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AI-IoT based Smart Pill Expert System

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*Abstract***— The paper discusses the implementation of a proposed Smart Pill Expert System (SPES) which is based on AI-IoT technology to automate pill dispensing with an effective user interface. The purpose of the proposed SPES is to provide expertise in the real-time diagnosis and thus support every individual and institution that is dependent on medication. Medical Non-Adherence (MNA) is one of the major factors of prolonged recovery, financial troubles, and premature deaths. This product is developed to be used in old age homes, hospices, and home healthcare centers and is capable of catering to the needs of single and multiple users simultaneously. With API and web services, new resources are provided for caregivers (family members, nurses, and doctors) to continuously track and monitor the users. Because of minimal human intervention, SPES has a failure rate of less than 5%.**

Keywords— Smart Medication, Healthcare, Expert System, Artificial Intelligence, Internet of Things (IoT), Cloud Computing

I. INTRODUCTION

Evolutions in smart healthcare technologies have led people to live a better lifestyle with each passing generation. The extent of benefits would have been even more prominent if the percentage of medication errors could be seized and circumvented. In many cases, negligence has led to death and an increase in the expenditures by millions each year. Even though more than 80% of the population above the age of 60 years are prescribed to take medicines multiple times a day, statistics indicate that 70% of adults do not follow a prescribed course of action, manipulate their dose or cease to continue drug therapy simply due to negligence or non – adherence [1,2]. According to the World Health Organization (WHO) statistics, around 92% of all elderly people above the age of 65 and 8% of all children suffer from one or more chronic conditions that require treatment [3]. Poor eyesight, forgetfulness, Alzheimer's, dementia are only a few of the many cases that could lead to medicine consumption errors. But another issue that has been in existence all along is non-adherence [4].

Non-adherence is one of the major causes of death and has risen to a staggering 60% amongst all medicine users [5,6]. Globally the burden of medication due to non-adherence is estimated to be $600 billion annually and along with a rise in incidences related to chronic diseases, the cost of hospitalization and emergencies have drastically increased. To overcome these overburdening costs, medication adherence has become more important than ever.

Because of these alarming statistics and analysis, numerous technology systems, and tools for the prevention of medication errors have undergone tremendous research and development [7]. The global population of all people above the age of 60 years is said to grow exponentially in the coming years. Therefore, long-term healthcare expenditures are bound to increase. To look after the aging population and achieve a better quality of healthcare, an increased number of expert systems within major hospitals and other such clinics are being implemented so that they can be used for preventing medical errors [8].

In this paper, an AI-IoT based Smart Pill Expert System is proposed. SPES is a safe, organized, and efficient pill dispensing expert system made to provide and support every individual and institution which also controls cost and ensures that users and patients follow their medical prescriptions within a given deadline. With the appropriate set of sensors, the system ensures that the right patient is taking the right medication at the right time thereby reducing the economic burden of non-adherence as well as providing efficient and prompt healthcare.

II. GLOBAL ADHERENCE MARKET

Challenges are arising amongst medical care providers to render quality service, which is anticipated to fuel the revenue development in the approaching years. The geriatric population and the intermittent subscriber are forming the major customer base in the global pill dispenser market. The dispenser market has also witnessed exponential growth because of the need to provide prompt, hassle-free services to users. There is an increase in acceptance amongst current technologies used in products such as dispensing cabins, smart pillboxes, and more to help patients, providers as well as management to monitor and ensure a better lifestyle. Most medical companies, pharmacies, and healthcare providers are now focused on providing medication adherence systems combined with hardware and software technologies as improved technology allows for ease in monitoring and generating product information about a patient for prompt healthcare support [9,10]. With a market rate of $1.7 million as of 2016, the market is said to reach $3.02 billion at an approximate Compound annual growth rate (CAGR) of 8% [11].

A. Traditional devices

Most traditional systems or pill dispenser units allow users to organize and handle their prescriptions independently; however, these available pill dispenser units do not provide adequate security and additional support for users at a given point. Most of the available units are general pill holders that generate an alert on the passage of time

TABLE 1- A COMPARISON OF THE VARIOUS SMART SYSTEMS USED FOR MEDICATION ADHERENCE.

