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Artificial Intelligence Powered Amharic Language Conversational Robotic Chatbot System for Selected Ethiopian Hospitals

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ABSTRACT

Artificial intelligence-powered chatbots are conversational agents designed to simulate intelligent conversations between intelligent robotic systems and users. The objective of this research is to provide healthcare services to all users in the Amharic language, without limitations, and to offer convenient and cost-effective access to healthcare services from the comfort of their homes. This AI-powered interactive chatbot has been specifically developed for Nigist Eleni Comprehensive Hospital, the sole public hospital in Hossaena city catering to a significant population with services ranging from emergency care to referral cases. The study introduces an innovative AI-powered Amharic-based chatbot conversation that serves as a personal virtual doctor for each end user. This chatbot is trained extensively to provide relevant answers to healthcare-related questions and interact with patients in a human-like manner. During the development of this intelligent system, a dataset of 12,127 pairs of questions and answers in Amharic was collected, encompassing greeting sentences, various user queries, symptom descriptions, disease classifications, specialist details, and well wishes. These datasets were preprocessed using substring algorithms, and the structured datasets were accurately mapped to the artificial intelligence modeling language as AIML files. The Naïve Bayes algorithm was then employed to train the mapped datasets. As a result, the developed prototype offers an interactive Amharic chatbot conversation system for end users. This system can analyze user queries and provide corresponding answers with an accuracy rate of 95.7%.

Keywords: Artificial Intelligence, Robotic Chatbot, Amharic Conversational Bot.

1. INTRODUCTION

Artificial intelligence-powered Chatbot is a new 21-century technology that is designed to simplify the human computers interaction and to simulate a conversational chat with the user in their natural language to get different services from different service providers [3]. This research work creates an idea to implement an intelligent system that will be powered by artificial intelligence conversational Chatbot for Nigist Eleni Comprehensive Hospital to provide medical services for remotely located patients to reduce medical staff's work

barrier, users costs expenditure, westing time for simple cases and to prevent extra disease infection due to crowded environment. As we have stated above there is only one public hospital in Hossaena town that provides a lot of medical services for a million-population including nearby kebeles, delivering healthcare services for this massive population with limited medical staff and limited working environment is very difficult. So this intelligent research work creates an appropriate solution for the mentioned problem by implementing an artificial intelligence-powered chatbot system that is used to deliver relevant medical service for remotely located patients through electronic means at home. Generally, this artificial intelligence-powered chatbot research work is implemented in Nigist Eleni Specialized Hospital using the Amharic language to provide healthcare services for all educated communities to get medical information based on users' raised medical queries at their home rather than presenting in hospital for simple cases.

1.1 Literature related to proposed work

There are a lots of artificial intelligence powered chatbot research work conducted throughout the world by different researchers. Among those conducted research work, we have reviewed the more recent and more related to our works as follows below. Chin-Yuan Huang et al [1] conducted research under the title of Chatbot-supported Smart Wireless Interactive Healthcare System for weight Control and health promotion, the researchers include many features such as a function allowing user to conduct conversations with chatbot application through auditory or textual methods, provide customized support (e.g. diet and exercise tracking and advice, eating tips, proactive weight prediction, eating order) and some other information (e.g. nutrient intake recommendations, anthropometric measurements). On the other paper Sarthak V. et al presented the artificial intelligence chatbot in an android system using open source program-O [2]. The researchers introduce the new services android based chatbot system for both textual and voice communication. When the user gives the input in text format the first mode is activated. The user input is passed to the middleware API for the response. On other hand when the user gives the voice input then second mode is activated [2], in this voice mode they first convert the voice into text before sending it to middleware API. In this process, firstly the pattern matching algorithm is executed for matching of the valid response from the available AIML scripts. When a pattern is matched, the corresponding template is returned to the middleware. Then middleware encodes the template into the JSON format and sends the reply to the android app. After receiving the response app decodes the JSON and gives the response to the user [2]. Urmil Bharti et al are conducted the research work and developed an application called "Aapka Chikitsak" [3] that able to provide users healthcare consultation, counseling and information with multi-lingual support (English and Hindi) to improve the healthcare and well-being of the growing population in India and continue provision of healthcare access at ease post the lockdown as well. Conversational tele-health assists in the form of an automated conversation between the user and computer in the form of either chat or voice. Divya S [7] et-al. work shows that a linear system user dialogue that proceeds from symptom extraction to symptom mapping, where it identifies the corresponding symptom, then diagnosis the patient whether it's a major or minor disease and if it's a major one an appropriate doctor will be referred to the patient, the doctor details will be extracted from the database, the user will be identified by the login details which is stored in the database [7]. kennedy Ralston et-al. are conducted a research on the title a voice interactive multilingual student support system using IBM Watson[8], The general architecture of this proposed voice interactive multilingual chatbot based on the use case scenario text, text-to-speech, and language translator for developed chatbot.

