispenser provides fall detection, monthly payment on per-use basis. The design is very neat, compact and an improved update from the previous designs. Customization of the ideal service plan is provided for each user. There is integration of mobile app tie-up for coordinating easy communication between user and his caregiver. Waterproof designing has been implemented for a better and efficient life cycle. A good battery life with customer care services is a plus point for this model. (Sangvanloy & Sookhanaphibarn, 2020) Hero's Pill Dispenser provides flexible scheduling for up to 10 different medications on a daily dosage basis. The device caters for a 90-day period with predefined intervals for medicine dispensing. These are independent of dosage size and shape. Audible and visible alarm alerts are provided for missed dosages along with security notifications. It's the most affordable option that never runs out and has a pay per plan service.

IMPLEMENTATION

The proposed design approach of SPEC 2.0 is formulated in 4 stages: Architecture Design, Proposed System Block Diagram, System implementation and Testing.

Architecture Design

The architecture of the proposed system can be viewed as a top view and a dispensing view.

The top view shows the closed rectangular structure that houses the medication. This structure has a plastic covering that can be opened for filling the medications based on the user's requirements. There are 3 compartments in which 2 time slots (Day" D" and Night" N" / Morning "M" and Evening "E"). There is a dummy compartment that is placed at the opening mouth of the structure for pill dispensing. The structure rotates anticlockwise, starting from the empty compartment. There is an alarm buzzer mounted.

The dispensing view shows the actual working of the dispensing mechanism of the system. The rectangular structure is mounted on top of the structure. Below this, there is a container box that acts as the pill box which has a flap mechanism powered by a DC Motor employed for the over- dosage event handling. This sits on top of the compartment containing the over-dosage container.

Block Diagram

Here we are using Renesas Micro-controller which sends command to the L293D Motor Driver. It is a motor driver used by micro controllers to automate driving the DC motors. This motor driver drives 2 motors in our case. The 1st DC motor is connected to the Pill Container is used to rotate the pill

Figure 1. Top view

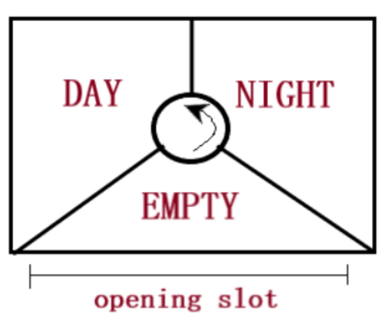
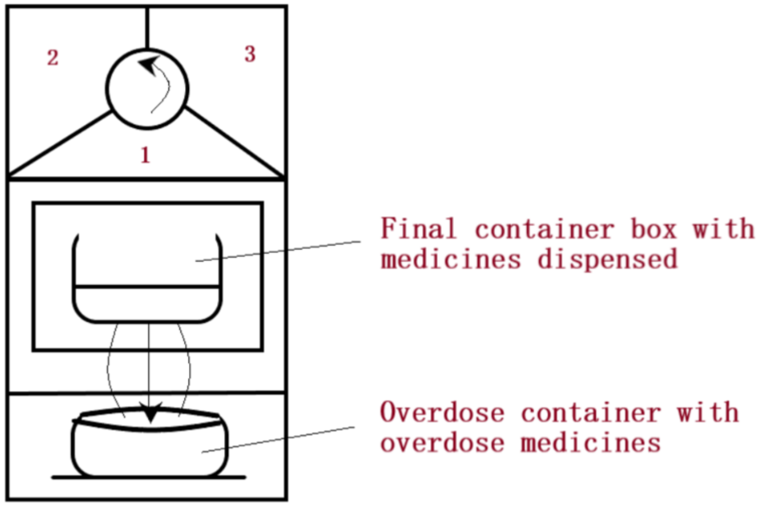


