International Journal of
Advanced Science and Convergence

ISSN : 2619-8150
Volume 4, Number 1, March 2022
https://doi.org/10.22662/IJASC.2022.4.1.009

Design an artificial intelligence chatbot to support patient declaration and direction of examination rooms for outpatients

Thi Ngoc Thao Pham[1,4], Ha Phuong Truc Nguyen[1,4], Thi My Ni Pham[1,4], Quang Than Tran[2,4] and Hoanh Su Le[3,4*]

[1]Student, University of Economics and Law, Ho Chi Minh City, 700000, Vietnam
[2]Lecturer, University of Economics and Law, Ho Chi Minh City, 700000, Vietnam
[3]Dean & Lecturer, University of Economics and Law, Ho Chi Minh City, 700000, Vietnam
[4]Vietnam National University Ho Chi Minh Chi City, Ho Chi Minh City, 700000, Vietnam

Abstract

Background/Objectives: Automation is a trend currently, and chatbots are an excellent way for organizations to automate customer service duties. The medical profession has been put under immense strain during COVID-19 outbreaks as the number of patients increases rapidly, causing medical institutions and hospitals to be overcrowded. Users will find it challenging to schedule an appointment at a clinic, provide health advice, or update information due to this. **Methods/Statistical analysis:** A chatbot that supports users in advising, making appointments, and screening COVID-19 patients at clinics can be a valuable resource for both the user and the clinic in this situation. This paper developed a framework for developing a chatbot for clinics using a specific Frequent Answer Question (FAQ) dataset relating to COVID-19 and frequent diseases in Vietnam. In our study, the RASA framework was used with data collected from interviewing receptionists and website of clinics. **Findings:** Our chatbot can act as a counsellor, assisting patients with scheduling appointments, answering inquiries about symptoms of common illnesses, in particular, COVID-19 patient screening. In addition, we integrated our chatbot with Facebook Messenger and Zalo, two major social networking sites in Vietnam. **Improvements/Applications:** For specific implementation with each clinic, dataset enhancement and new services information update are necessary for broader applications.

Index Terms

AI chatbot, Hospital bot, Health and medical, COVID-19, RASA

Corresponding author: Hoanh Su Le
sulh@uel.edu.vn

• Manuscript received February 3, 2022.
• Revised March 7, 2022; Accepted March 21, 2022
• Date of publication March 31, 2022.

I. INTRODUCTION

As the demand for Machine Learning and Artificial Intelligence (AI) grows, there will be new technologies that impact our daily lives, including virtual assistant robots or simple chatbots [8]. They are known as automatic conversational agents and represent a form of artificial intelligence interaction between humans and computers using natural language processing (NLP) [1]. Due to their effectiveness, these applications are used in various industries including business, finance, education and even healthcare [2]. Context-based is the most advanced of all the above methods because it uses machine learning and artificial intelligence techniques to store and process trained models, helping chatbots provide better and appropriate answers when users ask bots domain-specific questions.

The usual hospital process is entirely manual: hospital managers spend the entire day organizing appointments and responding to patients' many questions. Continuing or repeating the same behaviors and words is neither necessary nor constructive. Bots make such jobs simple to accomplish. In the current dangerous COVID-19 pandemic scenario, it is helpful to use chatbots to limit direct interaction between individuals and quickly screen persons infected with COVID-19 [3]. Besides, the epidemic situation is becoming highly complex daily, with the number of infections increasing sharply. The medical workforce is becoming overwhelmed with work. Therefore, it is efficient to systematize and develop a chatbot capable of managing user requests and providing relevant information quickly and accurately.

Consequently, our proposed health chatbot for patients, linked with Messenger and Zalo, two popular messaging platforms in Vietnam, would serve as a medical consultant, aid with appointment scheduling, and provide suitable and straightforward anti-COVID-19 interventions. Another advantage of this bot is Vietnamese language processing and covering most communication scenarios between clinics and patients. The suggested chatbot can be a better solution as a good communication channel for both users and hospital staff and helpful in reducing the crowd.

