International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

VoiText Care: ANFIS driven Persuasive Mobile Application for Medication Adherence Intervention

Uzoma R Alo[1], Michael S Julius[*2], Chinyere I. Akobundu[3], Victoria N. Ezeano[4], Doris N. Nnakwuzie[5], Fidelis N. Uguru[6]

Submitted: 12/01/2025 **Revised:** 27/02/2025 **Accepted:** 11/03/2025

Abstract: The prevalence of medication non-adherence to long-term therapies among outpatients with chronic disease has continued to be an issue of serious concern to healthcare institutions and general public. Multifaceted intervention approach to motivate and promote positive health behavior of patients towards medication adherence is highly needed. In this paper, the design of voice and text (VoiText) Care App, a persuasive mobile application that leverages patient's assessment score of medication non-adherence level (data) with four (4) linguistic terms (variables) generated by ANFIS algorithm for delivering of personalized and persuasive adherence intervention message is proposed. The four linguistic variables (terms) of medication non-adherence level are: very low non-adherence (VLNA), low non-adherence (LNA), high non-adherence (HNA) and very high non-adherence (VHNA). With assessment score, level of non-adherence of patient is mapped with linguistic terms and it is used to determine the persuasion strategy or principle to be adopted for the composition of the persuasive messages. With combined potential of agent voice call, short message service of mobile phone technology, persuasive strategies and web portal, the developed persuasive mobile application could efficiently improve adherence to medication.

Keywords: agent voice call, ANFIS, intervention, medication adherence, persuasive technology, SMS,

1. INTRODUCTION

Medication non-adherence to long-term therapies among outpatients with chronic diseases is not only a longstanding problem (Kardas, 2024), but also a common and multifaceted problem in healthcare systems. However, persuasive technology driven intervention system can be used to navigate the challenges of medication non-adherence as it plays an essential roles that cannot be over-emphasized. Persuasive based applications are systems that are designed to interactively foster changes in people's attitude or behavior or choice without pressurizing them (Orji *et al.,* 2018; Arathi *et al.,* 2018; Fogg, 1998). A system or device or application is only qualified to be described as persuasive when such a system or device or application was created, designed or applied with intention to change human attitude or behavior. Persuasive technology can take several forms such as website, portal, games, wearables, smartphone apps, virtual reality environment, robots etc (Song and Fiore, 2017).

With the emergence of mobile phone and wearable devices, the design of persuasive based application in healthcare to motivate and promote health behavior is becoming popular (fritz *et al,* 2014) and efficient especially in the area of medication adherence intervention. Recently, there are several persuasive based applications that have adopted the use of persuasive message aimed to change human behaviour and attitude from 'bad' to 'good' and 'good' to 'better', especially in the areas of healthcare and marketing (Lopez and Condori-Fernandez, 2017). Examples of such applications include use of telephone calls and short message service of mobile phone to deliver alert and notification messages for reminding patients when to take medications (Forman *et al.,* 2018; Thakkar *et al.,* 2017; Hameed *et al.,* 2011).

However, the choice of specific contents of persuasive based messages is usually determined by the various levels of persuasiveness or strategies or

1 Alex Ekwueme Federal University Ndufu Alike, Nigeria
2 Evangel University, Akaeze, Nigeria
**Corresponding Author Email: julius.michael@evangeluniversity.edu.ng*

principles adopted. There are six layers of persuasiveness (persuasive strategies or principles) developed by Cialdini (2021) which are reciprocity, commitment, consistency, social proof, liking and scarcity as found in (Lopez and Condori-Fernandez, 2017). Persuasive message-based adherence intervention techniques describe the kind of innovative technological means or tools by which persuasive intervention functions/messages are delivered to patients and caregivers while feedback messages are delivered to the healthcare provider (Julius *et al,* 2021).