Figure 2. Dispensing view



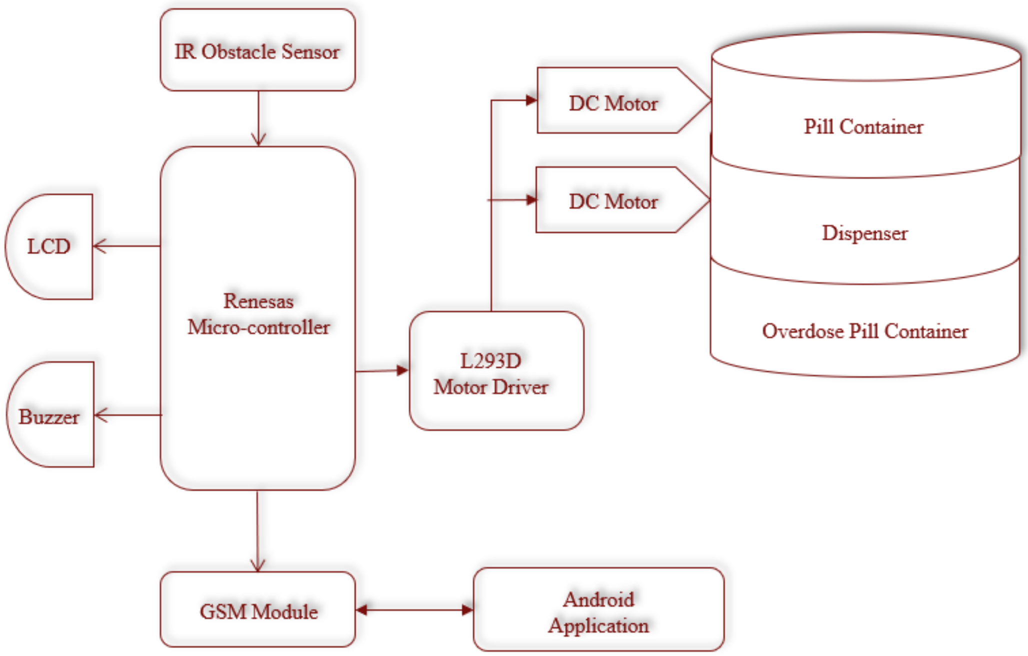
container in the clockwise direction according to medicine's timings. The 2nd DC motor is connected to the Dispense, its function is to drop the dispensed medicine to the overdose pill container as a safety measure if the medicine in not consumed within the stipulated time limit. For the working of the 2nd DC motor, we are using IR Obstacle Sensor, it is used to check whether the medicine has been taken by the user or not from the dispenser box. To make all of the above-mentioned functionality possible we have an android application for the user to operate the product like they can set alarms and check their previous medical history. For obtaining the connection between the android application and micro-controller we have used GSM Module, and data transfer between app and GSM module is uni directional. To maintain the medical history, we are using a database server, which is interacting with the android app in a uni-directional manner. Through the LCD, any data can be displayed to the users. Through the buzzer, at the time of dispensing, it is used as an alarm for the user.

Implementation

Since the proposed system is a prototype, we are mainly focusing on 4 events for a single day. The 4 main events are Filling up medication in the system, setting up the time interval through the mobile application, dispensing and taking care of over-dosage medication.

1) *Filling medication:* There is a closed rectangular design. We are not adopting a matrix design with rows and columns since each compartment will then require a stepper interface for pill dispensing, increasing the number of hardware components. There is a single hollow opening cut out at the front in the design for pill dispensing. There will be an outer circular plastic cover given for the head that can be opened/ closed for filling up the medication to providing safety of no sharp edges. The Doctor's prescription usually revolves around 2- time frames Morning-Evening / Day-Night for a day. Each time frame has a predefined time interval to indicate the same as M – 12 AM to 1 PM E – 2 PM to 11:59 PM but based on the user's preferences of his medication intake, it will be varied. The user can set his own time interval duration in the predefined time frame for medication dispensing There are 3 compartments that are linearly placed next to each other. So, we will have 2 compartments that indicate a day with 2 intervals like D1M, D1E. To provide easy usability and better understanding, the compartment will have markings of D1M, D1E in the bottom. There is another compartment that is left empty to indicate the initial starting

Figure 3. Block diagram of SPEC 2.0



point setup of the system. The buzzer will be set off when the pill dispensing event occurs. An SMS will also be sent to the registered mobile number for both the results of the pill dispensing event (Medicine Consumed Medicine Not Consumed)

2) *Setting up the alarm in the mobile application:* The mobile application allows the user to set his time intervals for a given day based on his medication intake. The user would login in with his credentials (username, password). If the user has already registered his mobile number, he can directly set his alarms.
3) Else, the user will also have to register his phone number for availing the SMS service. With the predefined time intervals, the user can select a given date and alarm time for his morning evening medication. There will be an ON/OFF button provided for each time interval. Once the ON button has been selected, the data (day, time) will be stored in the database and will be sent as a SMS to the SPEC 2.0. This data needs to be accurate and can be set well ahead in time or at the present time. Once the pill dispensing event occurs, the status (Medicine Consumed Medicine Not Consumed) will also be appended stored in the database. These data can be viewed under "View Data" screen.
4) *Dispensing Mechanism:* The medication housing is placed on top of the final container box that houses the dispensed medication. Based on the alarm time slot selected by the user for a given day and given time in the time interval through the Android Application, an SMS will be sent to the hardware component and in turn to the DC motor to rotate and access the required compartment. An alarm beep will be sounded on the activation of the pill dispensing event. When the compartment is accessed at the hollow opening cut, due to gravity and force, the medication directly drops downward into the final container box. An SMS will be sent to the registered phone number of the user to report the same. This container box will provide a flap mechanism with a DC Motor for the over-dosage event. The flap mechanism is deployed vertically at the end of the box that will open its flaps downward.

