KNOWLEDGE-BASED CHATBOT FOR HUMANOID ROBOT IN RESTAURANT FOR QUESTION AND ANSWERING SYSTEM

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ABSTRACT. *Knowledge in the humanoid robot is the most important feature to be able to give a response to the user. Robots should be also able to learn through conversations to be capable of new things. The development of a knowledge-based chatbot for a humanoid with the human is a challenging task. A chatbot is one of the most promising expressions of interaction between humans and machines and represents a question answering system. In this paper, we propose a model of a question answering system based on Google Dialogflow and a knowledge-based feature in Dialogflow. We gave text-based knowledge to the robot based on information about the restaurant and the food's products. Based on our experiment, the system was able for giving the answers as expected, with the accuracy of the system reaching 92%.*
Keywords: Humanoid robot, Knowledge, Chatbot, NLP

1. **Introduction.** Conversational AI (artificial intelligence) use cases are diverse, such as customer support, e-commerce, and robotics in education. Humanoid robots with excellent knowledge and excellent response are our hope for the future. Researchers have been fascinated with the possibility of developing a humanoid robot that engages in social interaction. Thus, the field of human-robot interaction (HRI) over the past several decades has emerged as a crucial field for the design of social robots that are useful, intuitive, and user friendly [1]. Nowadays, the model of the simple humanoid robot based on the smartphone can be based on a chatbot system. The chatbot is a program to sense the context of the conversation and execute the right bot flow [2]. One of the easy ways for giving knowledge to a chatbot is using Dialogflow. Dialogflow is a technology from Google, (build-once deploy-everywhere development suite for creating conversational interfaces) for websites & mobile applications. It provides natural and rich conversational experiences such as virtual assistants [3]. Dialogflow handles the job of translating natural language into machine-readable data, using a machine learning model trained by your examples. Once it identifies what the user is talking about, it can hand this data to the backend where you use it to make a response [3].

Many new kinds of research for virtual assistants were developed by the researcher. For example, Reyes et al. [4] developed a virtual assistant that enables students to access interactive content adapted for an introductory undergraduate course on artificial intelligence. This chatbot can show answers to frequently asked questions in a hierarchically structured manner, leading students by either voice, text or tactile input to the content that better solves their questions and doubts. Budiharto et al. [5,6] proposed a model for intelligent humanoid robot that focuses on question answering systems. The model has the self-learning capability to give responses from people based on deep learning and big

data. Unfortunately, it is still difficult for giving knowledge and correct responses to the user. In Dialogflow, with the help of the knowledge base connector, we can set up the bot to answer repetitive questions which will save more time. This would be more interactive and easier for the users and removes the manual process of defining a lot of intents and their answers. Leung and Wen [7] compared 3 types of restaurants ordering methods: phone ordering, online ordering, and chatbot ordering. From the study, chatbot ordering is better suited with quick-service restaurants, that have a simple menu. Phone ordering is for special and more complicated items, and online ordering is suited with more expensive items and more complicated items.

In this paper, our objective is to make a chatbot that is able for answering questions from the user as a virtual assistant. The main contribution of this research is to develop a novel model of chatbot based on the knowledge related to the restaurant and the food products, to be used in the robot. The advantage of this study is that the chatbot model can be implemented to the humanoid robot in the restaurant, to reduce the workload of the waitress to receive the order. The result of this study shows the accuracy of this chatbot reaches 92% when being tested with several respondents.

In summary, our model is very simple, reliable and can be used as a novel model for developing an intelligent chatbot for a humanoid robot. Part 1 is an introduction, Part 2 is the concept of Dialogflow for Chatbot, Part 3 is the proposed method, Part 4 is the experimental result, and Part 5 shows the conclusions. Figure 1 shows our prototype of a humanoid robot named as Anggita-Bot using an iPhone 12 that can be used in a humanoid robot at the restaurant.
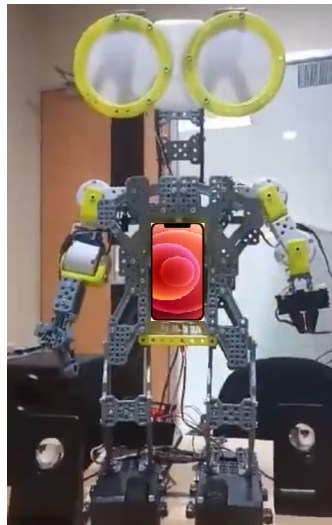

FIGURE 1. Our chatbot named as Anggita-Bot that can be used in humanoid robot at a restaurant

Another approach to bridging the connection from human to the robot as a virtual assistant is by using visual communication. Tan and Sato [8] studied the use of visual communication between a robot and a human, to make a robot can understand human thought related to object recognition or pattern understanding. The proposed system intends to be used by those who find it difficult for shopping, such as patients, disabled or elderly people. The robot can pick items in the rack automatically. Recently, the chatbot systems are not restricted to mimicking human-like conservations but also designed to be accessed through virtual agents such as Amazon Alexa or Google Assistant, with applications in the fields of e-commerce, businesses, education, information retrieving, entertainments, etc. [9]. Chabot for restaurants already implemented in several fast-food companies, like Burger King, Dominos, Pizza Hut, and have followed suit with their proprietary chatbots [10].