S. No.	Technology-based comparison	Features	Limitations
1	**Sensor-Based Systems [12,13,14,15]**	• Can detect bottle cap opening, etc. • Ease of mobility • Non-invasive • Mobile Application Interface	• Battery plays a crucial role in determining the life of the system. • The accuracy of medication detection is low.
	• Pill Dispenser with Alarm via Smart Phone Notification. [12]	• Alarm based device to take the right medication. • Notifications and alerts via a smartphone application.	• No security protocols in place. • Only applicable for a single user. • Does not provide 'hands-on' medical assistance.
	• The Autonomous Pill Dispenser: Mechanizing the Delivery of Tablet Medication. [13]	• Dispensing pills on schedule. • Controlling device via API.	• No security protocols in place. • Only applicable for a single user. • Works on a flip mechanism to dispense pills with the help of users. • Does not provide 'hands-on' medical assistance.
	• Smart drugs: Improving healthcare using Smart Pill Box for Medicine Reminder and Monitoring System [14]	• Notifications and reminders to take pills via API. • Improves patient medication adherence.	• No security protocols in place. • Does not provide 'hands-on' medical assistance.
	• An Electronic Pillbox for Continuous Monitoring of Medication Adherence [15]	• It can determine if the wrong compartments were opened. • Prompt users to take medication if they have missed a dose	• Does not provide 'hands-on' medical assistance. • High cost, single-user device. • Limited security in terms of identifying the user.
2	**Proximity-Based Systems [16,17]**	• It can detect the absence or presence of medication with the help of a reader's antenna. • Non-invasive	• It needs to be combined with other sensors and devices to make it applicable for verification. • Based on high-level assumptions and self-sorted medications.
	• RFID-based Smart Medicine Drawer for Assistive Environments [16]	• Ability to detect if the medicine cabinet is closed or open. • Medication tracking based on RFID tags on 'bottles'.	• Based on assumptions - 'If a bottle is removed, a pill has been taken'. • Security limited to RFID tags placed on containers.
3	**Vision-Based Systems [18,19]**	• It can detect the absence or presence of medication with the help of a camera. • Non-invasive	• It needs to be combined with other sensors and devices to make it applicable for verification.

Solutions to medication non-adherence are based on multiple elements. The introduction of smart pill dispensers with the addition of digital technology has provided alerts and notified patients through audio or visual interfaces to take their medication on time, making the product more reliable and useful.

Recently developed dispensers have also implemented low-end security to prevent excess dosage from being taken or users from taking the wrong pills. Even the more intricate product designs have limited themselves to alerting individuals through text messages within a given time frame. Compared to manually controlled devices, electronic-based systems have drastically improved approachability, portability, and also the accuracy of measuring adherence.

Table 1 provides a comparison of some of the existing technologies used and their approach to combating the struggle of non-adherence. Technology has resolved many issues from the healthcare perspective, but there are still certain obstacles that need to be overcome for pill dispensers to have a global impact. As detailed in the table below, there are many factors still hindering the growth of these systems such as security, user's comfort, etc. [15] The Electronic Pill Box, for example, helps in identifying the wrong medication but does not help in preventing the same from being consumed. The Radio Frequency Identification Device (RFID)-based Smart Medicine Drawer helps keep track of RFID tagged bottles but is limited by the presumption that if a bottle has been removed from the drawer, one pill has been consumed [16]. The AI-IoT based smart pill expert system was designed to overcome most of these issues with the ability to cater to multiple patients with state-of-the-art technology and to provide an approachable user-friendly interface.

III. PROPOSED SOLUTION

The elderly and sick usually require support from caretakers, loved ones, and doctors, and their medical condition needs to be continuously monitored to prevent serious accidents [20,21]. They may also need separate instructions on different dosage times.