5) *Over-dosage Event:* Based on the predefined time du- ration threshold (10 seconds), a medication is deemed overdosed if the user doesn't remove them from the container box, which is handled by the IR Obstacle Sensor. In that case, the box activates the flap mechanism through the DC Motor that will drop the medication downwards to another container called "Over-dosage container", that is lying exactly under the final medicine compartment box, used for the storage of over-dosage medication. A SMS will be sent to the user to report the same.
6) *System Implementation:* The implementation has been broken down into 4 modules – Hardware setup, Software setup, Integration of Hardware Software components and Design Structure. Hardware implementation includes embedded C programming with the MC components. The Hardware setup involves programming of the Renesas Micro controller with the LCD, Buzzer, IR obstacle sensor, L293 Driver circuit to in turn operate the DC Motor, Analog-to-Digital Converter and GSM Module. The IR obstacle sensor is attached to the MC at the Input Port 3. The DC Motors that is responsible for accessing the medicine compartment and for the over-dosage event, are placed at Output Port 5. The Buzzer is also mounted at the Output Port 5. A/D Convertor pins ANI0 – ANI4 are assigned as analog input. Serial Transmission channels UART0 UART1 are used for both transmission receival with a Baud rate of 9600 bps transfer rate. Software implementation involves the design of Android mobile application. The Android mobile application is built with Android stack using JDK. Eclipse was used to provide a common user interface (UI) model for working with tools using the ADT plugin as an integrated environment. The Android software development kit (SDK) includes everything you need to start developing, testing, and debugging Android applications. The application has 5 screens – Login, Home Page, Register GSM number, Set Alarm and View Data. The user logins with his username password. The Home Page consists of options to navigate to the other 3 screens. Register GSM number page asks the user to register his phone number for receiving SMS. Set Alarm screen allows the user to select his day-time alarm for his pills to be dispensed. There are ON/OFF buttons provided for the morning evening slots. View Data provides a consolidated view of the number of transactions of the pill dispensing events. It has 4 columns – Dates, Times, Status and Action. Dates Times indicate the user's selected day-time slot. Status is "Medicine consumed" / "Medicine not consumed". Action can be used to delete a particular event. Integration involves connection of the MC hardware to the Android App. This involves setting up the GSM functionality of sending SMS containing the daytime from the Android App to the hardware. The hardware's GSM Module receives the SMS sent to it (GSM module has its own SIM Card for receiving sending SMS). Based on the daytime received, the DC Motor in the pill housing will move and access the compartment. Design structure involves building the outer and inner structures. The pill housing structure was created using a rectangular plastic box. The compartments were bifurcated using the remaining PCBs (4) mounted in the teeth of the DC Motor at counts of 6 that is mounted centrally in the rectangular plastic box. In the rectangular plastic box, a hollow opening is cut out at the base for pill dispensing. Under this, there is another smaller rectangular plastic box that is screwed onto a clamp support, in turn to the other DC Motor for the over-dosage event. This DC Motor is mounted below the pill housing compartment that will flap up down. The whole product is mounted over a cardboard sheet that contains the circuitry and SPEC 2.0 structure.

WORKING

A user fills up his prescribed medication for a day manually. To set his own customized alarm time at which the medication must be dispensed, he specifies the timing through the mobile application like for D1 Morning slot, he chooses the time interval for dispensing his medication to be at 9:00 AM. This information will be hosted locally on the device. When D1 arrives, at exactly 9 AM, an alarm beep is sounded, and the compartment is accessed by the DC motor that moves a certain amount of distance. The medication drops down to the final container box, waiting for the user to remove them. If the user picks up the medicine, it is said to be "consumed" and an SMS is sent to the user to report the same. After 10 seconds or more, if the medicine isn't removed, it is said to be "over- dosage". At this event, the box activates its mechanism and drops down the medication to the over-dosage container and an SMS is sent to the user to report the same. The DC Motor will remain in its position until the next time interval for D1 Evening slot is triggered.

The overall system flowchart and its BPMN diagram can be formulated.