2. **Dialogflow for Chatbot.**

2.1. **Knowledge base for chatbot.** In our previous work, we successfully proposed the basic knowledge system and speech recognition system using stemming and tokenization for the humanoid robot [11,12]. A knowledge base represents a collection of knowledge documents that you provide to Dialogflow. Your knowledge documents contain information that may be useful during conversations with end-users. Chatbots are the program that interacts with humans using natural language. Human-chatbot communication lacked much of the richness of vocabulary found in conversations among people and exhibited greater profanity. Chatbots are used in many organizational domains where they can replace humans. There are many types of cloud-based chatbot platforms such as Dialogflow, Pandorabots.com, Luis.ai, and Wit.ai. Contextual chatbots are backed by artificial intelligence (AI), machine learning (ML), and natural language processing (NLP). This technology enables chatbots to continuously learn, offer accurate responses, and retain context to personalize conversations. In the extractive question and answering (QA) system in Dialogflow, the documents from the unstructured text are extracted and used for question answering. Developers of the modern conversation systems show the variety of techniques to initiate and maintain dialogue learning from interactions with humans over the Internet. Statistical significance shows these dialogue systems are an improvement on their predecessor [13]. Amato et al. [14] researched the use of chatbots in the food sector. The chatbot represents the waiter, to take orders and give some information about the restaurant. The chatbot uses a txt file as the knowledge base, such as the food menu and price.

2.2. **Question and answering (QA) system.** QA system is a computer science discipline within the fields of information retrieval and natural language processing (NLP), which is concerned with building systems that automatically answer questions posed by humans in a natural language. In the open domain, people can ask any question, and the QA system will find an answer from the web or other sources and give the user the respective answer (the entire world's knowledge is required). In knowledge-based QA, it is converting the natural language query into a structured database query. Dialogflow offers two types of knowledge connectors: FAQ and knowledge base articles. Knowledge base articles are based on the technologies used by Google Search, which look for answers to questions by reading and understanding entire documents and extracting a portion of a document that contains the answer to the question. This is often referred to as open-domain question answering.

The study by Patil et al. [15] showed Dialogflow has some advantages compared to IBM Watson, in terms of easy maintenance software, converting user's expression to structured data, and supporting multi-language. In addition, Dialogflow also has other capabilities, such as speech recognition, object detection, and cross-platform API to request and check permissions for the other applications present in the device. Dutta [16] compared different chatbot platforms: Dialogflow.com, Wit.ai, Luis.ai, and Pandorabots.com, based on NLP capability and feature development ability. Based on the evaluation, Dialogflow can handle sub-intent purposes of the user's text as input and can be accessed using the web browser and Android apps.

Ricciardelli and Biswas [17] used reinforcement learning (RL) to make the chatbot can improve the performance from user conversation. The scores predicted by the model are used as rewards for the RL agent. The result shows an increase in performance from an initial 50% success rate to 75% in 20-30 training epochs.

3. **Proposed Method.** A Dialogflow agent is a virtual agent that handles conversations with your end-users. It is a natural language understanding module that understands the nuances of human language. Dialogflow translates end-user text or audio during a

conversation to structured data that your apps and services can understand. Dialogflow agent can handle the types of conversations required for your system [18]. Knowledge connectors are meant to complement the intents of an agent and offer a quick and easy way to integrate existing knowledge bases into a chatbot [19]. We developed a program based and it will be displayed in a smartphone embedded with the humanoid robot as shown in Figure 1. First, we should create a knowledge base with 50 questions and answers on text-based knowledge with the question-and-answer column as shown in Figure 2 below.

1	Question	Answer
2	Why hasn't my order arrived yet?	Please allow up to 60 minutes to receive
3	Is there a real person that can help?	Yes, a real person is available to help.
4	When do you open?	We are open Monday through Sunday
5	When do you close?	We close at 11pm Monday through Sunday
6	How do we pay?	We accept credit card, debit card, or cash
7	Do you have parking?	Yes, there is parking on the street.
8	Do you have a patio?	Yes, we have patio seating available.
9	Do you offer delivery?	Yes, we deliver.
10	Can I pickup my order?	Yes, we offer curbside pickup.
11	Can I send back my food?	Unfortunately, we don't accept return
12	Can I get a refund?	If you're unhappy with your order, we can give you a voucher

FIGURE 2. Example of knowledge based on text in Dialogflow

The model of knowledge-based chatbot that can be accessed using web application from the smartphone is shown in Figure 3.