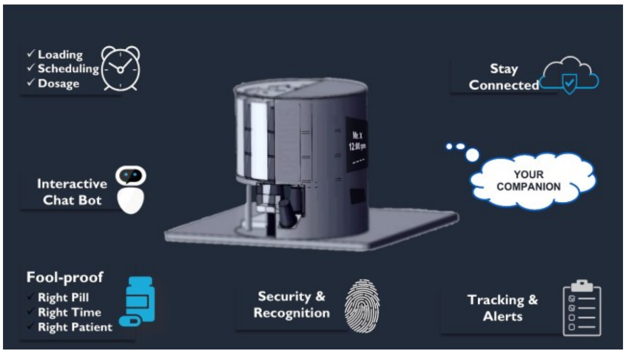

Figure 1 - SPES and its integrated features

The expert system was designed keeping in mind the latest trends in technology, while at the same time ensuring that the device is compatible and accessible to the elderly with their limited knowledge and insight. This paper describes the implementation, operations, and working of the SPES along with its features as shown in figure 1. The proposed system is robust, intelligent, and secure, with the ability to cater to single/ multiple users simultaneously. As the system has a built-in fingerprint scanner and a passcode detection security, which is used to uniquely identify the subscriber. Not only does the system facilitates the right medication to the right user, but it also provides a means for family members, nurses, and doctors to continuously track and monitor users as shown in the architecture of figure 2. The product is mainly used in seniors' residences, managed care, hospitals, hospices, old age homes, and other living facilities; it can also be used at an individual's home. Enhanced features such as cloud connectivity, Internet of Things, and an Artificial Intelligence-based interactive Bot for health care prognosis separate the SPES from the current global pill dispenser market.

A. Physical Dispenser Unit

The programmable automatic dispenser design allows caretakers and loved ones to reliably administer pills to a patient without needing to be physically present at the scheduled medication time. A caretaker or the user can easily set these doses through an ergonomically designed interface.

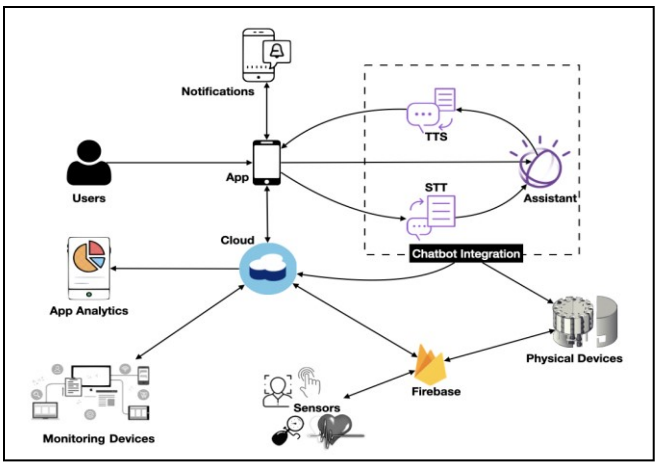

Figure 2- AI-IoT based Smart Pill Expert System Architecture

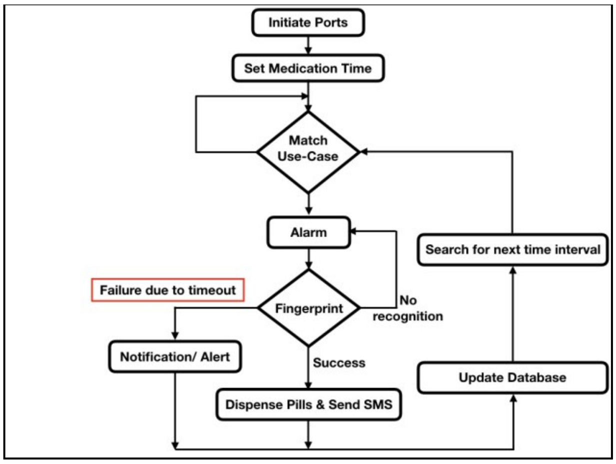

Figure 3- Flowchart of the dispenser unit

The SPES architecture can support two or more individuals, each having their prescribed course loaded. With fourteen different slots, the dispenser is capable of providing medication three times a day, seven days a week and each cup within the dispenser is capable of holding seven different kinds of pills. The flowchart, as shown in figure 3, shows the working of the pill dispenser and the step by step process of dispensation of the medical containers. The timer is preprogrammed based on the user/patient's prescribed course of action and their medical requirements. Consider a user who is required to take pills in the morning (post-breakfast) and afternoon (post-lunch). Scheduling can be done via an application interface by a doctor or the person-in-charge via an in-built calendar. At the given instance, an alarm will be generated thus notifying the user to take their medication. The authorized user will then place their fingerprint on the fingerprint sensor. The fingerprint will then be matched with the database which holds a predefined set of stored data. This will ensure that kids and other users do not accidentally dispense the pills in unwanted circumstances since each person has a separate identification.

Once the fingerprint has got a match, the cup holding the pills for that particular period will be dispensed. If the user forgets to take his/her pills, alerts and notifications will be sent to their phones as well to their loved ones. The intricate design of the machine ensures that only a single cup falls from the dispensing unit into the tray. To ensure that the pills are taken out from the tray after they are dropped, the alarm will continue to sound until the user takes the cup.

