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Interactive Automated Agent for Campus Environment using Deep Learning

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***Abstract*: In the past few decades, Artificial Intelligence has crept its way through various domain thus gaining popularity on numerous platforms, mostly in mobile platform that has increased exposure to chatbot applications. These applications, also known as the Interactive Automated Response System, is a machine conversation system that interacts with humans via communication in Natural Language. Over the time, chatbots have gained its popularity and has contributed a huge impact in different fields of education, business, medical, etc. Automated Response System are basically proposed to reduce human effort, save time, provide 24x7 service, resolve issues, and many more. In this paper, authors have proposed a system to implement an Automated Response System for Campus Environment. Machine learning algorithm (Artificial Neural Network) and Deep Learning (Convolution Neural Network) have been used to build the Automated Response System. This Automated Response System can further be used for human-machine interaction to provide suitable answers to user queries. Moreover, the Convolution Neural Network model can be used to answer image queries related to the campus environment.**

***Keywords*:** Natural Language Processing, Artificial Intelligence, Deep Learning, SQL, Information Retrieval, Question Answering, Chatbot.

I. Introduction

Language delivers an important role in the field of communication and Artificial Intelligence (AI) plays a major role in the human-computer interaction. Michael Mauldin used the word "chatbot" to refer to these conversational algorithms in the year 1994. In 1966, Joseph Wiesenbaum built Eliza, the first chatbot [1]. Using natural language in real-time, automated response systems communicate with people. Statistical Machine Translation (SMT), template rules, and information retrieval are just a few of the methodologies that fuel it [2-5]. With the help of machine learning and deep learning techniques, automated response systems can be enhanced and worked more effectively and efficiently. It is a program used to organize human conversation via text, text-to-speech (TTS) as well as speech-to-text (STT). The Natural Language Processing (NLP) model is mainly trained to understand the human language [6]. For building and training of NLP model, huge amount of data is required that is usually known as Corpus with a lot of human interactions [7-9].

Today, a large portion of people's lives have been absorbed by technology. Smart gadgets like smartphones, smartwatches, IoT devices, etc. are mostly all-around humans [10-15]. These gadgets can communicate with one another and work together to offer helpful services [16]. The Chatbot was created with the intention of simplifying daily life by assisting users who are looking for information and responding to frequently asked questions. Chatbots are primarily used for chat oriented and/or task-oriented roles. At present, with the help of IoT devices, automated response system can control the electronic devices, book tickets, provide suggestions on various topics such as music, places, etc [17-21]. Some of the advanced automated response system include Google Assistant, Alexa, Siri and Cortana [22-29]. In order to give people better service and an improved experience, automated response systems, or chatbots, are primarily built for businesses like e-commerce, the education sector, the healthcare sector, etc. A Chatbot responds by processing specific keywords and patterns. It reduces human effort and error thereby providing 24x7 service [30-34].

Automated response systems require communication interface or a communication window that will provide response based on the input provided [35-37]. In this paper, authors have divided the system into two parts for improving the development by designing an efficient and interactive automated response system that is shown later in figure 1. It includes front-end where users can interact with automated agent to solve their queries and the backend where deep learning models are used to generate answers to user queries. The backend part is developed using python [38-40].

The authors have used deep learning method to build an automated response system for a campus environment (i.e., for Adamas University, India). This system can answer

frequently asked questions (FAQ) and various other queries related to the said campus. It can provide information related to faculties, courses, departments and many more using text, speech and images associated to the said campus. The virtual assistant is designed to support the users to solve any kind of issues or queries related to University and also easily locate places inside campus with image query. For example, by locating buildings, classrooms, and other relevant points.

The paper has been organized in the following way. Section 2 discusses about some of the related works in this field. Section 3 provides a clear view about the proposed chatbot. Section 4 focuses on Implementation of proposed worked. Section 5 concludes the paper and discusses about the future scope of automated response agent.

II. Related Works

For decades, researchers have been working on automated response system to create innovative methods and algorithms [41-43]. In this section, authors have discussed on some of the significant researches in this field. There has been a long history of automated response systems [44-47]. A significant amount of research papers and articles are there that provide us a great overview of various techniques and algorithms that have been used in the area of automated response system [48-50]. Based on the said research work, authors have highlighted on some of the noteworthy works till date.