With the high rate of mobile phone owners and advances in both mobile phone applications development and persuasive technology, adaptive and personalized persuasive messages that can promote and improve medication adherence behaviour of patient could easily be composed and delivered to individual patients based on the level of medication non-adherence and persuasion strategy or principles. In this study, VoiText, a persuasive mobile application that leverages on assessment score of medication non-adherence level (data) with four (4) linguistic terms (variables) generated by ANFIS algorithm for delivering of personalized and persuasive adherence intervention messages to improve medication adherence is proposed. The four linguistic variables (terms) of medication non-adherence level are: very low non-adherence (VLNA), low non-adherence (LNA), high non-adherence (HNA) and very high non-adherence (VHNA). With assessment score, level of non-adherence is mapped with linguistic terms and it is used to determine the persuasion strategy or principle to be adopted for the composition of the persuasive message contents. VoiText Care uses an agent voice call, SMS and web portal to deliver a personalized multilingual persuasive message to patients who are on long time medications.

The paper is organized as follows: in section 1, background to the study is provided, section 2 presents related studies, and in section 3 design methodology and structure are presented, section 4 and 5 shows the prototype implementation of VoiText Care App and conclusion respectively.

2. RELATED LITERATURE

The use of persuasive based applications and systems to drive and motivate healthy behavior in the domain of healthcare such as medication adherence intervention, fitness and wellness is becoming a new area of research interest centered on human computer interface (HCI) and ubiquitous computing (Fritz *et al,* 2014; Orji, Julius *et al, 2024* and Moffat, 2018).

Orji and Moffat (2018) in their study opined that persuasive based applications and systems are primarily designed to be an interactive system that can drive behavioural change in people and make them to embrace behaviours that are beneficial to their wellness and desist from the harmful ones. Some health domain where persuasive technologies with different strategies have been successfully applied were highlighted by Orji and Moffat, 2018 to include the following areas: physical activities, eating, dental health, disease management, smoking and substance abuse, sexual behavior, general health, clinical appointment, routine management and others.

Several studies have adopted the use of technological tools especially mobile phone and web services/applications to remind and motivate patients to adhere to their prescribed medications. Examples of such technological tools are gamified and incentivized mobile App (Altuwayrib et al., 2023: Tran et al., 2022); relational agents (Bickmore *et al.,* 2010); automated persuasive text messages (Luong et al., 2024: Loughran and Gibson, 2023: Brown *et al.,* 2018; Kamal *et al., 2017*) as reminder and alert; mobile phone application with web applications (Forman *et al.,* 2018; Hameed *et al.,* 2011); agent voice call (Reidel et al., 2018); telephone call reminder (Thakkar *et al.,* 2015) and hybrid cloud based systems. The reports of the studies have shown significant positive outcomes both in clinical trials and treatment management of illnesses.

Similarly, other technologies like smart pill box, wearable sensors, ingestible biosensors, computer vision and RFID have been used to deliver adherence intervention functions (Thakkar *et al.,* 2015). However, these tools are more of hardware driven intervention tools and they are not only patient unfriendly in terms of usage but also cost ineffective. In most times, these tools are not practicable for clinical settings usage (Julius *et al.,* 2021).

In the design and evaluation of persuasive based intervention application to improve medication adherence, four (4) major categories of persuasive system features commonly available in medication management systems were identified in the review study by Win et al., 2017. These include primary task support, dialogue support, system credibility support and social support. Also, in a review study the use of gamification and incentives in mobile health Apps to improve medication adherence was carried out by

(Tran et al., 2022). It was established that with seven gamification mechanics identified, medication adherence levels of chronic health conditions could be improved via health education and motivation as intervention.

Han et al., 2019 developed a mobile application named Adhere4U. The study evaluated whether the use of the Adhere4U mobile medication manager application could improve adherence among renal transplant recipients ≥1 year post transplantation. Adhere4U provided medication reminders, monitor medication use, and information on immunosuppressant.

Okuboyejo *et al*, (2013) developed and implemented web and voice based mobile health application called "MedAlert". It is a medication adherence intervention delivery mobile app that helps patients adhere to their prescribed medication, clinical appointment via short message service technologies, voice calls and website. Patients receive both SMS and voice call at a scheduled time and period in form of alert message and reminder. In addition, the system provides website for both physicians and patients for the medication management. The website application integrated Twilio API for the sending and receiving SMS and voice calls and messages targeted to encourage patients to adhere to their prescription.