2. MATERIAL AND METHODS

Data collection is the primary task of our proposed research work on an artificial intelligence-powered chatbot conversation system for Nigist Eleni Comprehensive Hospital. We have gathered approximately 12,127 data points from the hospital to feed into our designed chatbot after applying preprocessing techniques. The collected data consists of various user queries, including greetings, symptoms, disease types, questions and answers, specialist details, and well wishes, which have been incorporated into the research dataset. The full document of our research work contains all the collected data.

2.1 Data preprocessing

Since the text data collected from Nigist Eleni Comprehensive Hospital is unstructured and noisy, preprocessing techniques are necessary to transform the unstructured text into a clean and consistent format suitable for training and learning purposes in the designed chatbot system. Text preprocessing techniques such as tokenization, punctuation mark removal, stop word removal, stemming, lemmatization, and keyword extraction have been applied to standardize the inputs of the AI-powered robotic system.

2.2 Proposed model

This proposed AI-powered conversational chatbot is an automated intelligent computer program that interacts with end users. Its purpose is to automate the medical services of Nigist Eleni Comprehensive Hospital. The research work is designed to enhance the healthcare delivery system using advanced AI technologies, providing general medical services to users in the comfort of their own location and without time limitations. These medical services include consulting, preventive care, maternal care, nutritional support, safe drug services, follow-up for discharged patients, and follow-up for chronic patients. Figure 1 illustrates the proposed model of the chatbot conversation.

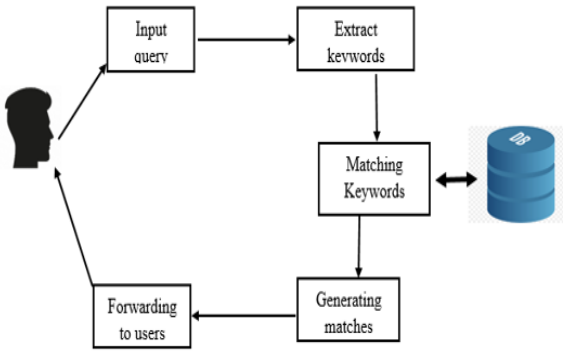

Fig 1. The proposed chatbot conversation model

In the designed research work on Artificial Intelligence (AI) powered systems, users can input various queries into the system, each having its corresponding paired response that is mapped to the AI modeling language files. Conversations with the AI-powered chatbot system can start with greeting text or symptom descriptions, which are then pre-processed using substring algorithms. The pre-processed symptoms are appropriately positioned, and symptom comparisons are performed to identify disease classifications based on the given symptoms from the users. If the symptoms provided by the users are successfully mapped to the AI modeling language, they are recognized by the conversational system. Otherwise, the given symptoms are ignored or considered as undefined, and the system prompts the users to provide additional symptoms. The research work is developed on the Panda Robot virtual platform, which is freely available for developing AI-powered chatbot systems. Structured datasets in the form of question-and-answer pairs are mapped to this platform using pattern and template tags. These datasets are fed into the virtual platform to generate responses for user queries based on the matched pairs in the AIML file. When a user query is found in the mapped AIML file, the chatbot responds accordingly. Otherwise, the user is advised to input other symptoms to obtain an appropriate response. Users can continue the conversation until they are satisfied with the chatbot's responses. The

dialog flow of this conversational chatbot system is depicted in Figure 2, and the working principle of the proposed system is accurately illustrated in the fol-lowing diagram for easy comprehension.