(i) J. B. Cyril et al. [51] proposed a web application with the help of a handheld gadget. IoT devices have been used so that the application used enables home automation and provides high security. Raspbian, Python, Natural Language Toolkit, Microsoft Azure Server, IFTTT and other hardware like Raspberry Pi with Wifi, PIR Motion Detector, Electrical Lock, Router, Temperature Sensor have been used.

(ii) P. Chiu et al. [52] had used Deep Convolutional Neural Network (CNN) and Long Short-Term Memory in Recurrent Neural Network (RNN-LSTM). For short sentence feeling acknowledgment, the most extreme precision is 95.6%. This exploration utilizes the Unity 3D model to execute AR-relevant discourse robots.

(iii) B. Setiaji et al. [53] has proposed a chatbot that comprises of the core and interface. It gathers information from the database by using Relational Database Management Systems (RDBMS). Pascal and Java are utilized to assemble the interface. They have also used Artificial Intelligence Mark-up Language (AIML).

(iv) V. Ilievski et al. [54], in their paper, presented the Transfer learning (TL) Technique that can be effectively applied to support the exhibitions of the Reinforcement Learning-depending on the goal-oriented Chatbots. Finally, the transfer learning approach is corresponding to extra preparation, for example, a warm beginning.

(v) M. Kowsher et al. [55] explored a pioneer work in the field of discourse framework in Bengali. The primary aim of this work was to create a Chatbot depending on a precise information base. It chats with the client depending on the pattern matching algorithm and hence improve its presentation measure by gaining from the communication. The Chatbot is 88% accurate. They have used Naïve Bayesian algorithm, Natural Language Toolkit and Dictionary Based Search by Removing Affix (DBSRA).

(vi) Xu et al. [56] present another conversational framework that makes for client support via online media. State-of-the-art deep learning techniques such as Long Short-Term Memory (LSTM) networks are applied to produce reactions for client support demands via web-based media. Seen that a deep learning-based framework had the option to take recorded as hard copy styles from a brand and move them to another.

(vii) R. Ranoliya et al. [57] proposed and executed an interactive Chatbot for the University climate using AIML. This Chatbot can be used by any University to answer FAQs for curious understudies in an intuitive manner.

III. Design of Chatbot

For decades, researchers have been working on automated response system to create innovative methods and algorithms [41-43]. In this section, authors have discussed on some of the significant researches in this field. There has been a long history of automated response systems [44-47]. A significant amount of research papers and articles are there that provide us a great overview of various techniques and algorithms that have been used in the area of automated

For designing an efficient and improved development of the automated interactive agent, the process has been divided into two parts (Figure 1) that includes [58-61]: (i) Front-end where a user can interact with agent (The conversation of the user and the automated response system is displayed here). The front-end is developed using Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), and JavaScript (JS) (ii) In the backend part, deep learning models work to generate the answers to user queries. Backend is developed using Python and MySQL. Figure 1 illustrates the proposed design for chatbot system. Firstly, a device is required to access the interface. The chatbot is located in the bottom right corner of the interface. By using the chatbot, user can ask query via text, speech using mic button or image by uploading images. Deep learning models are employed on the backend to generate replies, and the user is presented with the results in accordance with their inquiry.