Similarly, Shellmer *et al*, (2016) designed and developed mobile health application named "Teen Pocket PATH" to improve medication adherence in adolescent solid organ recipients. The main screen of "Teen Pocket PATH" and the mobile App has functions that include but not limited to: display daily medications to be taken and shows all prescribed medications; provides digital calendar platform where details of appointments and prescriptions can be added; create log and history of all medications taken and view all receive health information tips with regards to organs transplant.

Several persuasive mobile application based interventions for improving patient adherence to medication with alerts, reminders, tracking, education, warning and other functions are in development, but there are still significant challenges relating to intelligent and dynamic delivery of persuasive messages to individual patients based on their non-adherence level and factors that influence the non-adherence. Knowing the patients' medication non-adherence level and its associated factors could help in developing and delivery of an appropriate and efficient patient centered intervention.

3. METHODOLOGY

3.1 Persuasive strategies/principles in medication adherence

In the domain of healthcare, reviewed studies on persuasive strategies highlighted several principles of persuasion that have been employed to bring about the intended persuasion outcomes. These principles include but not limited to: tracking and monitoring; audio, visual and textual feedback; social support, sharing and comparison; persuasive messages, reminder, alert, rewards, points and credits; goals and objectives; competition, leader boards, ranking, tailoring, personalization and customization; praise, cooperation and collaboration; virtual rehearsal and simulation; emotions and persuasive images; progress; positive reinforcement; negative reinforcement; suggestions and advice; video based persuasion (Orji and Moffat, 2018).

Other theories and models such as knowledge-attitude-behaviour (KAB) model, social influence, and social comparison theory with social learning theory have been identified (Orji et al. 2019). Also, according to (Lopez and Condori-Fernandez, 2017), reciprocity, commitment, consistency, social proof, authority liking and scarcity were also developed. These theories and models with persuasive principles have been successfully applied in many domain areas including healthcare and education.

3.2 Design of ANFIS driven persuasive adherence messages

Leveraging persuasion strategies and principles towards the delivery of efficient adherence intervention messages that can promote and improve medication adherence behavior of patients is one of the main objectives of this study. The study adopts the use of adaptive neuro fuzzy inference system (ANFIS) to leverage on patient's level of medication non-adherence data before the delivery of intervention messages.

ANFIS is one of the supervised and hybrid soft computing algorithms that combines the strength of fuzzy logic and neural network for effective knowledge representation and learning capability respectively (Egwor et al., 2018). Its adaptive nature does not only makes the delivery of intervention messages non-monotonous but also patient-centric as

it addresses the individual issues of non-adherence of the patient. The messages are generated and delivered based on the individual's assessment score of medication non-adherence level and the associated factors (patient's belief, knowledge, perception and behavioural pattern)

In this paper, fuzzy logic is used to abstract and represent both the patient's non-adherence level and its associated factors as linguistic variables with four membership functions. By applying fuzzy logic algorithm, five fuzzy inputs which are non-adherence level, belief, knowledge, perception and behavioural pattern are considered. Each of the input is fuzzified into four linguistic variables as shown in the table 1.

Table 1. Fuzzy inputs and linguistic variables

Input	Linguistic Variable
Patient's Non-adherence level (PNAL)	Very high, High, Low, Very low
Patient's belief level on medication (PBM)	Worse, Bad, Good, Excellent
Patient's knowledge level on medication and disease (PKM)	Inadequate, Fair, Good, Excellent
Patient's perception level towards medication and medical advice (PPP)	Bad, Fair, Good, Excellent
Patient's behavioural pattern (forgetful level) PBP	Highly, Moderately, Rarely, Not

With triangular membership function, at least three points (k, l, m) are required to define membership function of any of the input variables. The triangular membership function is defined as:

$$f(x;k,l,m,) = \begin{cases} 0, & x \le k \\ \frac{x-k}{l-m} & k \le x \le l \\ \frac{m-x}{m-l} & l \le x \le m \\ 0, & m \le x \end{cases}$$