RESULT

The overall SPEC 2.0 has been successfully built following up on the architecture and design. The mobile application has successfully been built and has been sent across to the Google Play Store. There are around 8 test cases that have been brought to light to test the working of the system - To check whether the Morning slot has been accessed successfully and the medication has been dispensed, To check whether the database has been updated with the success of the user

Figure 4. Flowchart of SPEC 2.0

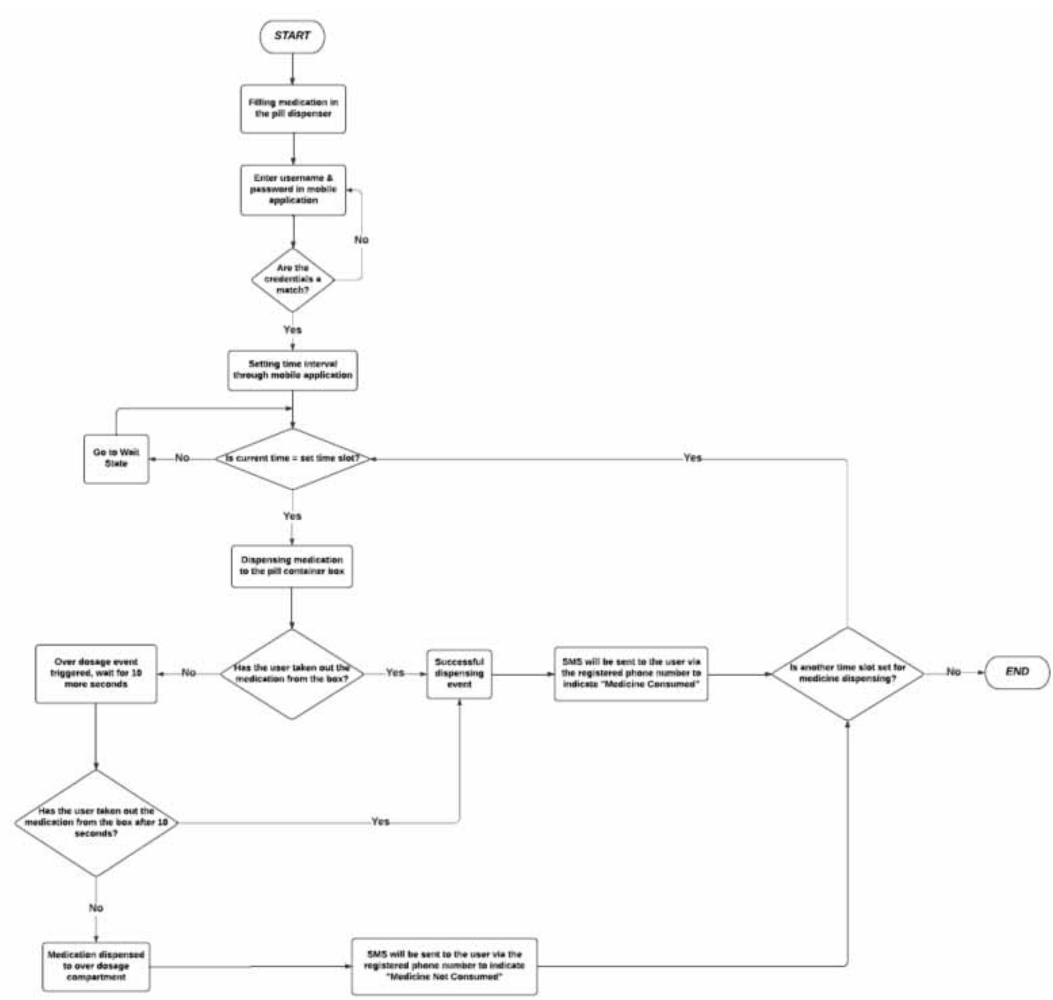
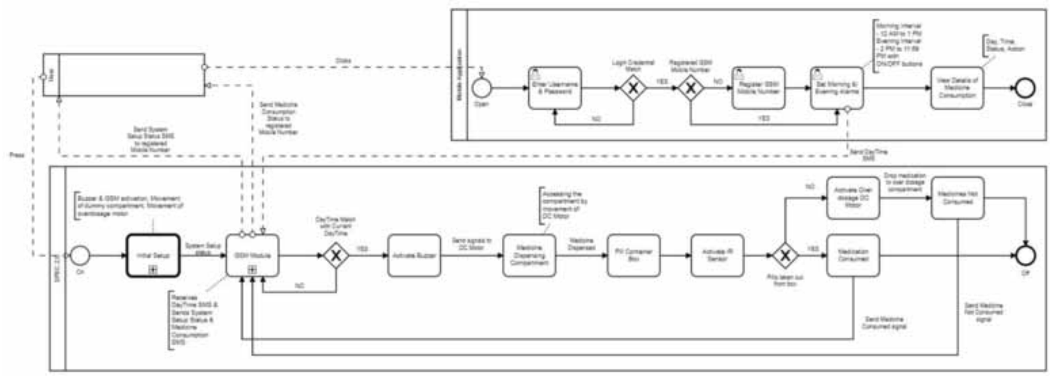