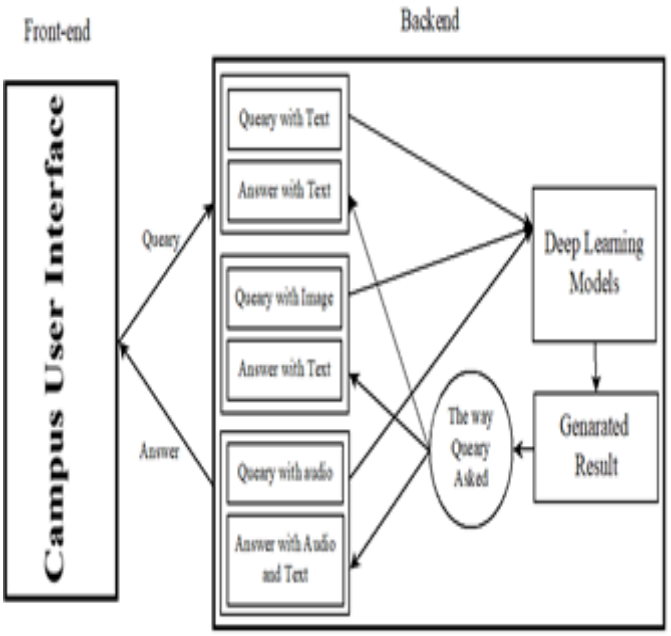


Fig. 1. Design of Chatbot

A. *Types Of Chatbot*

Over the years, there has been a consistent growth in the development of automated response system. As shown in Figure 2, Chatbot can be divided into three types based on the technical complexity and functionalities of chatbots [62-65]: (i) Simple chatbot (ii) Smart chatbot (iii) Hybrid chatbot.

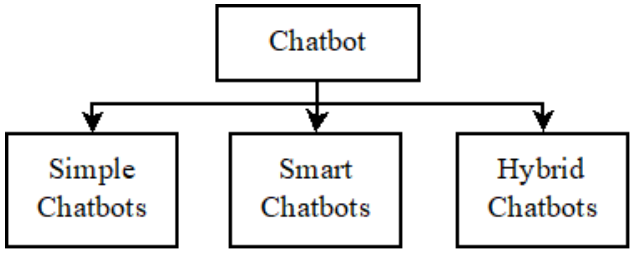


Fig. 2: Types of Chatbot

1) *Simple Chatbots*

Rule-based chatbots also known as simple Chatbots have limited capabilities [66]. It works mainly upon frequently asked questions (FAQ). These kind of chatbots are basically task-specific i.e., the chatbot can answer to only pre-set or pre-programmed queries. It cannot understand unknown questions. Simple chatbots are very simple to build and train. These chatbots are best suited for straightforward dialogues.

2) *Smart Chatbots*

These are Artificial Intelligence (AI) enabled chatbots. These bots have an artificial brain that understands intent, languages, and sentiments. These type of chatbots continuously get smarter as it learns from its previous conversations. Smart chatbots provide a more human-like experience. This type of chatbot resolves user service tickets on email, messaging, chat, and voice. It provides the highest accuracy and automatically resolves 70% of the user queries without any interaction [67].

3) *Hybrid Chatbots*

Hybrid Chatbots are a combination of Simple chatbots and Smart chatbots. In this type of chatbot, a live chat feature is also provided [68-70]. In a live chat, there will be a user support person who will address all the real-world queries. These chatbots have some rule-based parts and also they can understand the languages, intent. So, this reason hybrid chatbots are balanced to interact with users. The hybrid chatbot providing a blend of artificial intelligence and the intellectual capabilities of a human. According to an IBM study, 80% of routing tasks and user questions can be addressed by chatbots.

IV. Implementation of Proposed Work

Chatbots provide self-service options to the users to simplify the business workflow, reduce customer service costs. The chatbots help IT support, Medicine Industry, Travel Industry, Banking Industry, E-commerce Industry, and so on. In this paper, the authors have built a campus interactive automated agent for a university environment (i.e., ADAMAS UNIVERSITY). To implement our work we use Flask Framework, where the frontend part is developed using HTML, CSS, JS, and backend part MySQL, Natural Language Processing (NLP), Deep Learning Models. The architecture of our model (Figure 3) works in the following process.