B. AI-based Chatbot for Healthcare Prognosis

Most users, especially the elderly people above the age of 60 tend to be more distant and hostile towards modern technology due to social, cultural, or even physical barriers. To improve responsiveness and create a genial approach to the SPES System, an interactive AI-based Chatbot was introduced to act as a companion for the elderly based on [22]. The Interactive Chatbot for healthcare prognosis can respond to the user's queries and requests. It can alert the user and also act as a source of communication for the elderly and the sick when caretakers are not present.

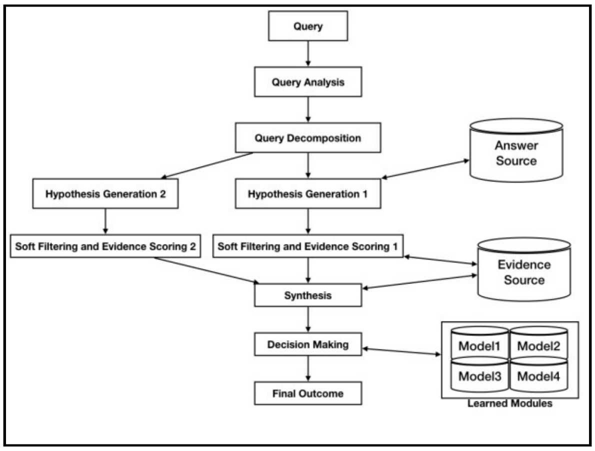

Figure 4- Chatbot query-response based on cognitive computing

The Health prognosis Bot also provides general information including details of its functionality, prescribed medication times for two different users, and also information on general sicknesses such as flu, influenza, cough, headaches, and many more along with their symptoms and the prescribed course of treatment as incorporated in [23,24]. The general workflow of the Chabot's query-response occurs at every point of communication with the user and is based on the flowchart given in figure 4.

- The Healthcare prognosis bot utilizes DeepQA for content or query analysis. The Bot works on the query posed by the user and decomposes it to find keywords or phrases.
- These services implement two deep parsing elements; English Slot Grammar (ESG) parser and a Predicate-Argument Structure (PAS) builder [25]. At first, the ESG parser is used for the deep-level analysis of the query/statement put forward by the user. The parser decomposes the query and generates a different hypothesis based on all the keywords present within the query. The PAS builder works on top of the ESG. The Predicate Argument Structure helps in combining multiple sentences that have the same meaning. Each sentence is considered unique at the ESG level whereas the passive and active alterations are considered as one at the PAS level. PAS drops terms that have very low importance and aids in the hypothesis generation.
- After the query is analyzed and decomposed, multiple hypotheses are generated ensuring a certain degree of correctness, by gathering information from answer sources in its primary search of the database. DeepQA utilizes parallel decomposition to work on sub-clues simultaneously within each hypothesis. Once a hypothesis is generated, it undergoes pruning at the soft filtering and evidence scoring level. In this stage, the information gathered in each hypothesis must cross a certain threshold. This threshold acts as a filter to eliminate the lowest probable set of scenarios (For example: <0.2 Confidence Level are eliminated). Once this initial threshold is crossed from the various techniques of gathering evidence, the information is then sorted and filtered.
- Most of the deep learning analysis is performed at the scoring level. The user's input text is mapped against the evidence gathered between the question and the keywords in the database. Once individual scores are generated from each of the given hypothesis, the resultant scores are evaluated and the best scenario is considered.
- Numbers, keywords, and special characters have a higher level of confidence and are therefore easier to classify and synthesize when compared to long sentences. A simple conversation example in figure 5 depicts how the Healthcare Prognosis Bot responds to a user's query to determine possible underlying health conditions.

Our interactive bot utilizes the family of probabilistic algorithms based on the assumption of conditional independence [26]. In natural language processing, one of the best-supervised machine learning algorithms used in text classification is logistic regression [27]. The healthcare prognosis bot is based on a retrieval model implementing logistic regression.