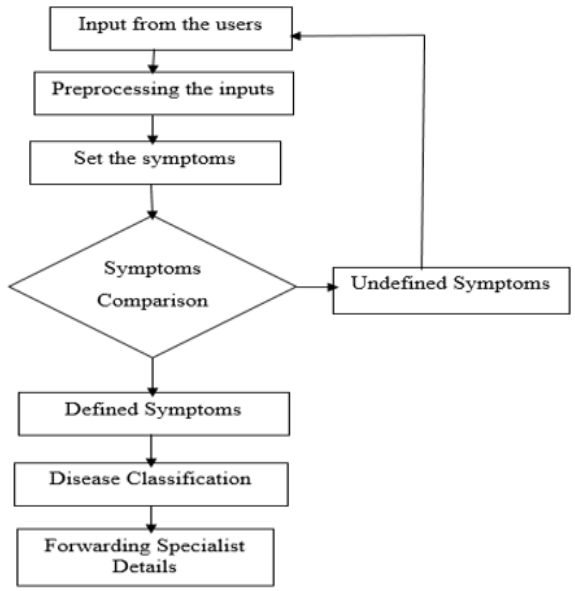

Fig 2. Dialog flow of the proposed system

The dialog flow of this conversational chatbot system is depicted in Figure 2, and the working principle of the proposed system is accurately illustrated in the following diagram for easy comprehension. The proposed artificial intelligence-powered conversational agent has five main dialog flow phases: context identification, Keyword extraction, mapping AIML files, disease classification, and referring specialist lists.

2.3 Context identification

The end-users start their conversation with the designed intelligence system by text chat. Those text chats may be greetings or symptoms of users' internal feelings. So, those text conversations need some preprocessing techniques to standardize the inputs of the proposed system requirement. Once the users' inputs are preprocessed using substring preprocessing algorithms, then it will be very easy for text conversation between end-users and the designed AI-powered robotic system because each keyword is used in the text conversation with appropriate context recognition in the designed artificial intelligent modeling language files.

2.4 Keyword extraction

The second phase for the developed intelligent conversational chatbot system is keyword extraction. In this phase, each textual query of users like ሰላም, ጤና ይስጥልኝ, አንተ ማን ነህ, የት ነው የሚገኙት፣ ምን ይሰማዎታል, and so on should be processed to extract the keywords. The designed system extracts keywords from the given inputs of the users in the textual format as a result all textual conversations have their keywords which are extracted by the designed system. Based on the extracted keywords from the users' input, the requested information from the user can be understood by the designed intelligent conversational chatbot system and the intelligent system can provide the relevant information for the user from the stored artificial intelligence modeling language files. As we know that different users of the system may use different queries for the same case, so all those queries should be extracted and filtered out the keywords to minimize the complexity of the conversation and to provide the efficient required information for users.

2.4 Mapping AIML file

In this phase, all possible conversational queries are stored on the AIML files to develop the new conversational intelligence system in the form of question and answer pairs using pattern and template tags respectively. As mentioned previously, more than 12,127 pairs of Amharic corpus have been collected.

```
<aiml Version="1.0.1" encoding = "UTF-8"?>
<Category>
<pattern>ጤና ይስጥልኝ </pattern>
<template> እንኳን ወደ ንግስት እሌኒ ሆስፒታል የጤና አገልግሎት ሲስተም በሰላም መጡ </template>
</category>
</aiml>
```

Fig 3. Sample of AIML file structure

This dataset comprises greeting sentences, various user queries, descriptions of symptoms, disease classifications, specialist details, and well wishes. These data are used as a dataset to feed the virtual working platform.