II. RELATED WORKS

A. Chatbot

A chatbot is a conversational agent that uses natural language to engage with users. There are several chatbots accessible to service in various areas. A common feature when deploying a chatbot is to support answering FAQs, helping to increase the efficiency of consulting and answering questions for users. Due to their high applicability, chatbots are developed popularly with various techniques. Bhavika R. Ranoliya presented the design of a chatbot that any University can use to provide an efficient and accurate answer for any query of students based on the dataset of FAQs using Artificial Intelligence Markup Language (AIML) and Latent Semantic Analysis (LSA) [13]. The web-based bot engine Frequently Asked Queries (FAQ) in Hospitals was integrated by several machine learning approaches like gradient descent (GD) and natural language processing (NLP) algorithms [7].

Some chatbots apply contextual learning algorithms to develop and enrich modules related domains. Contextual Learning (CL) is a learning system that ties brain actions to creating patterns that have meaning, which helps short-term store memory and helps to keep long-term memory applied later [15]. The jollity chatbot is implemented in Rasa, an open-source conversational AI framework and it is easy to customize with 12 intents and 8 text examples constituting a total of 100 input samples and their response [14].

Besides, the work proposes a context-aware self-attentive NLU (CASA-NLU) model that uses multiple signals, such as previous intents, slots, dialogue acts, and utterances over a variable context window addition to the current user utterance [16]. Based on the researched theories and studies, we gain the knowledge and domain to serve as the basis for our chatbot research applied to the medical field.

B. Medical and healthcare industry

Healthcare is vital in life, especially for today's busy individuals. It must be designed to provide patients with the most convenient and quick service experience possible. Cristian Cola built a video appointment solution using web technologies in 2016, which proposed taking advantage of web technologies to handle doctor appointments [11]. The term "Healthcare in the pocket" was mentioned in the research, which points out the evolution of functional and design requirements to develop highly effective mobile-phone health interventions [12]. Moreover, the 'K-Bot' Knowledge Enabled Personalized Healthcare Chatbot is developed by keeping in mind that the user saves their time consulting the doctors related to their health issues [9].

To adapt to the current dangerous and emergency of the COVID-19 epidemic, there have been many related studies to build supporting technology products directly into each disease handling process.

In Spain, Chatbot SanIA has also been constructed to assist to fight the COVID-19 crisis, making information available and maintaining continuity of care by providing advice, including psychological assessment, to patients whenever they want it 24/7 [10]. The University of California, San Francisco Health designed and implemented a digital chatbot-based workflow to screen healthcare workers for COVID-19 symptoms and exposures before each clinical shift to make the screening process efficient and straightforward [5]. Furthermore, some COVID-19 virtual agents have already been set up and are linked to messaging applications. The World Health Organization (WHO) has partnered with WhatsApp and Facebook to develop a dedicated coronavirus messaging service in 7 languages [4].

Then, using benchmark case studies, we evaluate our technique and compare it to current research on medical issues and chatbots in the region and throughout the world.

C. RASA framework

RASA is an open-source machine learning platform that allows developers and product teams to automate voice and text interactions, allowing bots to go beyond simple questions. RASA is divided into two sections: RASA NLU and RASA Core. Rasa NLU and Core attempt to bridge the gap between research and implementation by making machine learning improvements accessible to non-experts who want to build conversational AI systems. The natural language understanding module in Rasa is called Rasa NLU. It comprises interconnected modules that combine a variety of natural language processing and machine learning libraries into a consistent API. Intents and entities are handled by RASA NLU. It almost determines whether or not the response from the chatbot is correct. This framework often uses custom pipelines with multiple algorithms to identify intentions based on the various contexts of your chatbot's input. Rasa Core supports a machine teaching approach where developers correct actions made by the system. RASA Core will control the dialogue and execution based on the NLU's output (intents and entities) [6].