From the above stated definition, the formulation of the membership functions for behavioural pattern (forgetfulness level) in crisp values is defined and denoted as follow:

$$LA(x) = \mu(x:) \begin{cases} notforgetfulifLA(x) \le 3 \\ rarelyforgetif\ 3 \le LA(x) \le 5 \\ moderatelyforgetfulif\ 5 \le LA(x) \le 9 \\ highlyforgetfulif\ 9 \le LA(x) \le 12 \end{cases}$$

$$Notforgetful(x) = \begin{cases} 0 & ifx \le 0 \\ \frac{x}{1.5} & if\ 0 < x < 1.5 \\ 1 & ifx \ge 3 \end{cases}$$

$$Rarelyforgetful(x) = \begin{cases} 0 & ifx \le 0 \\ \frac{x-3}{2} & if\ 3 \le x < 5 \\ 1 & ifx \le 5 \end{cases}$$

$$Moderatelyforgetful(x) = \begin{cases} 0 & ifx \le 5 \\ \frac{x-5}{4} & if\ 5 \le x < 9 \\ 1 & ifx \ge 9 \end{cases}$$

$$Highlyforgetful(x) = \begin{cases} 0 & ifx \le 9 \\ \frac{x-9}{6} & if\ 9 \le x < 12 \\ 1 & ifx \ge 12 \end{cases}$$

The formulation of the membership function for patient medication non-adherence level is:

$$LA(x) = \mu(x:) \begin{cases} verylowifLA(x) \le 1 \\ lowif\ 3 \le LA(x) \le 3 \\ highif\ 5 \le LA(x) \le 5 \\ very\ highif\ 5 \le LA(x) \le 8 \end{cases}$$

$$Verylow(x) = \begin{cases} 0 & ifx \le 0 \\ \frac{x}{0.5} & if\ 0 < x < 0.5 \\ 1 & ifx \ge 1 \end{cases}$$

$$Low(x) = \begin{cases} 0 & ifx \le 0 \\ \frac{x-1}{1} & if\ 1 \le x < 3 \\ 1 & ifx \le 3 \end{cases}$$

$$High(x) = \begin{cases} 0 & ifx \le 3 \\ \frac{x-3}{1.5} & if\ 3 \le x < 5 \\ 1 & ifx \ge 5 \end{cases}$$

$$Very\ high(x) = \begin{cases} 0 & if x \leq 5 \\ \frac{x-5}{2} & if\ 5 \leq x < 8 \\ 1 & if x \geq 8 \end{cases}$$

For instance, if patient's non-adherence level is very high and the associated factor such as behavioural pattern is highly forgetful then the persuasive strategy will be based on commitment and consistency by sending several personalized reminders using the message catalog and delivered via short service message (SMS) and agent voice call.

3.3 Design Architecture of VoiTextCare App

In VoiText Care App, multi-tier client-server design architecture was used. This is because it is an extension of three-tier client-server architecture with three additional features that support the design of hybrid user interface of both voice and web with several clients (users) in the presentation tier. These features include replication of the components within a tier, further specialization of tiers and addition of portal services. With multi-tier architecture, different user interface, multiple application servers and data servers can be accommodated at the presentation tier, business logic tier with intelligent services and data tier respectively. Figure 1 illustrates the multi-tier design architecture of VoText Care App. The client tier has both mobile phone user interface and web user interface. It is the tier that handles the user interface processing only and presents the App to the end user for use. The application tier hosts the several application servers which includes Voice and SMS application (Twilio and Africa talking APIs), multi-lingual translator/converter APIs, ANFIS algorithm, web servers (IIS-HTTP, FTP, email and other service; .NET Common Language Run-time server and other tools for developing web and other applications. It handles application processing which is referred to the business logic including the various modules in the APP. The last tier hosts the multiple data servers consisting of data dictionary, recorded voice data, text data, patients' data, and medication data and so on in the database for the data storage and modifications. In VoText Care App Microsoft relational database management that supports stored procedures and standard SQL commands. MSQL is a multiuser and multi-thread Relational Database Management System (RDBMS).