A. Disease Classification

The disease classification is the fourth phase which happens after users' symptoms pass comparison stages, as described above the artificial intelligence modeling language files store different disease types with corresponding symptoms to provide answers to the users' query. Once the given symptoms pass a comparison, then the designed chatbot system will provide the possible disease type to the user as a response to the raised query based on the symptoms given.

B. Referring Doctor

Referring to a specialist doctor for the end user is the last phase in this presented architecture. Once the designed system suggests the probability of disease type based on the given symptoms, then the developed chatbot system will provide a specialist doctor's address as additional information for further medication.

3. RESULTS AND DISCUSSION

The results and discussion section encompasses four primary phases: creating a chatbot interface, feeding the bot, training the bot, and testing the developed chatbot. This research work utilizes the free open standard platform provided by Pndora Bots for the development of an intelligent conversational chatbot system. All possible conversations between end users and the designed intelligent chatbot system regarding healthcare issues at Nigist Eleni Comprehensive Hospital are mapped to artificial intelligence modeling language files.

Creating chatbot UI:

The research work is developed on the Pandora Bots virtual platform, which serves as an open standard support for the creation of an artificially intelligent chatbot platform. On this platform, a new Amharic chatbot system is developed from scratch using artificial intelligence markup language scripts. To create a chatbot conversation using the artificial intelligence markup language on the Pandora Bots open standard platform, one needs to log in with an email ID and password. The integrated development environment (IDE) provides an interface to create a new chatbot system by specifying a relevant name for the chatbot and selecting the appropriate language. After entering the bot name and selecting the language, clicking the create button proceeds to the creation of a new blank bot.

Feeding the bot:

During the feeding-the-bot phase, structured pairs of questions and answers are written in the blank bot editor using artificial intelligence markup language tags to develop the proposed chatbot system. In this phase, the collected datasets, such as conversational queries, possible symptoms, disease types, specialist details, greetings, and well wishes, are mapped correctly to the AIML file, along with the corresponding responses for the raised questions by end users. Figure 4 illustrates the correct structuring and mapping of all the collected Amharic corpus to the artificial intelligence markup language files.

Fig 4. Feeding Amharic corpus to the created bot

Training the Chatbot:

Training the developed bot system is the process of learning the dataset of structured and mapped AIML files to the designed bot, for answering what the end-user is talking about, and how to respond to queries to the users'. Once the structured corpora are mapped on the AIML files on the pandora bots working platform, then the naïve bayes algorithm will be employed to train the possible dataset that helps to aware the structured dataset to the designed bot and then, the developed chat-bot is getting ready for chat conversation with the end users.

Testing a chatbot:

In this testing phase, the different functionalities of the developed system for conversations between end-users and the intelligent bot will be tested before being deployed at Nigist Eleni Comprehensive Hospital. Let's take a look at some examples of possible conversations between end-users and the developed bot system.

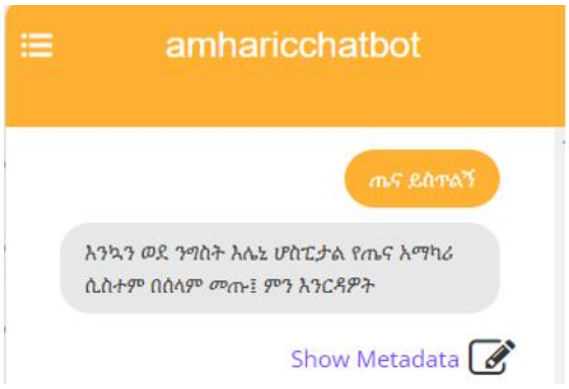

Fig 5. The first conversation with the developed bot

As shown in Figure 5, the end user starts his/her conversation with the greeting Amharic word "ጤና ይስጥልኝ" statement, and then the developed system will be understood what the users want to say by extracting the keywords and then forwarding the relevant response among deep answers query as shown above on Figure 5 "እንኳን ወደ ንግስት እሌኒ ሆስፒታል የጤና አማካሪ ሲስተም በሰላም መጡ፤ ምን እንርዳዎት".

