

**A NATURAL LANGUAGE PROCESSING BASED CHATBOT
FOR AUTOMATING INFORMATION RETRIEVAL IN
CONSTRUCTION INDUSTRY USING BIM**



FINAL YEAR PROJECT UG 2016

By:

| | |
|--------------------------|------------------------------|
| USAMA BIN ALEEM | 173764 (Group leader) |
| MUAZ ASHRAF | 187577 |
| ALI AFZAL PANSOTA | 187031 |
| SHAHRUKH KHAN | 198587 |

**Dr. Muhammad Usman Hassan,
Assistant Professor,**

NUST Institute of Civil Engineering
School of Civil and Environmental Engineering
National University of Science and Technology, Islamabad, Pakistan

2020

This is to certify that the

Report entitled

**A NATURAL LANGUAGE PROCESSING BASED CHATBOT FOR
AUTOMATING INFORMATION RETRIEVAL IN CONSTRUCTION
INDUSTRY USING BIM**

Submitted by

| | |
|--------------------------|---------------------|
| USAMA BIN ALEEM | 173764 (G.L) |
| MUAZ ASHRAF | 187577 |
| ALI AFZAL PANSOTA | 187031 |
| SHAHRUKH KHAN | 198587 |

Has been accepted towards the requirements for the undergraduate degree

Bachelors of Engineering in Civil Engineering

Dr. Muhammad Usman Hassan,
Assistant Professor,
NUST Institute of Civil Engineering (NICE),
School of Civil and Environmental Engineering (SCEE),
National University of Sciences and Technology, Islamabad, Pakistan.

List of Abbreviations

| | |
|------|---------------------------------------|
| 3D | Three Dimension |
| 4D | Four Dimension |
| AI | Artificial Intelligence |
| BIM | Building information Modeling |
| BOQ | Bill of Quantity |
| HTML | Hyper Text Markup Language |
| MIT | Massachusetts Institute of Technology |
| NLP | Natural Language Processing |
| NLU | Natural Learning Understanding |
| POS | Part Of Speech |

TABLE OF CONTENT

| | |
|---|----|
| 1.INTRODUCTION | 1 |
| 1.1 General..... | 1 |
| 1.2 Problem statement..... | 2 |
| 1.3 Aims..... | 2 |
| 1.4 Objectives | 2 |
| 2.LITERATURE REVIEW | 3 |
| 2.1 General..... | 3 |
| 2.2 Automation in Construction Industry | 3 |
| 2.3 Building Information Modeling (BIM)..... | 4 |
| 2.4 Chat Bot System for Construction Daily Report | 4 |
| 3.METHODOLOGY | 5 |
| 3.1 General | 5 |
| 3.2 Selection of data type..... | 5 |
| 3.3 Development of BIM model: | 6 |
| 3.4 Data extraction from BIM model..... | 7 |
| 3.5 Chat-Bot development | 7 |
| 3.5.1 Natural Language Processing: | 7 |
| 3.5.2 Recognition of user’s Intent..... | 9 |
| 3.5.3 Chat-bot’s work process | 9 |
| 3.6 Final testing and bug fixes | 11 |
| 3.7 Practical data retrieval system..... | 12 |
| 4.RESULTS | 13 |
| 4.1 General..... | 13 |

| | | |
|-------|---|----|
| 4.2 | Mechanism | 13 |
| 4.2.1 | Spreadsheets | 13 |
| 4.2.2 | Web interface | 14 |
| 4.2.3 | Conversation and information retrieval | 15 |
| 5. | CONCLUSION AND RECOMMENDATION | 17 |
| 5.1 | Conclusion | 17 |
| 5.2 | Recommendations | 18 |
| 5.2.1 | Expanding the chatbot scope to other areas: | 18 |
| 5.2.2 | Connecting Chatbot with internet | 18 |
| | REFERENCES | 19 |

TABLE OF FIGURES

| | |
|--|----|
| Figure 1- Project Methodology and Workflow..... | 5 |
| Figure 2– BIM Model of a House..... | 6 |
| Figure 3 - Dynamo script for Data Extraction | 7 |
| Figure 4 – Chat-bot Work Flow..... | 10 |
| Figure 5– Example of Chat-bot Work Flow. | 10 |
| Figure 6– Practical Data Retrieval System | 12 |
| Figure 7– Schedule of Windows..... | 13 |
| Figure 8–Schedule for Doors..... | 14 |
| Figure 9– Chat-bot Greeting. | 14 |
| Figure 10– Chat-bot Testing 1 | 15 |
| Figure 11– Chat-bot Testing 2 | 16 |

ABSTRACT

A NATURAL LANGUAGE PROCESSING BASED CHATBOT FOR AUTOMATING INFORMATION RETRIEVAL IN CONSTRUCTION INDUSTRY USING BIM.