III. RESEARCH METHOD

A. Creating chatbot's process

a. Analyzing business requirements

We conducted surveys and short interviews at local clinics. Since then, we have noticed the difficulties that medical staff face, such as having to answer the same questions repeatedly with different patients. In addition, there are high requirements for the accuracy of data and answers to customer inquiries. And the patients need to be served 24/7; they want to be able to book an appointment at any time. Moreover, the situation of the COVID-19 pandemic is complicated, and clinics want to screen patients for signs of infection or not before coming to the clinic for an appointment.

For the above reasons, we have built an AI chatbot model to support automatic appointment booking and screening for COVID-19 symptoms before patients come to the clinic. Using the data gathered, we created the following functional diagram of the chatbot: When a person interacts with the chatbot for the first time, it will greet them and then offer them alternatives. Answering questions, speaking with a doctor, and scheduling appointments are all alternatives. When the user chooses the appointment booking option, the chatbot will inquire about COVID-19 symptoms, and if the user has COVID-19 symptoms such as cough, fever, or other, they will be routed to the agency approved healthcare. If the user does not demonstrate specific symptoms, the chatbot will ask for additional information to schedule an appointment. If the user is unsure which department to visit, the chatbot will refer them to the online consultation function, where medical staff advise and guide them. Fig. 1 depicts the technique described previously.

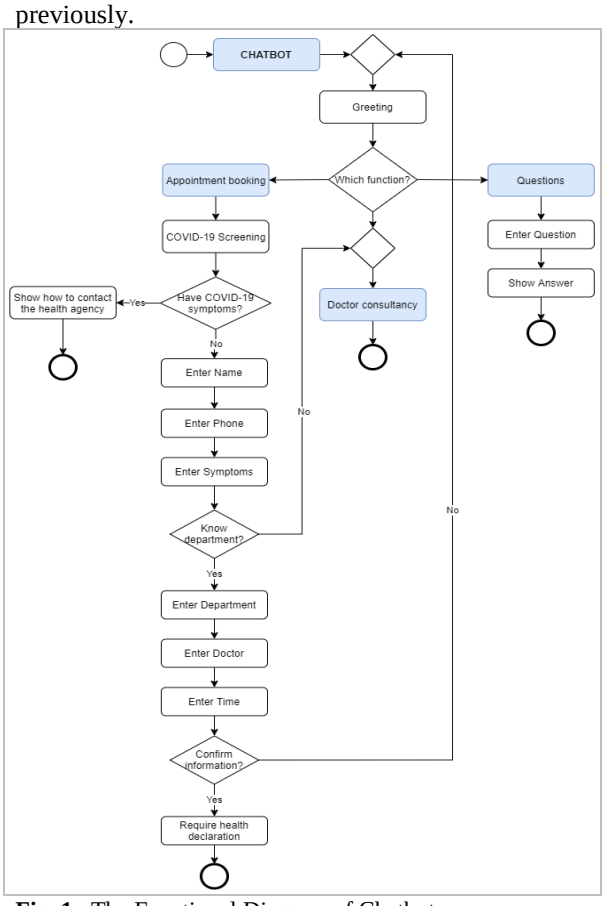

Fig. 1. The Functional Diagram of Chatbot

b. Creating training dataset

The dataset is separated into two sections: frequently asked questions (FAQ) regarding everyday health concerns and COVID-19 pandemic information. The whole data collection is based on authorized sources such as Vietnam's Ministry of Health and Ho Chi Minh City Center for Disease Control (HCDC) since information on health and the COVID-19 condition demands near-perfect precision.