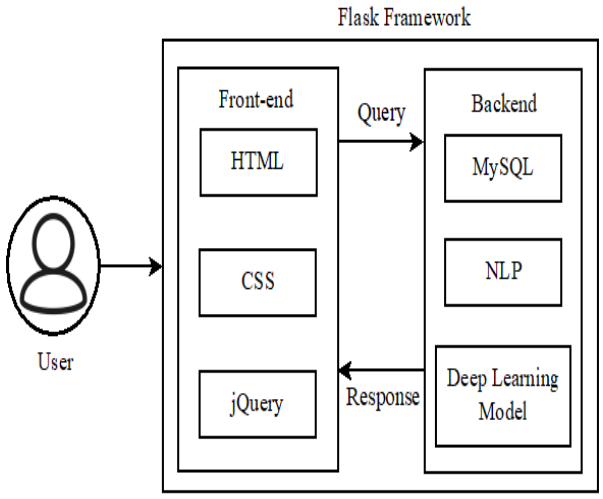


Fig. 3: Basic Architecture

A. *Work Flow*

The Chatbot reactions are a route that is well known to the user. The discussion follows a Basic English language and collaborates in an easy-to-understand way. The discussion between the user and the chatbot resembles a conversation similar to humans. The conversation working flow is shown in Figure 4. It illustrates the working flow of the proposed method. Firstly, a user opens the user interface opens in any device (i.e. Mobile, Computer, etc.). Secondly, in that interface authors build a communicator button using that a

chatbot can be activated or pop-up window open in were user asks his query. Thirdly, a user has three option to ask the query (i) An image query – where user upload the image related to campus and then these uploaded images going in Convolutional Neural Network (CNN) or Image classification Deep Learning model. The model generates a predicted result then the generated result collects its level from the Image data set and shows the answer in the user interface (This model is capable of predicting the place, person). (ii) A Text and Audio Query – if the user asks any query through text or through audio. If the user asks any query by text and it's related to campus then the query is preprocess using Natural Language Processing (NLP) then it comes to Artificial Neural Network (ANN) Deep learning Model. The Artificial Neural Network model predicts an ID number using that ID number the answer is collected from the Text Database and shows in the user interface. The main distinction in the case of an audio inquiry is that the user speaks the question, which is subsequently transformed into text using voice recognition. Otherwise, the procedure is the same as for a text query, but the interface displays the result both vocally and in writing.

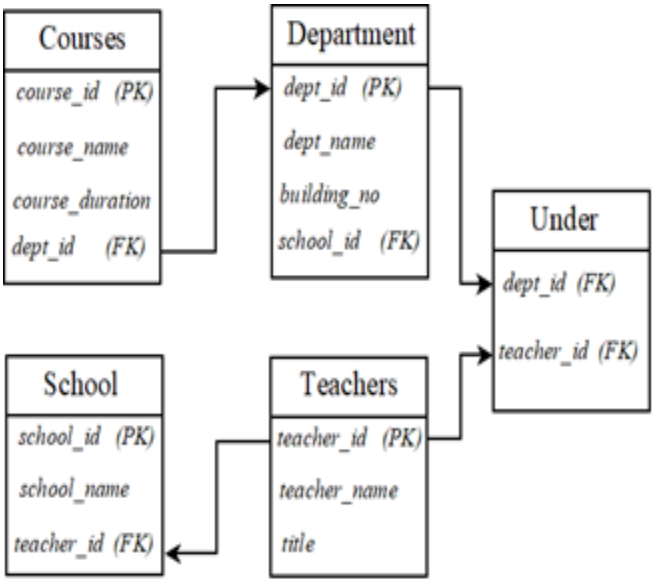


Fig. 4: Working Flow

B. *Database Creation*

Every organization has its own Database, where all the data are stored. The design of the database should reflect any organization, project, or field where the database is required. Because a database includes bulk information deposited in the framework to make it easier to locate and explore relevant information. Using this database the data fetching technique gets boosted, which means we can easily fetch data from the database. In this project, we create a database using MySQL. The relationship of the tables is shown in Figure 5. This is a small representation of the main database schema. Where in courses table "course_id" worked as a primary key (PK) and "dept_id" as a foreign key (FK) which get refers from Department table primary key "dept_id", in that way Primary key and foreign key are created for others tables (i.e., Department, Teacher, School and so on).