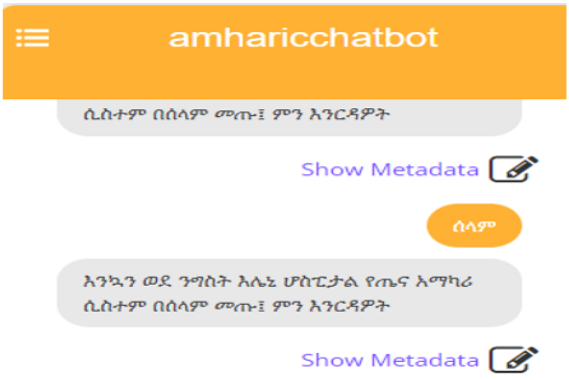

Fig 6. Users start conversation with another greeting word

As depicted in Figure 5, users can initiate their conversation with the developed systemusing various greeting sentences such as "ጤና ይስጥልኝ" (Tell me about the news), "ሰላም" (Hello), "ሰላም እንዴት ናችሁ" (Hello, how are you?), and other greeting phrases that can be used by end users. However, the intelligent system extracts only the keyword to provide an appropriate response. As shown in Figure 7, when the end user continues the conversation by inputting the query "የጤና አገልግሎት ፈልጌ ነበር" (I'm looking for healthcare services), which has a similar meaning in English, the intelligent bot system responds to the end user with the corresponding paired match content, which is "please tell us about your feeling symptoms እባከዎ የሚሰማዎትን የህመም ምልክቶች ይንገሩን" (Please describe your symptoms). The user can then continue the conversation by providing their feeling symptoms.

Fig 7. User request a healthcare service of developed system

As depicted in Figure 7, the intelligent system prompts users to provide the symptoms they are experiencing to classify and identify the types of diseases that may be affecting them. Users are now expected to accurately submit their feeling symptoms in order to receive medical services from the developed system.

Fig 8. Disease classification based on users given symptoms

Once the end users submit their feeling symptoms, the intelligent chatbot system will provide the expected disease type with the address of a specialist doctor for further medical treatment. So users can take the address of the specialist for extra medication services to meet in person. Once the end user gets satisfied with the healthcare services, they can end the conversation with closing words like "ስለአግልግሎታችሁ አመሰግናለሁ፣ አመሰግናለሁ፣ስለሰጣችሁኝ መረጃ አመስግናለሁ" and so on.

Fig 9. Users end the conversation with thanks message

As shown in figure 9, the user can end the conversation with the bot system using a thanks message after getting satisfied by the healthcare services of the developed Amharic bot system.

4. CONCLUSION

In this paper, we have introduced the novel Amharic chatbot system for Nigist Eleni's comprehensive hospital virtual medical advisory system for different cases. The system can answer user queries in the form of a textual method for the Amharic language, and it can only answer the request of the user, which are stored on the dataset only. If users insert undefined symptoms in the artificial intelligence markup language, it will recommend the end-user to insert other symptoms to get a relevant answer from a developed bot. The current chatbot is a text-based chatbot with a fixed set of responses, as a future work, it is highly recommended to develop a knowledge-based chatbot which includes text, speech, and spell suggestion features. Generally, the developed system provides a simple platform for every user to get electronic medical advice at home using their smart devices without costing time, money, etc., and it tries to address virtual medical advising and recommendation services in Amharic languages for all interested end-users.

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