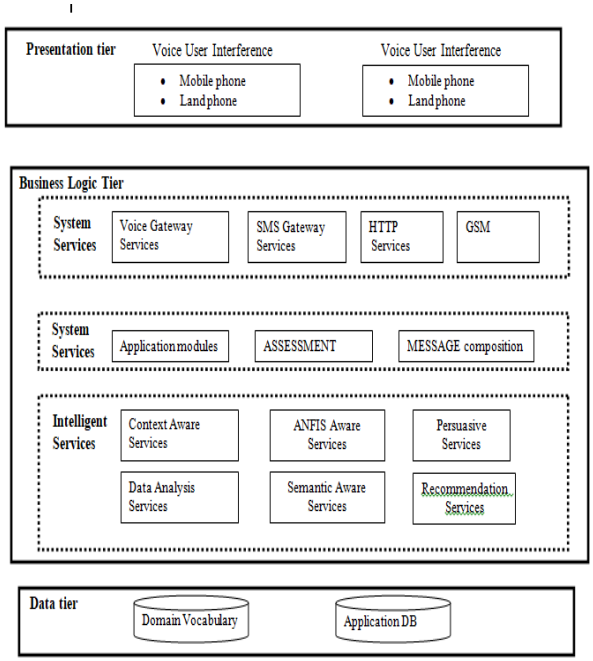

Figure 1 Multi-tier design architecture of VoText Care App adapted from Okuboyejo et al., (2013)

4 PROTOTYPE IMPLEMENTATION

A multilingual persuasive mobile medication adherence intervention App driven by adaptive neurofuzzy inference system named "VoiText Care" was developed. The App was implemented using .Net framework with C# programming language and Microsoft Structured Query language (MSQL) for the web user interface and database management respectively. Application Programming Interface (API) of Africa talking and Twilio were integrated to provide voice and SMS services for the mobile phone users. This enable the APP to place an agent voice call to patients on medication with personalized and persuasive message contents based on persuasive strategies and principles. Message content functions may focus on prescription details, next scheduled clinic visit, health information tips, education, awareness, warning against non-adherence medication time and dose and so on.

In addition, ANFIS algorithm was applied in order to adapt the level of persuasiveness and medication non-adherence of patient based on the assessment score. It provides and combines both web and mobile phone user's platforms where adherence intervention persuasive messages are composed and delivered via the integrated technological delivery tools such as SMS, Voice agent call and USSD.

Examples of personalized and persuasive message are ***'Chinedu take you drug, all of us doctors want you well', 'Adebayo remember to take your drug, drug not taken cannot work', 'Grand Pa, believe God and take your drug', 'Kunle you are already getting better, continue to take your drug do not stop it'*** and so on. The content of the message depends on the non-adherence level assessed and factor that cause the non-adherence in the individual patient. Figure 2, 3, 4 and 5 show the implementation screenshots for patient adherence assessment form, assessment result, persuasive messages delivered by SMS and persuasive messages delivered by agent voice call respectively.