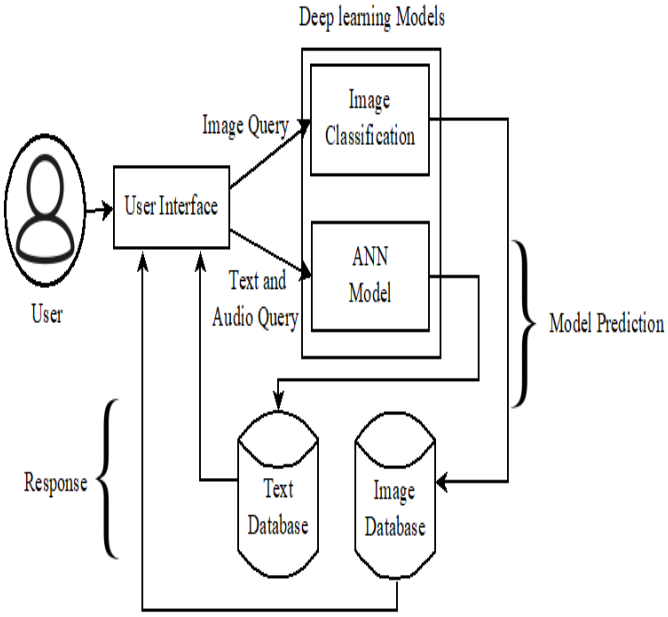


Fig. 5: Database Schema

C. *Conversation Data Creation*

By using the database schema, we can build the chatbot relevant data in the correct format. For a chatbot or automated agent, conversational data or dialog is very important. Using python, we connect to the database and fetch the data, and by using that data we prepare a dialog. Here, we create a JSON (JavaScript Object Notation) format chatbot data (Fig. 6) where main properties are 'tag', 'questions', 'answer' and each property has its values. Here tag contains the ID of the one dialog set, questions contain the possible question that can be asked, the answer contains the possible answers. This question-and-answer part is build based on that database fetched data. After finishing the train of deep learning model and deploy it the chatbot or automated agent can answer the query by using this conversational data. This data helps to answer the user through speech and text. By using MySQL database, the chatbot data is always be updated, because whenever any modification happened in the database then it automatically updated, so chatbot conversation data is dynamic.

```
{
    'tag': 't1',
    'questions': ['What is the name of campus?', 'What is the University name?',
                  'Name of the collage?', 'Full name of the collage?'],
    'answer': ['The Collage name is Adamas University', 'Adamas University',
               'Name of the collage is Adamas University']
}
```

Fig. 6: Dialog Data

For image data creating, we record multiple videos of the campus in different locations and collect campus faculty

images. Then convert those recorded videos into images frames and then level all the framed images, those framed images are level with respect to location or place, person, so that deep learning Convolution Neural Network (CNN) model can predict the image that can be classified. The level is stored in image data so after generating the answer or response by deep learning model then it can be shown in the user interface which level it is. This way conversation data is created for both the text and images.

D. Data Pre-processing

Data preprocessing is a data mining technique that is used to transform the raw data in a useful and efficient format so that data mining analytics can be applied. In data preprocessing steps involved data cleaning (this involves handling missing values, noisy data, etc.), data transformation (this involves normalization, selecting main required fields or attributes, discretization, and so on), data reduction (this involves data cube aggregation, dimensionality reduction, numerosity reduction and so on). Based on data types, data features, project, and to achieve the main goal data preprocessing is steps are decided and used. The Text data is written in the form of a natural language (i.e., English, Hindi, etc.). The text data consists of sentences, words, and characters in a meaningful and ordered manner. To train any deep learning model on text data at first, we need to preprocess first so the deep learning model performs more efficiently and more accurately. It is important to transform text data into a form that can be understood and used by machine algorithms, this is known as text pre-processing. In the text pre-processing (Figure 7) done using Natural Language Processing (NLP), perform.