Figure 5. BPMN of SPEC 2.0



taking out the dispensed medication from the pill container box for the Morning slot and a SMS indicating the same, been successfully sent to the user, to check whether the Evening slot has been accesses successfully and the medication has accessed successfully and the medication has been dispensed, To check whether the database has been updated with the success of the user taking out the dispensed medication from the pill container box for the Evening slot and a SMS indicating the same, has been successfully sent to the user, To check whether the Morning slot has been accessed successfully and the medication has been dispensed but the user hasn't taken them out from the pill container box, indicating "Over-dosage" event, To check whether the database has been updated with the failure of the user taking out the dispensed medication from the pill container box for the Morning slot and a SMS indicating the same, has been successfully sent to the user, To check whether the Evening slot has been accessed successfully and the medication has been dispensed but the user hasn't taken them out from the pill container box, indicating "Over-dosage" event and To check whether the database has been updated with the failure of the user taking out the dispensed medication from the pill container box for the Evening slot and a SMS indicating the same, has been successfully sent to the user.

The observed results were plotted as an outcome graph with respect to the system's accuracy and functionality. Based on these results, the system sometimes fails to perform its functionalities as it is not designed with a sturdy structure like 3D printed or wood structure. Sometimes, due to the user's network connectivity with his service provider, the network transmission might not be very efficient. So, there will be a bit of delay in the pill dispensing functionality. When there is a sudden power cut, the system stops working as it doesn't have a back-up battery. Considering all these use cases, based on the graph, the system provided overall 90% accuracy and functionality, a 5% increase from the existing systems.

CONCLUSION

Non-Adherence to medication is a grave issue with in- creasing growth in numbers of affected people with chronic diseases. To enhance this adherence, we have proposed the SPEC 2.0 to enhance the already existing problems like non- expand-ability, inconvenience, low reliability, and lack of communication. The system comprises of sensors and micro- controllers with the help of which data is analyzed by the machine and it eventually dispenses medication based on the user's customization.

The proposed system provides several advantages like scalability, remote manageability, reduced cost management and effort, facilitating the update of the medication schedule configured in the smart dispenser. The smart pill expert system can be used to as a solution to improve medication

Figure 6. SPEC 2.0 top view

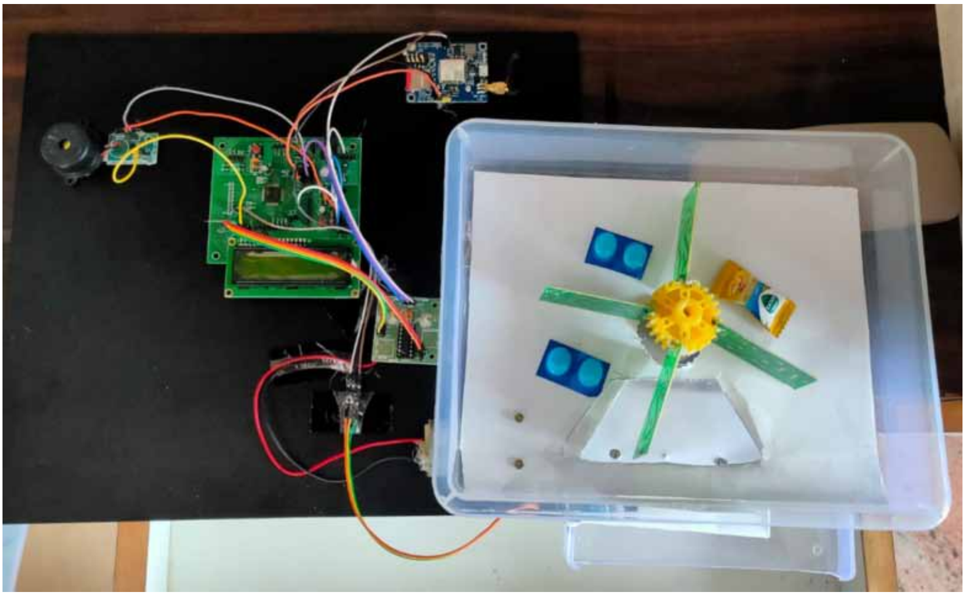
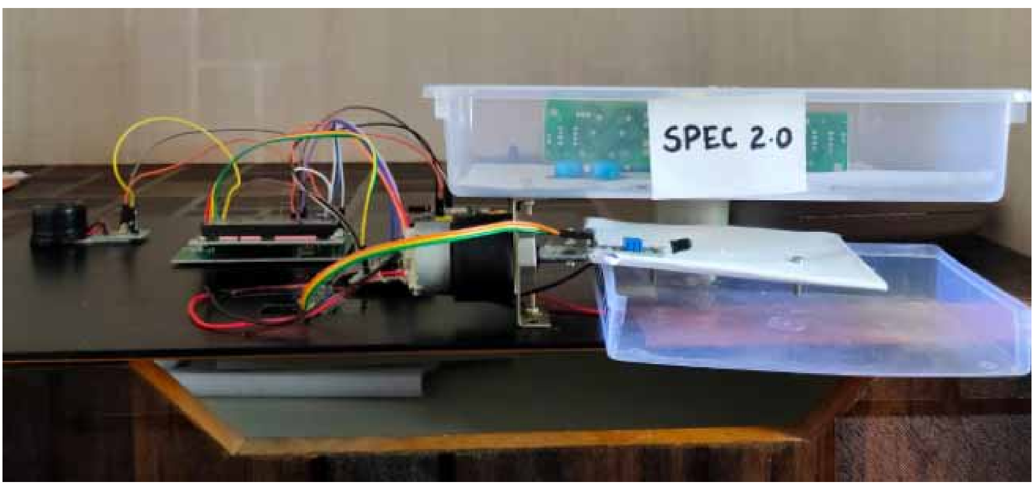