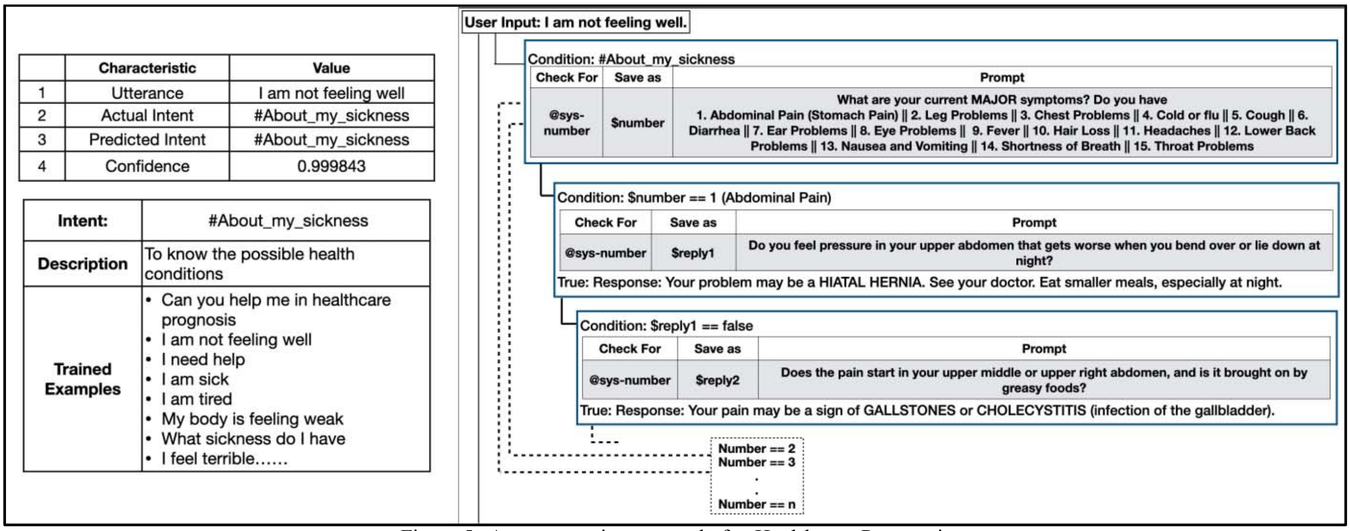

Figure 5- A conversation example for Healthcare Prognosis

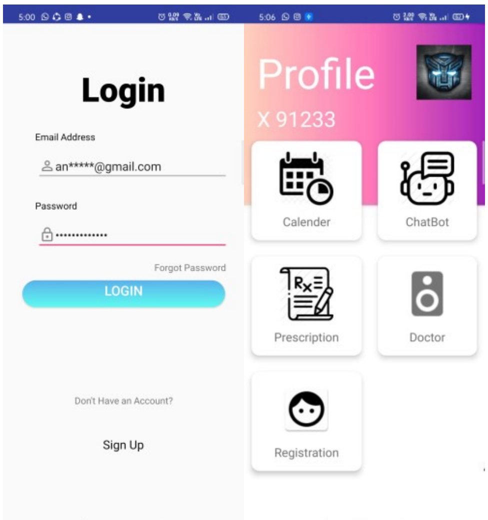

Figure 6 - Application Interface

Logistic Regression uses a set of predefined data to pick an appropriate response based on the users' input or questions [28]. This Regression algorithm was chosen among all other algorithms because of its simplicity and accuracy for the application. During the process of synthesis (if matching occurs), the cognitive system chooses the best possible route, filters out the hypothesis, and creates and provides answers most suitable for the user.

C. Application Interface

An API provides the user as well as their loved ones to continuously monitor and track the medication schedule at any given time and any given place. This intuitive application allows the doctor and the caretaker to monitor the patient even when there is no personal contact. After logging in, the application provides a general view of the pills that need to be taken along with their timing daily. A few of the modules are described below:

- Prescription: Provides an easy to read and understand set of instructions (compared to the usual handwritten form) that can be viewed by users, the pharmaceuticals in charge of refilling the dispenser and the caretakers to provide and care for the user as shown in figure 6.
- Calendar: Both loved ones and caretakers can continuously track and monitor the patients' medical intake and ensure that he/she is taking their medication on time. The application also provides an intuitive checkbox that informs the user about the pills, both forgotten and taken.
- AI-based Chatbot for healthcare prognosis: As mentioned in the previous section, the Chatbot, also known as Optimus, allows users to easily interact and obtain medical diagnosis and health facts.

D. Tampering and Authentication

One of the major challenges faced by any IoT system is unauthorized access which can lead to erroneous operation of the device by either reprogram the schedule or block usage. A tampered device under certain situations provide unsecured access to ensure innocent children, which may lead to medical poisoning.