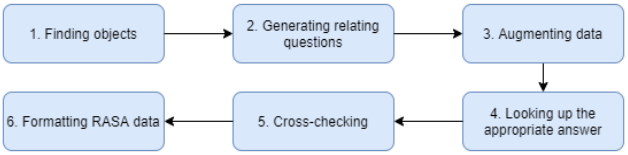

Fig. 2. The framework of preparing dataset

Step 1: Finding objects

We conducted a small survey of hospitals and clinics and searched trustworthy forums for information on common medical concerns and the COVID-19 pandemic. To cover all cases, we approach each disease and the specific situation of COVID-19, such as vaccination, nutrition, common illnesses. Then, after analyzing the existing data, the frequently asked questions (FAQ), which patients are often confused about, are generated in a defined structure.

Step 2: Generating relating questions

Based on the topics we found, our team started to analyze and come up with relevant frequently asked questions patients could ask. The process of generating the FAQ dataset began with determining the most commonly asked questions to determine which material would best relieve care team members of volume. We use a database of Covid-19-related consultancy data compiled from reliable sources. These queries were then categorized into COVID-19 related/Infectious Diseases-specific categories.

Step 3: Augmenting data

In actuality, input utterances can take a wide range of forms, resulting in unsatisfactory outcomes. There is no punctuation, additional words, missing words, and so on. We utilize the data augmentation approach to enhance the quantity of data based on the built-in synonym queries for the model to cover such situations and forecasts effectively. We supplemented the data in 4 different ways: data without punctuation, data with random residuals, random data losing 20% of words in a sentence, data lost random punctuation 20% of words in a phrase, and data lost random punctuation 20% of words in a sentence. We obtained a dataset of 3670 samples from 734 prior samples after data augmentation.

Step 4: Looking up the appropriate answer

From the data the question has built, we have searched for answers by referring to reliable health information sources such as Vietnam's Ministry of Health and Ho Chi Minh City Center for Disease Control (HCDC). Corresponding to each question, the data set will have one answer.

Step 5: Cross-checking

To ensure that the chatbot can give the correct answers, we cross-check the data by asking with different expressions. This ensures that the chatbot will not provide false information to the user.

Step 6: Formatting RASA data

Each sentence delivered by the chatbot has a specific message for the user. The chatbot must first understand their intent to respond to a user, then extract the relevant information and send replies. We use RASA in this model, so we generate the dataset using the steps below to match the technique used.

Creating intents: In our research, the intentions were questions. Users posed questions to the chatbot during their interactions. With 114 intents and 734 samples, we created a dataset of intentions. Our dataset contains three sorts of queries for our chatbot model: clinic questions, health FAQs, and COVID-19 FAQs.

Creating entities, locations, and forms: In our study, the entities were departments and phone numbers. We set up departmental options depending on the clinic and the rules for entering a phone number. Forms are used to outline the processes for booking appointments. We developed the appointment booking process based on the actual procedure at the clinic. The slot contains information such as name, phone number, department, clinical symptoms, doctor, and time that must be filled in when booking an appointment using the given form. To arrange an appointment, users must fill out all available slots.

Creating answer: We have built the corresponding answer data for the possible questions of the user when interacting with the chatbot. Each intent leads to an answer.

c. Creating scenario structure

A story is a sort of training data that may be used to train a chatbot conversation management model that can generalize to previously unexplored conversation paths. We did a brief survey of the clinics to understand the appointment booking procedure better. The team then produced 110 stories for the chatbot to use for it to connect with the user as naturally as possible. Furthermore, we understand the need to screen patients for COVID-19 before scheduling appointments. Individuals with COVID-19 who visit the clinic for a face-to-face examination risk spreading the virus to the rest of the community.

As a result, COVID-19 screening questions have been introduced into the patient procedure.

In our research, we also utilize another method for creating stories, which is called interactive learning, in which we learn to engage with bots. This option enables users to generate conversations automatically following a live chat with bots. If the bot incorrectly identifies intents or slots, the user can train the bot to be correct.