Figure 7. SPEC 2.0 dispensing view



adherence by prevention of under and overdosing. However, it fully cannot prevent nonadherence events occurring voluntarily like pretending to consume the medication or discarding them after dispensing. It can find its usage in every household or hospital that has a medical supervision and can be marketed as an efficient solution. The main achievement is to facilitate a healthy, tension free life to those who are taking pills regularly and to provide this solution at an affordable cost. The future enhancements that can be provided to this system can be usage of multiple users, Housing of liquid medication, Up-gradation to 3 time slots – Morning, Afternoon and Night, Up-gradation to 7 days of a week Back-up battery power supply, Integration of Cloud Services to facilitate easy access of data for a user's doctor, 3D Printed outer structure, Generation of reports for a particular user's pill dispensing events and Security feature of fingerprint or an open/close door mechanism.

Figure 8. SPEC 2.0 mobile app – home page and alarm setting page

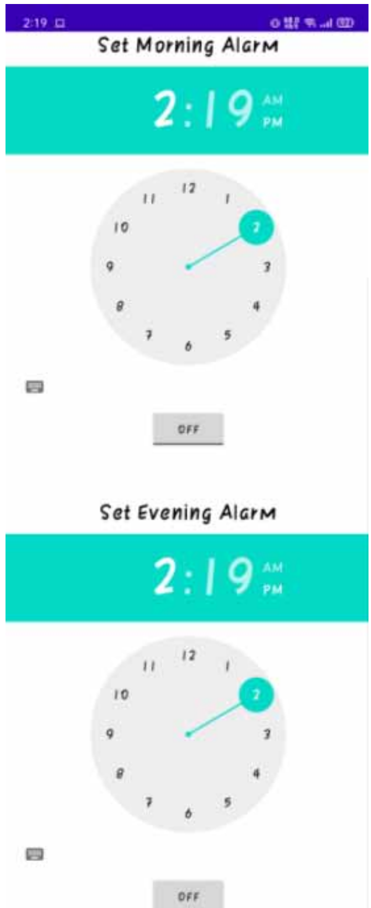
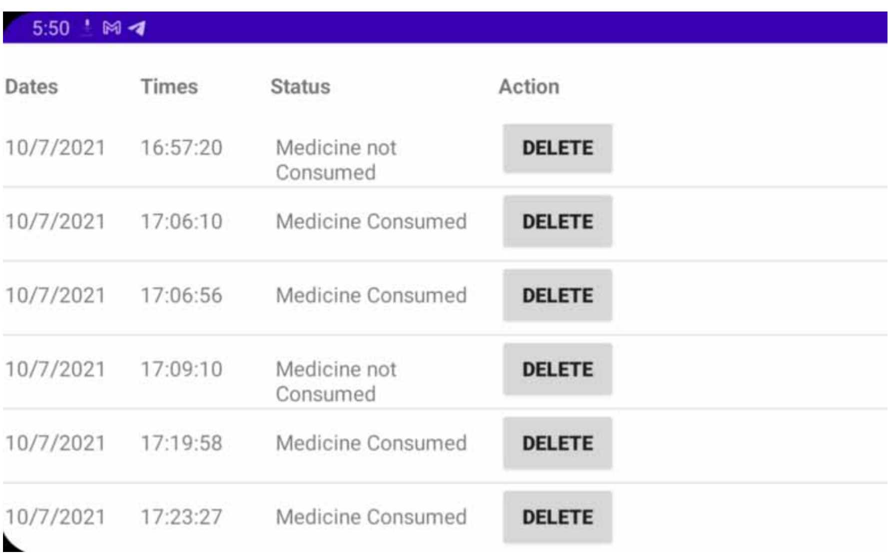