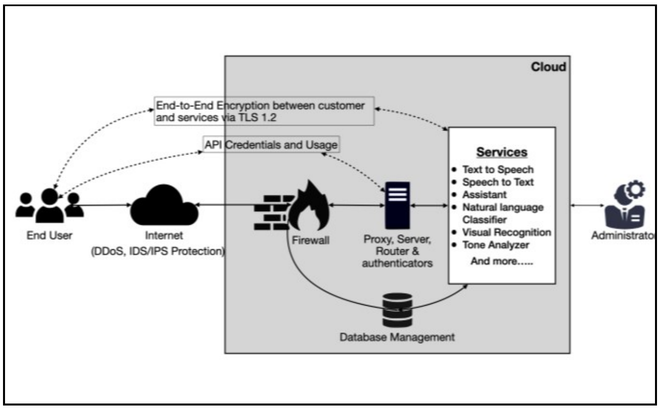

Figure 7- SPES Authorization and Authentication

- The SPES ensures that only those individuals who have the requisite authorization be granted access to their medication. To support disabled patients or handicapped individuals, the Smart Pill Expert System enables caretakers or loved ones to provide for the sick. The device itself is locked by a caretaker to ensure pills are not taken out of context. Fingerprint and Keypad authentication ensures that only authorized users take their pills at the allotted instance.
- To ensure data privacy for each user via the Chatbot, the Smart Pill Expert System supports high-level end-to-end encryption to protect data at rest (stored data) as well as data in motion (in transported). Advanced Encryption Standards (AES)-256 is used to encrypt Client data stored at rest and the entire client data is sent over the Internet via Transport Layer Security (TLS) 1.2. The SPES supports private network endpoints to ensure that data isn't transferred over the public network [29]. It also specifies that all resources provide server and database encryption, circuit and device level firewalls, protection and monitoring details, intrusion detection, program source code inspection, and daily vulnerability scanning as depicted in figure 7.

IV. PROCESS VALIDATION AND RESULTS

The results were obtained by analyzing the user's communication with the SPES System. As shown in figure 8, once a query is put forward to the System via a Chatbot or an Application Interface, the query is analyzed and decomposed followed by a primary search of the local database. To improve upon compliance with the user's needs, a high confidence level response is generated by checking the Global Database stored in the cloud. The global database is a compendium of users' health records and prescription history, hospital database, and the individual's diagnosis reports. The back end processing includes validation with data mining, analysis, filtering, identification, and data encryption as mentioned in the previous section.

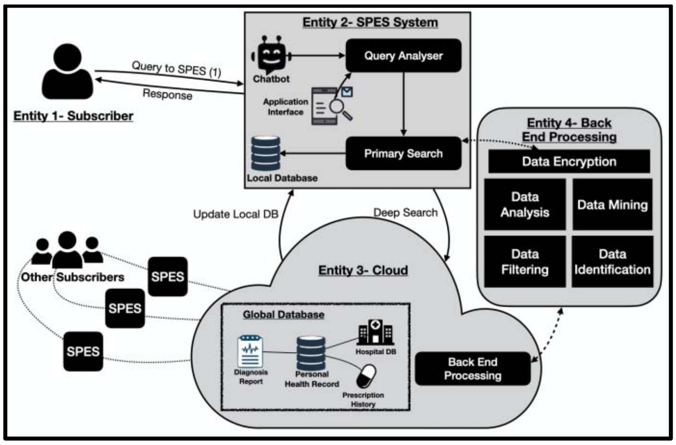

Figure 8- Data Acquisition environment for Healthcare Prognosis Chatbot

The metrics were calculated for all responses where the trained purpose/goals have a threshold or confidence level above 0.7 since the medical prognosis should ensure a very high degree of certainty in understanding the users' requirements and thus accurately provide a response. If the query has a low level of confidence, then the Chatbot will prompt the user for further clarification. All possible examples within the scope of the Chatbot as well as those which were considered irrelevant to healthcare prognosis were used in the above analysis.

- Topic Accuracy: The ability of the bot to match a set of test examples to their respective intent (purpose/goals) and provide the right answer to the user's query.
- False Acceptance Rate (FAR): The fraction of out-of-domain instances that were falsely presumed to be on-topic and were accepted.
- Bot Coverage: The total proportion of test samples that return confidence levels greater than the threshold.

As the number of trained examples increase, the classification of the user's intent becomes easier. Thus leading to a drastic drop in FAR and an exponential growth in Topic Accuracy as the percentage of coverage increases as shown in figure 9, with an accuracy of 95%.