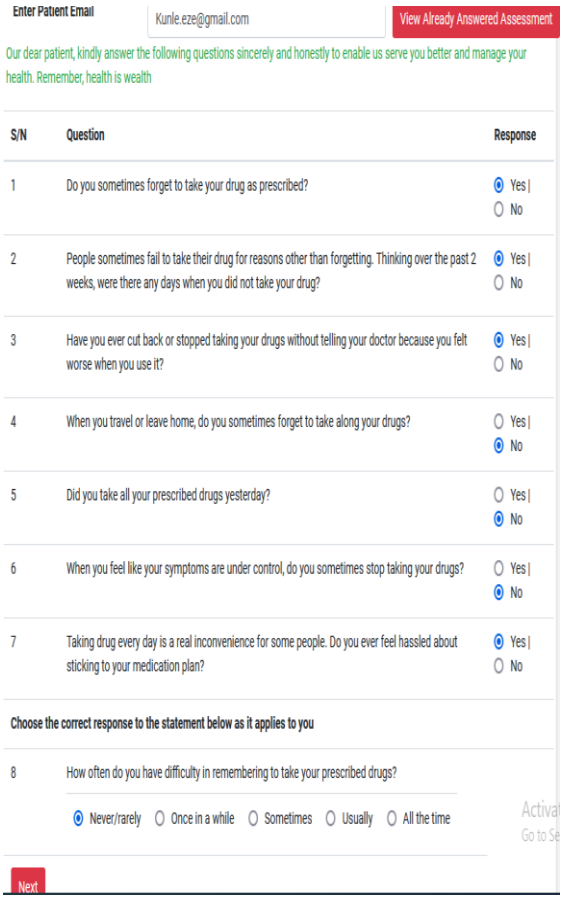

Figure 2 Patient adherence assessment survey form

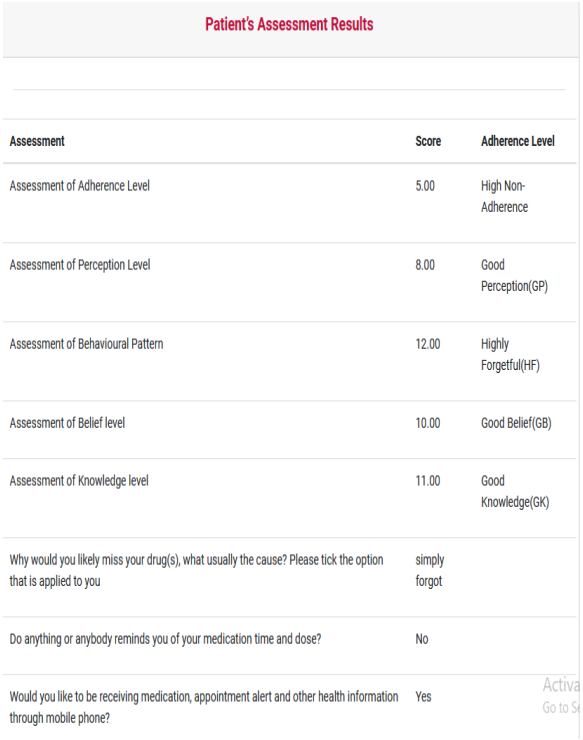

Figure 3 Adherence assessment result

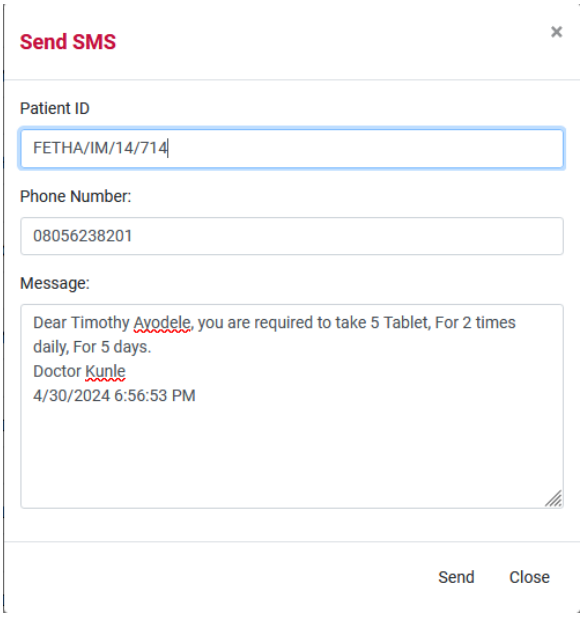

Figure 4. Persuasive message delivered by SMS

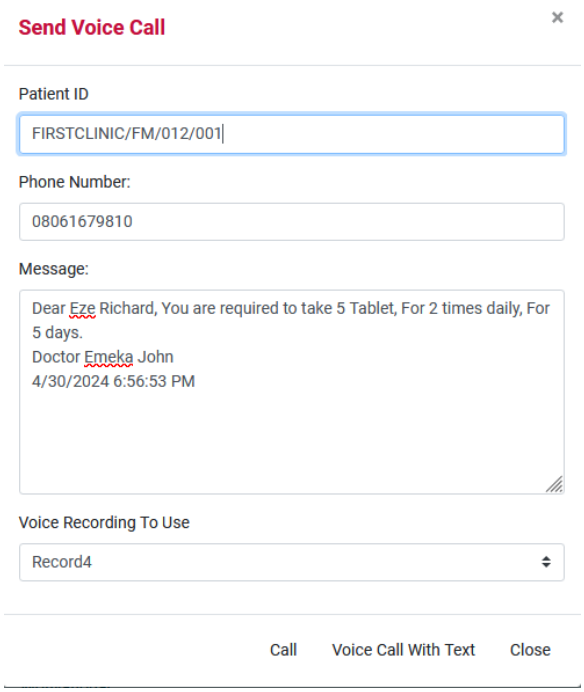

Figure 5 Persuasive message delivered by agent voice call

5 CONCLUSION AND FUTURE WORK

This paper presents a developed prototype of ANFIS driven persuasive mobile application intervention for improving medication adherence which is called "VoiText Care". It is a multilingual persuasive mobile medication adherence intervention App that combines both web and mobile phone technologies with two (2) application programming interface (APIs) which are Twilio Reset and Africa Talking. VoiText Care provides a secured end user interface and platform where adherence intervention persuasive messages are composed and delivered via the integrated technological delivery tools such as web portal, SMS, Voice agent call and USSD code. With the user-friendly web-based medication adherence intervention platforms for Physician, Patient and Admin to carry out activities that support and improve medication adherence behaviour of patients and to help patients adhere to their prescribed medication. Such activities include but not limited to: simplification of medication dose and dosage during medication prescription by physician; composition and delivery of clinic appointment notification and reminder messages by Admin; medication and health information message alerts by Admin; delivery of patient-centric persuasive message centered on motivation, information, how to take medication, warning against risk of non-adherence to medication, counseling and so on via SMS and agent voice call. In addition, patients are provided with web portal and USSD code to access their prescription, appointment date and other health information capable of improving their wellness.