B. Experiments

a. Metrics

The RASA NLU model has the function of intent classification and entity extraction. As a result, the metrics Precision, Recall, and F-1 score were applied. All metrics are averaged after being calculated on a single intent or entity. These will be clearly described in equations 1, 2, and 3:

$$Precision = \frac{TP}{TP + FP} \quad (1)$$

$$Recall = \frac{TP}{TP + FN} \quad (2)$$

$$F1 = 2 \times \frac{Precision \times Recall}{Precision + Recall} \quad (3)$$

Where:

TP: True Positive, intent/entity in question are predicted correctly.

FP: False Positive, intent/entity in question are confused with other intent/entity.

TN: True Negative: intent/entity in other questions are not confused with the considered question.

FN: False Negative, intent/entity in other questions are confused with the considered question.

b. Results

We divided the augmented data into two sections, train data and test data, in an 80/20 ratio. Table I shows the experiment results of Model.

Table 1. RESULTS OF EXPERIMENT

Metrics	Results
Precision	95.81
Recall	95.68
F1	95.25

C. Discussion

The RASA model performs well when trained on our data. The accuracy, recall, and F1 scores were 95.81 %, 95.68 %, and 95.25 %, respectively.

Table 2. EXAMPLES OF ERROR INTENTS

Index	Text	Intent	Intent Prediction
1	"Không đúng" (incorrect)	Deny	inform_noncovid (inform is not infected with covid)
2	"Giá xét nghiệm COVID-19" (Price of COVID-19 test?)	intent_ask_c_giavacxincovidtunguyen (intent to ask for voluntary vaccine test price)	intent_ask_c_doituongvaccine (Intent to ask for vaccine object)
3	"Chỉ thị 16 giãn cách xã hội là gì?" (What is Directive 16 on social distancing?)	intent_ask_c_chithi16giancach (intent to ask for Directive 16 on social distancing)	intent_ask_c_chithi15giancach (intent to ask for Directive 15 on social distancing)

However, there are several situations when the module will misunderstand and provide incorrect answers, such as when: 1) user input queries are similar across intentions, particularly yes/no. 2) There is a 20% loss of information in some inputs. 3) A number of signed inputs have been deleted. Table 2 shows several examples of erroneous cases.

IV. CHATBOT IMPLEMENTATION

Zalo and Facebook are presently the two most popular social networks in Vietnam. Therefore, we have decided to deploy our model on Facebook Messenger and Zalo. The advantages of using these platforms include using a familiar interface, not having to download and install additional applications, and having access to them 24 hours a day, seven days a week.

We then deploy our Model as an API. The most important thing we should do is host it on a cloud server available 24 hours a day, seven days a week. It implies that users may question the Chatbot whenever they want, and the Chatbot will respond immediately.

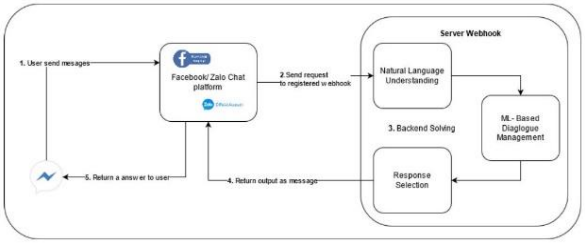

Fig. 3. The process of integrating a chatbot system with a chat platform.

Fig. 3 depicts integrating a chatbot system with a

chat platform. We set up a Webhook linked to the Official Account/Fanpage chat. When users send a message to the chatbot, Facebook/Zalo will send HTTP requests (method POST) to the webhook URL of the application. Webhook will receive real-time HTTP alerts of changes to specific objects and postback to messaging.