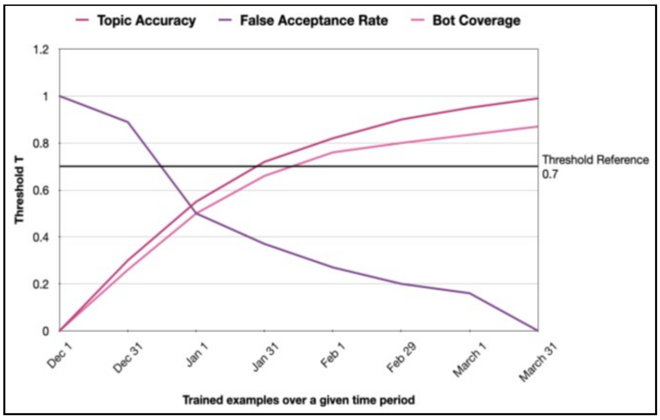

Figure 9- Four-month analysis based on trained examples

V. CONCLUSION

This paper describes the implementation, operations, and working off the SPES. The main goal of the system is to provide the right medication to the right patient at the right time. The biggest advantage of the SPE System is that it can support multiple users simultaneously, and control and monitor actions to prevent any errors from happening. With easy UI and flexibility, the SPES provides an easy to maintain physical dispensation with an Artificial Intelligence-based health prognosis Chatbot to answer user's queries. The proposed system has incorporated a robust security mechanism for user authentication and authorization. The performance in pill dispensing and accuracy in responses for the health care prognosis via chatbot is higher than its contemporary.

Future work includes interacting with pharmaceuticals along with the application interface for easy filling of medicines based on doctor's prescriptions, improving back end support for easier rescheduling, and installing pressure sensors to ensure that the pills are taken out of the dispenser after the user's fingerprint is authorized. One of the major challenges faced by any system including the SPES is 'active non-compliance'. Wherein the users may seem to cooperate with their medical treatment but choose not to consume medication by dropping or manipulating drug therapy. These users may place the pills in the mouth but not swallow those pills or use a simple technique to fool the technology. Wearable sensors integrated with SPES will help overcome these challenges and provide better adherence to medication compliance.