As part of our future work, we plan to integrate AI voice cloning API that will enable the generation of synthetic copy of patient and caregiver voices for an improved patient to caregiver engagement and communication. We also hope to apply CNN machine learning algorithm to improve the validation, accuracy and time construct of conversion of text to speech and speech to text.

References

[1] Aikaterini, K. & Stephen, S. (2017). Reasons for non-adherence to cardiometabolic medications, and acceptability of an interactive voice response intervention in patients with hypertension and type 2 diabetes in primary care: a qualitative study. BMJ Open 2017;7:e015597.doi:10.1136/bmjopen-2016-015597

[2] Altuwayrib, S. A., Mark Freeman, Nawaf Almutair & Khin Than Win (2024) Persuasive Design Principles for a Medication Adherence App for Chronic Arthritis Conditions. Persuasive Technology: 19th International Conference, PERSUASIVE 2024, Wollongong, NSW, Australia, April 10–12, 2024, Proceedings. pp 42-53 https://doi.org/10.1007/978-3-031-58226-4_4

[3] Ataguba G, Orji R. Toward the design of persuasive systems for a healthy workplace: a real-time posture detection. Front Big Data. 2024 Jun 17;7:1359906. doi: 10.3389/fdata.2024.1359906. PMID: 38953011; PMCID: PMC11215059.

[4] Brown, M. T., & Busell, J. K. (2011). Medication adherence: WHO cares?Mayo Clin. Proc. 86, pp. 304 –314.

[5] Cialdini, R. (2001). Influence: Science and Practice. Allyn and Bacon, Boston.

[6] Costa, E., Giardini, A., Savin, M., Meditto, E., Lehane, E., Laosa, O., Pecorelli, S., Monaco, A. & Marengoni, A. (2015). Interventional tools to improve medication adherence: Review of literature. Dovepress Vol. 9 pp. 1303-1314.

[7] Egwor, A. A., Onibere, E. A., & Odion, P. O. (2018). Application of neuro-fuzzy system: a literature review." International Journal of Computer Science and Network Security, Vol. 18, No.12

[8] Engelbertink, M.M.J., Kelders, S.M., Woudt-Mittendorff, K.M. *et al*. Participatory design of persuasive technology in a blended learning course: A qualitative study. *Educ Inf Technol* 25, 4115–4138 (2020). https://doi.org/10.1007/s10639-020-10147-x

[9] Foggi, C. H. (1998). Persuasive computers: persperctives and research directions. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. Doi: 10.1145/274644.274677.