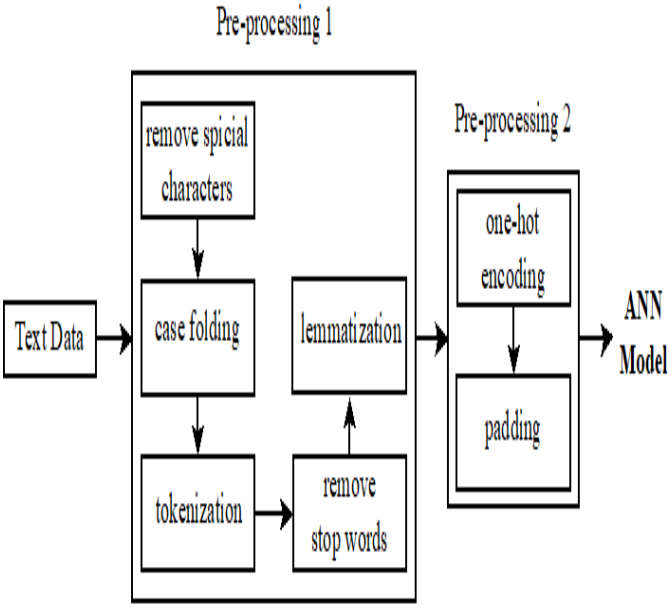


Fig. 7: Text Data pre-processing

Figure 7 illustrates have the following steps: (i) remove special characters – This comes under the data cleaning, where we remove all the special characters from the raw text (ii) case folding – This is an essential part of text data preprocessing because the model might treat a word in which it begins with capital letter different from the same word in which it begins with no capital letter (iii) word-level tokenization - Tokenization breaks the raw text into words, sentences called tokens. If any raw text is split into words using some separation technique it is called word-level tokenization. (iv) remove stop words – in text preprocessing one of the major forms of pre-processing is to filter out useless data such as useless words which are referred to stop words. A stop word is commonly used words (such as “the”, “a”, “an”, “you” etc.). (v) lemmatization – is one of the most common text preprocessing techniques used in Natural Language Processing (NLP). To reduce the inflectional form and sometimes derivationally related forms of a word to a common base form (example: car, cars, car’s converted into the car) (vi) one-hot encoding – One hot encoding allows the representation of categorical data to be more expressive because many machine algorithm cannot work with categorical data directly. So, it is required for both input and output variables that are categorical. (vii) padding – in the case of preprocessing of raw text data, not all the inputs or sentences are the same length but in the case of the train, all the neural networks that need input should be similar in shape and size. So, to convert all the inputs with the same size padding is used. After preprocessing is done Artificial Neural Network (ANN) model was used to train on this data.

Preprocessing is required to clean image data for model inputs. In the Image data pre-processing (Figure 8), perform (i) read image – a colored image consists of three color channels where a gray image only consists of one color channel which carries intensity information for each pixel showing the image as black and white. So, read the image in grayscale format. (ii) resize the image – in case each and every shape and size may be different so resize all the images as a fixed size (iii) remove noise – image noise is a random variation of color or brightness information in images. Digital images consist of image noise due to camera lenses, light, any sensor problem, and so on. This Noise needs to be minimized before train any Deep learning model. A Convolutional Neural Network (CNN) model was used to train on this data.

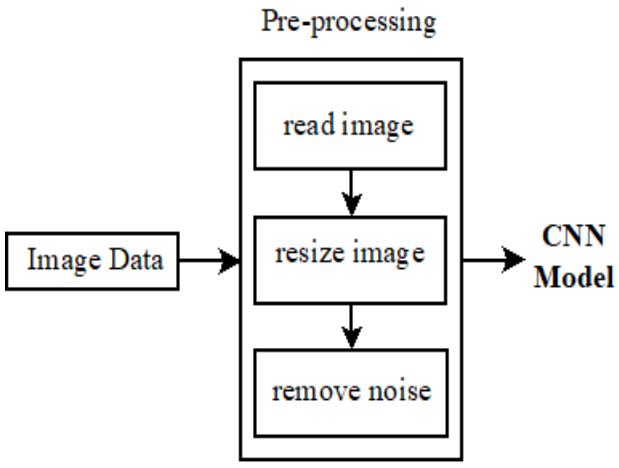
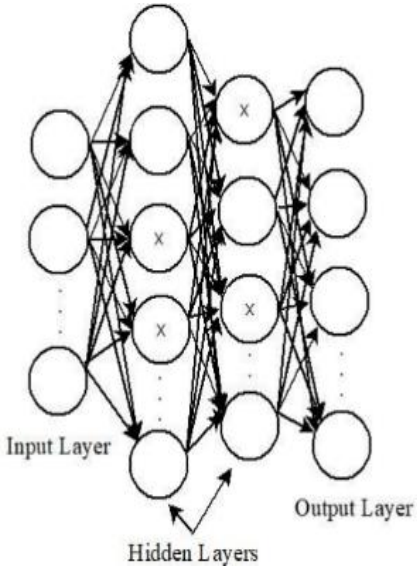