Figure 9. SPEC 2.0 mobile app – view data page



Dates	Times	Status	Action
10/7/2021	16:57:20	Medicine not Consumed	DELETE
10/7/2021	17:06:10	Medicine Consumed	DELETE
10/7/2021	17:06:56	Medicine Consumed	DELETE
10/7/2021	17:09:10	Medicine not Consumed	DELETE
10/7/2021	17:19:58	Medicine Consumed	DELETE
10/7/2021	17:23:27	Medicine Consumed	DELETE

Figure 11. Comparative analysis with existing system

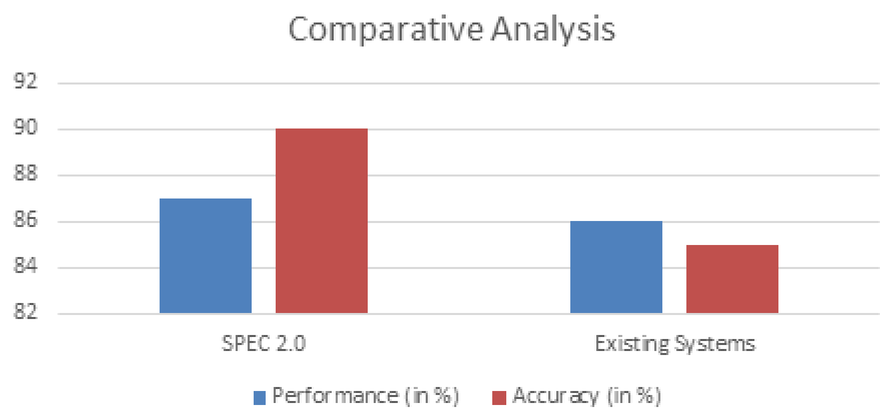
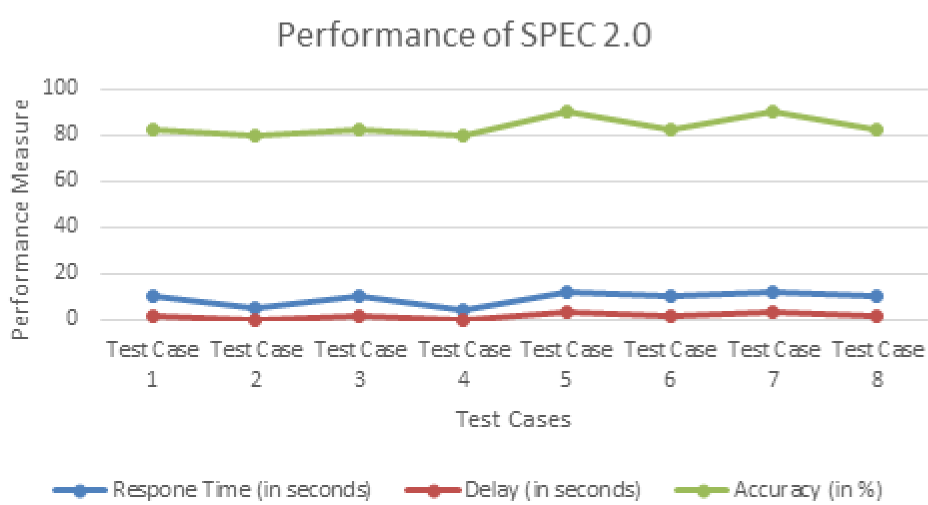


Figure 10. Accuracy and performance graph of SPEC 2.0



REFERENCES

Al-haider, A. J., Al-sharshani, S. M., Al-sheraim, H. S., Subramanian, N., Al-maadeed, S., & Chaari, M. Z. (2020). Smart medicine planner for visually impaired people. In *Proceedings of International Conference on Informatics, IoT, and Enabling Technologies (ICIoT '20).* IEEE. doi:10.1109/ICIoT48696.2020.9089536

Batz, D., Batz, M., Da Vitoria Lobo, N., & Shah, M. (2005). A computer vision system for monitoring medication intake. In *Proceedings of the Second Canadian Conference on Computer and Robot Vision* (pp. 362–369). IEEE. doi:10.1109/CRV.2005.5

Becker, E., Metsis, V., Arora, R., Vinjumur, J., Xu, Y., & Makedon, F. (2009). SmartDrawer: RFID-based Smart Medicine Drawer for Assistive Environments. In *Proceedings of the Second International Conference on Pervasive Technologies Related to Assistive Environments (PETRA '09).* Association for Computing Machinery, New York, NY, United States. doi:10.1145/1579114.1579163

Bombarda, A., Bonfanti, S., & Gargantini, A. (2019). Developing medical devices from abstract state machines to embedded systems: a smart pill box case study. In *Proceedings of International Conference on Objects, Components, Models and Patterns.* Springer. doi:10.1007/978-3-030-29852-4_7

Casciaro, S., Massa, L., Sergi, I., & Patrono, L. (2020). A smart pill dispenser to support elderly people in medication adherence. In *Proceedings of the Fifth International Conference on Smart and Sustainable Technologies (SpliTech '20).* IEEE. doi:10.23919/SpliTech49282.2020.9243773

Chawla, S. (2016). The autonomous pill dispenser: Mechanizing the delivery of tablet medication. In *the Proceedings of the Seventh Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON '16).* IEEE.