[10] Forman, L. S., Gregory, J. Patt, Sharon M. Coleman, Elena Blokhina, John Lu, Tatiana, Yaroslavtseva, Natalia Gnatienko, EvgenyKrupitsky, Jeffrey H. Samet, & Christine E. Chaisson. (2018). Use of Android phone application for automated text messages on International settings: A case study in an HIV clinical trial in St. Petersburg, Russia", Clinical Trials.Vol. 15(1) 36-43.

[11] Fritz. T., Murphy, G.C. & Zimmermann, T. (2014). Persuasive technology in the real world. A study of long-term use of activity sensing devices for fitness.

[12] Hameed, S. A., Shahina, B. T., MohdSharifudeen, N., Nur, D., Hassan, A. & Khalifa, O. (2011). Web-Based and SMS to facilitate health medical emergency, Australian Computer Society, Incorporation.

[13] Julius, M. S., Alo, U. R., Onu, F. U. & Akobundu, C. I. (2021). Machine learning framework to predict patient non-adherence to medication using non-clinical data: A prognosis approach. International Conference on Computer and Communications Management, ACM.

[14] Julius, M. S., Alo, U. R., Onu,F. U., Akobundu, C. I., Agwu, C. O., Ogbu, N. H., & Eze, F. C. (2024). Cloud-Based Medication Non-adherence Assessment and Intervention System, International Congress on Information and Communication Technology, Springer Nature Singapore. Pp 647-658

[15] Khin Than Win, Judy Mullan, Sarah Howard, Harri Oinas-Kukkonen. Persuasive Systems Design Features in Promoting Medication Management for Consumers.

[16] Lopez, F. S. & Condori-Fernandez, N. (2017). Design of an adaptive mobile application for simulating the medication adherence. ICST Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, 2017. ENICST178, pp: 99-105. DOI: 10.1007/978-3-319-49616-0-9.

[17] Loughran, Elliot and Gibson, Jewyl, "Using Mobile Apps to Improve Medication Adherence in Patients with Hypertension" (2023). Graduate Publications and Other Selected Works - Doctor of Nursing Practice (DNP). https://trace.tennessee.edu/dnp/97.

[18] Orji, Rita & Maffath, R. (2018). Persuasive technology for health and wellness state-of–the art and emerging trends. Health Informatics Journal. Vol-24(1) 66 – 91.

[19] Przemyslaw Kardas (2024): From non-adherence to adherence: Can innovative solutions resolve a Longstanding problem? Medication Adherence Research Center, Department of Family Medicine, Medical University of Lodz, Lodz, Poland

[20] Reidel, K., Tamblyn, R., Patel, V. & Huang, A. (2008). Pilot study of an interactive voice response system to improve medication refill compliance", BMC Medical Informatics and Decision Making 2008, doi: 10.1186/1472-6947-8-46, July (2008).

[21] Shellmer, D. A, Dew, M. A., Mazariegos, G. & DeVito D. A. (2016). Development and field testing of Teen Pocket PATH, a mobile health application to improve medication adherence in adolescent solid organ recipients", Pediatric Transplantation, Published by John Wiley & Sons Ltd 2016.

[22] Shi, L., Li, X., & Win, K. T. (2024). Investigating mobile persuasive design for mental wellness: A cross-domain analysis. *International journal of medical informatics*, *185*, 105353. https://doi.org/10.1016/j.ijmedinf.2024.105353

[23] Thakkar, J., Rahul, K., Tracey-Lea, K. S., Aravinda, T., Anthony, R., Mark, W. R., Julie, R. & Clara, K. C. (2016). Mobile telephone text messaging for medication adherence in chronic disease. JAMA Intern Med. 176(3):340-349. Doi:10.1001/jamainternmed.2015.7667

[24] Tran S, Smith L, El-Den S, Carter S .(2022). The Use of Gamification and Incentives in Mobile Health Apps to Improve Medication Adherence: Scoping Review. JMIR Mhealth Uhealth 2022;10(2):e30671.URL: https://mhealth.jmir.org/2022/2/e30671. DOI: 10.2196/30671