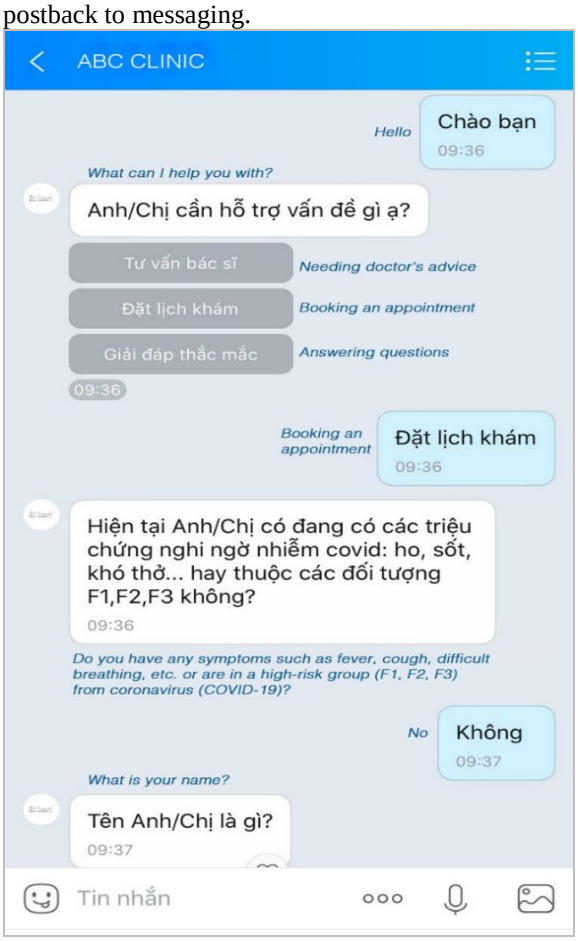

Fig. 4. Example of booking an appointment on Zalo

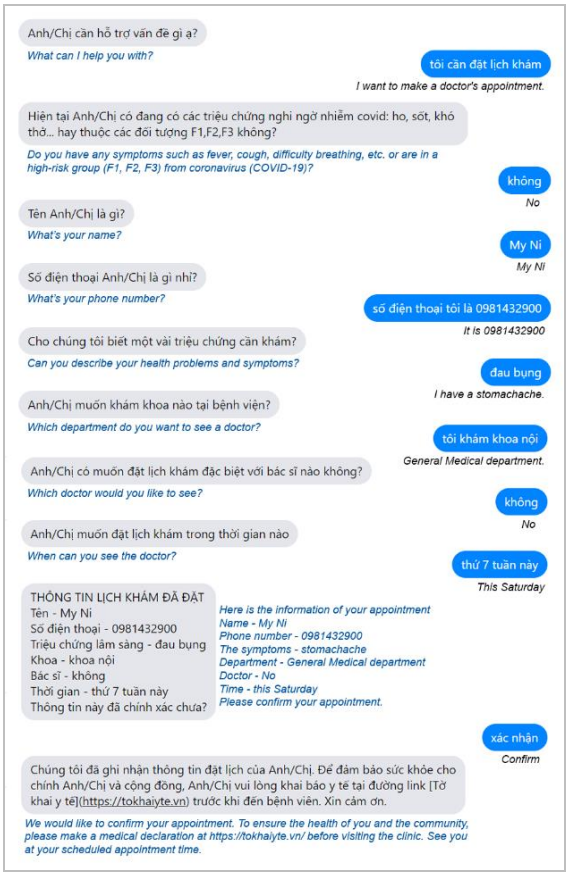

Fig. 5. Example of booking an appointment on Facebook

V. Conclusion

Our research resulted in developing an AI chatbot model that allows clinics to schedule visits, test for COVID-19 symptoms, and answer health and medical concerns automatically. Using the data augmentation technique, this study contributes to collecting medical and health data for 3670 samples. We used the open-source RASA for Vietnamese language processing and modified it with the RASA pipeline. We integrated this AI chatbot model into the Messenger app and Zalo app to assist clinics and hospitals in lowering personnel expenses and providing 24/7 consulting services to improve patient care. However, for specific implementation with each clinic, dataset enhancement and new services information update are necessary for broader applications.

Acknowledgment

This research is funded by University of Economics and Law, Vietnam National University Ho Chi Minh City (VNU-HCM) under grant number CS/2020-07.

REFERENCES

[1] Yan, R. (2018, July). "Chitty-Chitty-Chat Bot": Deep Learning for Conversational AI. In IJCAI (Vol. 18, pp. 5520-5526).