FIGURE 3. Model of knowledge-based chatbot using Dialogflow

First, the user inputs the question in user interface, and then, Google Dialogflow Agent will process the question, to match with suitable intents, and also identify the entities and context. If the entity needs to check the knowledge base, intent can access the knowledge base to search the information that the intent needs. Then, the intent will return the suitable response to Google Dialogflow Agent and will be sent to the user.

4. **Experimental Result.** When making a detect intent request, you can specify one or more knowledge bases for a possible response. Explicitly supplying knowledge base in a request overrides the settings for the enabled and disabled knowledge base. Figure 4 shows the result of our experiment when asking the Anggita-Bot.

5 respondents were asked to ask questions related to the restaurant and the result is shown in Table 1.

We can count the accuracy of the performance by using the accuracy formula:

$$\text{Accuracy} = \frac{\text{Correct Questions}}{\text{Total Questions}}$$

From our experiment, we can count the accuracy, 23 correct questions from a total of 25 questions. From the calculation, the accuracy of the chatbot reaches 92%.
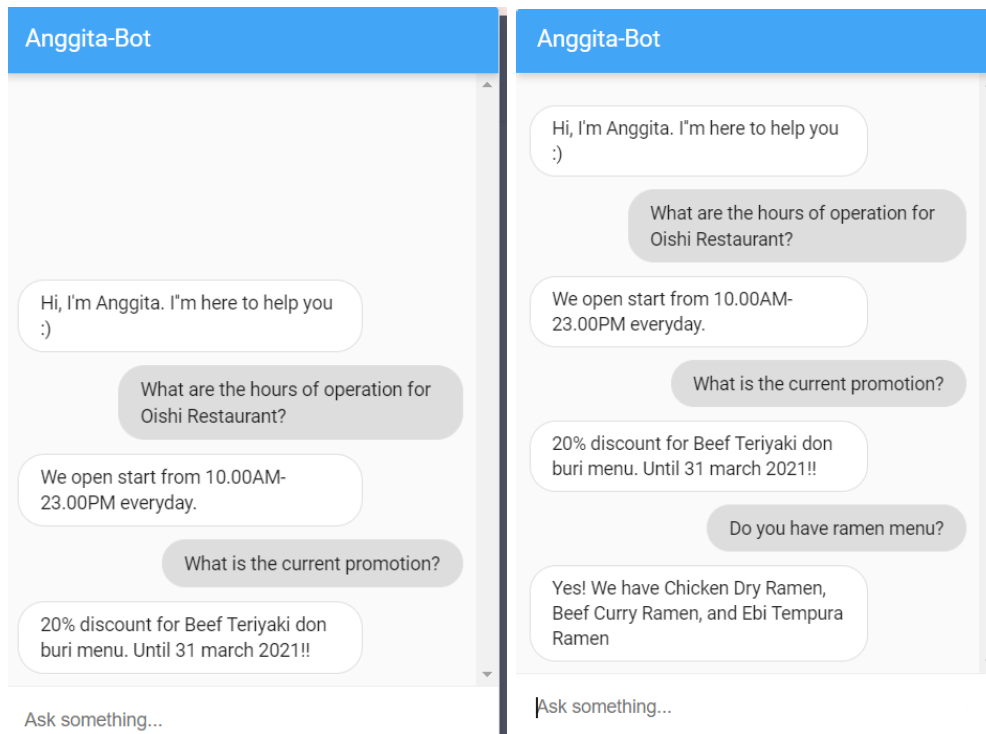
FIGURE 4. Result of the chatbot program for answering questions from the customer

TABLE 1. Performance results of the response from Anggita-Bot

Respondents	Total questions	Correct responses	Incorrect responses
Customer 1	5	5	0
Customer 2	5	4	1
Customer 3	5	4	1
Customer 4	5	5	0
Customer 5	5	5	0
Total	25	23	2

5. **Conclusions.** A knowledge base represents a collection of knowledge documents that you provide to Dialogflow. Your knowledge documents contain information that may be useful during conversations with end-users. Knowledge-based chatbot successfully used for answer questions with customer response is enough good. In our model, a chatbot for a humanoid robot was successfully developed with an accuracy of about 92%. Content with complete answers works best. For further research, we want to make the chatbot can handle custom menu request properly.

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