REFERENCES

1. C. Nananda, J.P. Fanale, P. Kronholm,"The Role of Medication Non-Compliance and Adverse Drug Reactions in Hospitalizations of the Elderly," Archives of Internal Medicine, 150 (1990):841-845.
2. "Smart Pill Boxes & Bottles Market: Improving Medication Compliance and Rising Need for Medication Monitoring & Management to Elevate Demand." Global Industry Analysis 2013-2017 and Opportunity Assessment 2018-2028.
3. "Adherence to Long-term Therapies, Evidence for action", World Health Organization, 2003, 110 pages [E], ISBN 92 4 154599 2.
4. Sokol, Michael C., et al. "Impact of Medication Adherence on Hospitalization Risk and Healthcare Cost." Medical Care, vol. 43, no. 6, 2005, pp. 521–530.
5. Kleinsinger F. "The unmet challenge of medication nonadherence." Perm J 2018;22:18-033. DOI: https://doi.org/10.7812/TPP/18-033.
6. Zullig LL, Blalock DV, Dougherty S, Henderson R, Ha CC, Oakes MM, Bosworth HB. "The new landscape of medication adherence improvement: where population health science meets precision medicine." Patient Prefer Adherence. 2018;12:1225–1230. doi: 10.2147/PPA.S165404. doi: 10.2147/PPA.S165404.
7. Thimbleby, H. (2013)., "Technology and the future of healthcare." Journal of Public Health Research, 2(3), e28. https://doi.org/10.4081/jphr.2013.e28
8. Durso, S.C., M.D., "Technological Advances for Improving Medication Adherence in the Elderly," Annals of Long Term Care, 9 (4), (2001): 43-48. Originally from Gandhi T K Burstin HR Cook, Drug Complications in outpatients, J. Gen Intern Med 2000., and Prescription medication compliance:A review of the baseline of knowledge, (NCPIEI, 1995).
9. Anacleto, Tânia Azevedo, Perini, Edson, Rosa, Mário Borges, & César, Cibele Comini. (2005). "Medication errors and drug-dispensing systems in a hospital pharmacy." Clinics, 60(4), 325-332. https://doi.org/10.1590/S1807-59322005000400011
10. De Bleser, L.; De Geest, S.; Vandenbroeck, S.; Vanhaecke, J.; Dobbels, F., "How Accurate Are Electronic Monitoring Devices? A Laboratory Study Testing Two Devices to Measure Medication Adherence." Sensors 2010, 10, 1652–1660. [CrossRef] [PubMed].
11. Automatic Pill Dispenser Machine Market by Type (Centralized Automated Dispensing Systems and Decentralized Automated Dispensing Systems) and by Application (Hospital Pharmacy, Retail Pharmacy, and Home Healthcare) - Global Opportunity Analysis and Industry Forecast, 2017-2023.
12. Othman, Nurmiza Binti and Ong Pek Ek. "Pill dispenser with alarm via smart phone notification." 2016 IEEE 5th Global Conference on Consumer Electronics (2016): 1-2.
13. S. Chawla, "The autonomous pill dispenser: Mechanizing the delivery of tablet medication," 2016 IEEE 7th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON), New York, NY, 2016, pp. 1-4.
14. Diaa Salama Abdul Minaam, Mohamed Abd-ELfattah, "Smart drugs:Improving healthcare using Smart Pill Box for Medicine Reminder and Monitoring System," Future Computing and Informatics Journal, Volume 3, Issue 2, 2018, Pages 443-456, ISSN 2314-7288.
15. Hayes, T.L.; Hunt, J.M.; Adami, A.; Kaye, J.A. "An Electronic Pillbox for Continuous Monitoring of Medication Adherence." In Proceedings of the International Conference of the IEEE Engineering in Medicine and Biology Society, New York, NY, USA, 30 August–3 September 2006; pp. 6400–6403.
16. Becker, E.; Metsis, V.; Arora, R.; Vinjumur, J.; Xu, Y.; Makedon, F. "SmartDrawer: RFID-based Smart Medicine Drawer for Assistive Environments." In Proceedings of the 2nd International Conference on PErvasive Technologies Related to Assistive Environments (PETRA '09), Corfu, Greece, 9–13 June 2009.
17. McCall, C.; Maynes, B.; Zou, C.C.; Zhang, N.J. "RMAIS: RFID-based medication Adherence Intelligence System." In Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology, Buenos Aires, Argentina, 31 August–4 September 2010; pp. 3768–3771.
18. Batz, D.; Batz, M.; da Vitoria Lobo, N.; Shah, M. "A computer vision system for monitoring medication intake." In Proceedings of the 2nd Canadian Conference on Computer and Robot Vision, Victoria, BC, Canada, 9–11 May 2005; pp. 362–369.
19. Valin, M.; Meunier, J.; St-Arnaud, A.; Rousseau, J. "Video surveillance of medication intake." In Proceedings of the 28th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS'06), New York, NY, USA, 30 August–3 September 2006; pp. 6396–6399.
20. Y. Jasemian, "Elderly comfort and compliance to modern telemedicine system at home," 2008 Second International Conference on Pervasive Computing Technologies for Healthcare, Tampere, 2008, pp. 60-63.
21. Harris, Randall E. "Epidemiology of chronic disease: global perspectives." Jones & Bartlett Learning, 2019.
22. N. Albayrak, A. Özdemir and E. Zeydan, "An overview of artificial intelligence based chatbots and an example chatbot application," 2018 26th Signal Processing and Communications Applications Conference (SIU), Izmir, 2018, pp. 1-4.
23. M. Bates, "Health Care Chatbots Are Here to Help," in IEEE Pulse, vol. 10, no. 3, pp. 12-14, May-June 2019.
24. Ketan Paranjape, Michiel Schinkel, Rishi Nannan Panday, Josip Car, Prabath Nanayakkara, "Introducing Artificial Intelligence Training in Medical Education (Preprint)", JMIR Medical Education, 2019.
25. M. C. McCord, J. W. Murdock and B. K. Boguraev, "Deep parsing in Watson," in IBM Journal of Research and Development, vol. 56, no. 3.4, pp. 3:1-3:15, May-June 2012.
26. Prasadl, B. D. C. N., P. E. S. N. K. Prasad, and Y. Sagar. "An approach to develop expert systems in medical diagnosis using machine learning algorithms (asthma) and a performance study." International journal on soft computing (IJSC) 2.1 (2011): 26-33.
27. M. Y. Helmi Setyawan, R. M. Awangga and S. R. Efendi, "Comparison Of Multinomial Naive Bayes Algorithm And Logistic Regression For Intent Classification In Chatbot," 2018 International Conference on Applied Engineering (ICAE), Batam, 2018, pp. 1-5.
28. Jurafsky, Daniel & Martin, James. (2008). "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition."
29. IBM, "Watson Developer Cloud security overview," Tech. Rep., IBM, 2016.

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