[2] Le Hoanh Su, Truong Dang-Huy, Tran Thi-Yen-Linh, Nguyen Thi-Duyen-Ngoc, Ly Bao-Tuyen, Nguyen Ha-Phuong-Truc. (2020). Development of an AI Chatbot to Support Admissions and Career Guidance for Universities. IJEMR, 4(2), 11-17.

[3] Battineni, G., Chintalapudi, N., & Amenta, F. (2020, June). AI Chatbot design during an epidemic like the novel coronavirus. In Healthcare (Vol. 8, No. 2, p. 154). Multidisciplinary Digital Publishing Institute.

[4] World Health Organization. WHO Health Alert brings COVID-19 facts to billions via WhatsApp; 2020.

[5] Judson, T. J., Odisho, A. Y., Young, J. J., Bigazzi, O., Steuer, D., Gonzales, R., & Neinstein, A. B. (2020). Implementation of a digital chatbot to screen health system employees during the COVID-19 pandemic. Journal of the American Medical Informatics Association, 27(9), 1450-1455.

[6] Bocklisch, T., Faulkner, J., Pawlowski, N., & Nichol, A. (2017). Rasa: Opensource language understanding and dialogue management. arXiv preprint arXiv:1712.05181.

[7] Mittal, M., Battineni, G., Singh, D., Nagarwal, T., & Yadav, P. (2021). Web-based chatbot for Frequently Asked Queries (FAQ) in Hospitals. Journal of Taibah University Medical Sciences.

[8] P. Kandpal, K. Jasnani, R. Raut and S. Bhorge, "Contextual Chatbot for Healthcare Purposes (using Deep Learning)," 2020 Fourth World Conference on Smart Trends in Systems, Security and Sustainability (WorldS4), 2020, pp. 625-634, doi: 10.1109/WorldS450073.2020.9210351.

[9] Pradhan, R., Shukla, J., & Bansal, M. (2021, April). 'K-Bot'Knowledge Enabled Personalized Healthcare Chatbot. In IOP Conference Series: Materials Science and Engineering (Vol. 1116, No. 1, p. 012185). IOP Publishing.

[10] Serra, C. Ã., Tanarro, A. A., Galisteo, D. T., Pacios, S. B., Gabriel, S. G., MartÃn, D. M., & TomÃ, F. (2021). Utility of SanIA Chatbot to Maintain Continuity of Care and Psychological Support During COVID-19 Pandemic. Biomedical Journal of Scientific & Technical Research, 33(5), 26287-26291.

[11] C. Cola and H. Valean, "E-health appointment solution, a web based approach," 2015 E-Health and Bioengineering Conference (EHB), 2015, pp. 1-4, doi: 10.1109/EHB.2015.7391431.

[12] Klasnja, P., & Pratt, W. (2012). Healthcare in the pocket: mapping the space of mobile-phone health interventions. Journal of biomedical informatics, 45(1), 184-198.

[13] B. R. Ranoliya, N. Raghuwanshi and S. Singh, "Chatbot for university related FAQs," 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI), 2017, pp. 1525-1530, doi: 10.1109/ICACCI.2017.8126057.

[14] K. Deepika, V. Tilekya, J. Mamatha and T. Subetha, "Jollity Chatbot- A contextual AI Assistant," 2020 Third International Conference on Smart Systems and Inventive Technology (ICSSIT), 2020, pp. 1196-1200, doi: 10.1109/ICSSIT48917.2020.9214076.

[15] Davtyan, R. (2014, April). Contextual learning. In Asee 2014 Zone I Conference (pp. 3-5). USA: niversity of Bridgeport.

[16] Gupta, A., Zhang, P., Lalwani, G., & Diab, M. (2019). CASA-NLU: Context-Aware self-attentive natural language understanding for task-oriented chatbots. arXiv preprint arXiv:1909.08705.