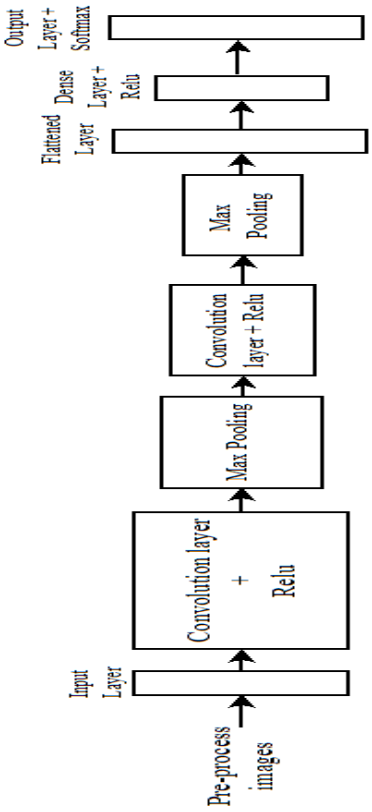
Fig. 8: Image Data pre-processing

E. Models

At the present time, the deep learning model is very useful, this model performs very much accurately and deep learning models play the main role in any work or project. Any project can consist of any number of deep learning models to achieve the desired goal. The author represents two deep learning models to achieve the desired goal. Artificial Neural Network (ANN) model (Figure 9. (a)) worked for audio and text input to predict the result and the other one is Convolutional Neural Network (CNN) model (Figure 9. (b)) worked to predict the result for image input data.



(a)



(b)

Fig. 9: Models (a) Artificial Neural Network (ANN) model (b) Convolutional Neural Network (CNN) Model

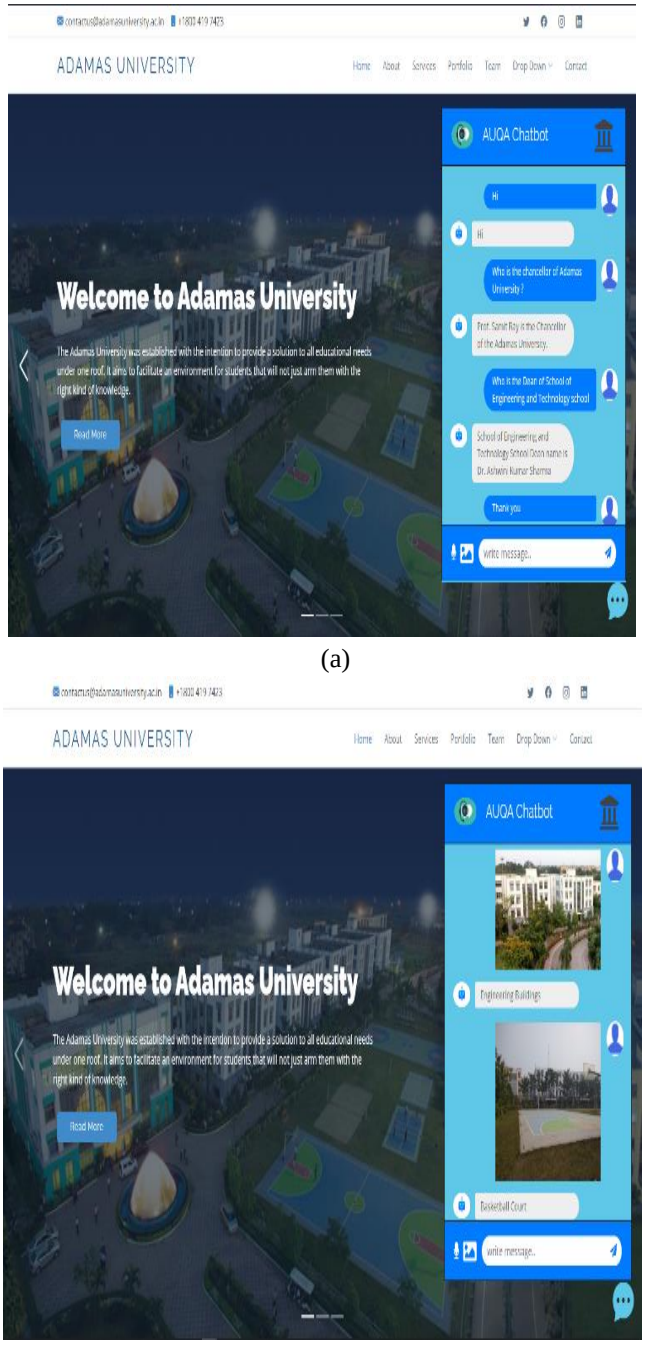
Artificial Neural Network is a special type of Machine learning algorithm, this is a nonlinear statistical model comprised of node layers. It contains an input layer, one or more hidden layers, and an output layer, each node or artificial neuron is connected to another and it has an associated weight and threshold. Artificial Neural Network (ANN) displays a complex relationship between input and output. The Artificial Neural Network (ANN) is a Sequential model. In the case of our build, ANN consist of the input layer, where an embedding layer (Text data is utilized by it. In order for each word to be represented by a different number, the input data must be integer encoded. Initially random weights are assigned on training dataset) is used where vocabulary size is 10000, the dimension of the dense embedding is 30, and the length of input sequences is 40. In the case of the hidden layer, we use three hidden layers. In the hidden layer, the Dense Layers (this is a fully connected layer means each neuron in a layer receives and inputs from all the neurons present in the previous layer) has used. Overfitting and Underfitting a major problem in Neural Network. Now, in our scenario, the dropout layer deleted a small number of neurons to combat overfitting (few neurons are discarded or ignored by this layer). In the hidden layer activation function is "**ReLU**' (it stands for rectified linear activation function. This function returns 0 if it received any negative input but for any positive input x it returns that x value) and at the end output layer, the Dense layer is used but here the activation function is '**Softmax**' (It assigns decimal probabilities to each class, this activation function mainly used in the output layer).