Diaz, A., & Vepuri, K. (2012). *Hero automatic pill dispenser*. Hero Health. https://herohealth.com/our-product

Hayes, T. L., Hunt, J. M., Adami, A., & Kaye, J. A. (2006). An Electronic Pillbox for Continuous Monitoring of Medication Adherence. In *Proceedings of the International Conference of the IEEE Engineering in Medicine and Biology Society.* IEEE. doi:10.1109/IEMBS.2006.260367

Jadhav, K., Vaidya, G., Mali, A., Bankar, V., Mhetre, M., & Gaikwad, J. (2020). IOT based automated fish feeder. In *Proceedings of the International Conference on Industry 4.0 Technology (I4Tech '20).* IEEE. doi:10.1109/I4Tech48345.2020.9102682

Mahmud, O. A., Khan, M. K., Roy, R., & Alamgir, F. M. (2020). Internet of things (IOT) based smart healthcare medical box for elderly people. In *Proceedings of the International Conference for Emerging Technology (INCET '20).* IEEE. doi:10.1109/INCET49848.2020.9153994

McCall, C., Maynes, B., Zou, C. C., & Zhang, N. J. (2010). RMAIS: RFID-based Medication Adherence Intelligence System. In *Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology*. IEEE. doi:10.1109/IEMBS.2010.5627529

Minaam, D. S. A., & Abd-ELfattah, M. (2018). Smart drugs: Improving healthcare using Smart Pill Box for Medicine Reminder and Monitoring System. *Future Computing and Informatics Journal*, *2*(2), 443–456. doi:10.1016/j.fcij.2018.11.008

Moise, M. V., Svasta, P. M., & Mazăre, A. G. (2020). Programmable IoT pills dispenser. In *Proceedings of the Forty Third International Spring Seminar on Electronics Technology (ISSE '20).* IEEE.

Mugisha, G. A., Muhumuza, C., Uzoka, F. M., Nwafor-Okoli, C., Nabunje, J., Arindagye, M., & Bukenya, J. N. (2020). Usability evaluation of low-cost smart pill dispenser by health care practitioners. In *Proceedings of the Future Technologies Conference (FTC '20).* Springer.

Nijiya, P. K., Najeeb, J., Rimna, A., Safa, K. P., Silvana, M., & Adarsh, T. K. (2018). Pill care - the smart pill box with remind, authenticate and confirmation function. In *Proceedings of the International Conference on Emerging Trends and Innovations in Engineering and Technological Research (ICETIETR '18).* IEEE.

Othman, N. B., & Ek, O. P. (2016). Pill dispenser with alarm via smartphone notification. In *Proceedings of the Fifth Global Conference on Consumer Electronics*. IEEE.

Philips, R., & Dibner, A. (2004). Automated medication dispensing device. https://www.lifeline.philips.com/business/medicationdispensing

Rao, A., B S, P., Shivani, A., & Mohan, R. (2020). IoT-based smart medicine kit. In *Proceedings of International Conference on Electronics, Computing and Communication Technologies (CONECCT '20).* IEEE.

Reddy, J. E. P., & Chavan, A. (2020). AI-IOT based smart pill expert system. In *Proceedings of the fourth International Conference on Trends in Electronics and Informatics (ICOEI '20).* IEEE.

Sangvanloy, T., & Sookhanaphibarn, K. (2020). Automatic pet food dispenser by using the internet of things (IoT). In *Proceedings of the Second Global Conference on Life Sciences and Technologies (Life Tech '20).* IEEE.

Valin, M., Meunier, J., St-Arnaud, A., & Rousseau, J. (2006). Video surveillance of medication intake. In *Proceedings of the Twenty Eighth Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS'06).* IEEE. doi:10.1109/IEMBS.2006.260647

Vandana Rao E is currently a software engineer at OneDirect Pvt Ltd, who recently graduated with a B.E in Information Science and Engineering from JSS Academy of Technical Education Bangalore.

Dayananda Pruthviraja is currently working as Professor in the Department of ISE at JSSATEB. He has Obtained Ph.D. degree from VTU and M.Tech degree from RVCE. His focus area is Image processing & Information Retrieval. He has published any papers in international journals and conference in the field of Image processing & Information retrieval.