Convolutional Neural networks (CNN) are very similar to ordinary Neural Networks. It is a Deep Learning algorithm that can take in an input image. This CNN mainly includes convolutional layers and pooling layers. The convolution layers contain a set of filters whose paraments need to be learned, the height and weight of the filters are smaller than those of the input volume. The pooling layer is usually incorporated between two successive convolutional layers. This layer reduces the number of parameters and computation by down sampling the representation. In the case of our build CNN model have an input layer, where the convolution layer is used and the activation function is 'ReLU', then in the pooling layer max polling is used. In the hidden layer, two convolution layer and two max-pooling layers are used then the flattened layer (Multidimensional layer need to convert into one-dimensional array for inputting it to the next layer). The flattened layer is connected with the next layer with is Dense layer here the activation function is 'ReLU' activation. At the end of the output layer, the dense layer is used, but the activation is 'Softmax'.

F. User Interface

User Interface (UI) is where users are interacting with computer, website or application. The main motive is to build an effective and efficient user interface to make the user's experience easy and intuitive. To represent any project or any

work, User interface plays a vital role. We try to make the user interface interactive and user-friendly to communicate with the automated agent. To ask a question via text, simply type it into the text field and click the submit button. A deep learning model then produces an output and displays the response below the question. Image - first click the image button, then pick the image, and then the picture and level of the image is shown in the conversation area. Voice - by pressing the mic button speech recognition is activated, then ask the inquiry vocally it displays in the query and generated answer on chat area and the Deep Learning models provide each of the queries' responses. The user interface displays the replies (Figure 10).



(a)

(b)

Fig. 10: Interface (a) Text query responses (b) Image query responses

V. Conclusion

Automated response system is one of the most convenient way of Human-Computer interaction using Natural Language. In this paper, the authors have implemented an automated interactive agent using deep learning models for Campus Environment (i.e., for Adamas University). The automated agent is capable of answering queries in the form of text or images related to campus environment through messages or verbally. The automated agent data is dynamic i.e., the agent data is collected from the database therefore any update in the database will lead to automatic update in the system.

Moreover, the authors will be adding Emotion Recognition and Feedback System features through which the agents will be able to make decisions and answer to the queries more accurately.

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