Construction projects are very intensive and involve a large number of complex activities. A large amount of information is required to be shared among different stakeholders regarding work progress on site. This takes a lot of time and affects efficiency. Even in this modern era construction industry (especially in Pakistan) is still lagging behind in developing a proper automated medium from where information can be retrieved easily. The purpose of our project is to develop such a medium. For this purpose, we developed a rule-based chat bot and integrate it with BIM from where necessary information will be acquired. A rule based chat bot is easy to train and can be integrated with any software easily. BIM can be used by only professionals but chat bot is user friendly and can be used by everyone. To develop this chat bot, we make use of Natural Language Processing (NLP). NLP is a mechanization which helps computers in understanding and interpreting human language. In our project chat bot is able to communicate in English.

INTRODUCTION

1.1 Background/General

Construction Projects are activity intensive. There are large number of activities involve and these activities are loaded with information. The information is shared between different stakeholders of a project. Getting a particular information at a time become a tedious task. Traditionally construction industry follows the conventional communication mode for information sharing. In conventional communication mode the information is communicated by people or through telecommunication devices and follow a long chain of command. The main drawback of this mode is that the information retrieval becomes a tedious task and affects the productivity negatively. Our main purpose of doing this project is to develop a new way of getting the required information. The technological advancements have make us possible to develop a highly sophisticated tool such as chat bot. We developed a chat bot which answers our queries related to a specific construction area of a project.

In general, a chat bot is a computer based program which stimulates the human conversation. A chat bot allows human to interact with digital devices as if they are interacting with real human. There are large number of chat bots available ranges from a simple program that answer a simple query to a highly sophisticated digital assistant.

When it comes to origin of chat bots it dates back to late 20th century when Joseph Weizenbaum at Massachusetts Institute of Technology (MIT) developed a chat bot called ELIZA. The ELIZA is considered as a first chat bot ever made. In 2009 a Chinese company WeChat created a more advanced chat bot. (The History of Chatbots | Onlim 2017)

Based on their working, there are mainly two types of chat bot, a simple chat bot also known as rule based chat bot and a smart chat bot or Artificial Intelligence based chat bot. In rule based chat bot there are pre written words and it can understand only these words. It also has pre-defined set of rules and it can't work, understand or communicate outside of these predefined rules. On the other hand, AI based chat bot is a more sophisticated bot which can simulate a real human

conversation with real-time responses to users based on machine learning. For our project we have created a rule based chat bot. A rule based chat bot can be trained faster, it can be integrated with other software easily. (Rule-Based Chatbots vs. AI Chatbots: Key Differences n.d.)

Natural learning process (NLP), a branch of artificial intelligence is the core of a chat bot. In simple words Natural Language Process is a technology which helps computers to understand human languages. Understanding a human language by machines is an arduous task and the basic objective of NLP is to read, understand and make sense of human languages that is valuable.

1.2 Problem statement

Construction projects involve a large number of activities and these activities are usually information intensive. There is large information sharing between different stakeholders and information is usually communicated through traditional methods. The traditional mode of information retrieval is based on person to person communication or through telecommunication devices and follow a long chain of command. The main drawback of this mode is that the information retrieval becomes a tedious task and affects the productivity negatively. So there is a need to develop a solution which makes the transfer of information quick and effortless and also makes information management more organized.

1.3 Aims

- To make construction project related information sharing swift process.
- To make sure every concerned stakeholder has easy access to information.
- To make sure our product is user-friendly, unique and successful in market.

1.4 Objectives

- To develop an automated method for ‘construction site related’ information retrieval, we will develop a chat bot.
- For information retrieval through BIM, we will integrate our chat bot with BIM.
- To validate the developed methodology on a domain of construction engineering and management.

LITERATURE REVIEW

2.1 General

Chat bots are gaining popularity as the world is changing and heading more towards efficiency in communication. These chat bots use NLP to understand human language and converse with us. Construction industry in this regard is no different and has a dire need for effective communication in this manner to achieve better and more timely results. Time constraints and information retrieval in construction are vital for adequate workflow. Otherwise, manually relaying information using people has been the norm, but that becomes superfluous when the time constraints are considered and also the reliability can be questioned due to the competencies of different individuals. Therefore, automating the process of information retrieval in construction bridges that gap, and through the use of an intelligent Natural Language Processing based Chat bot, that exactly is achievable. The research done by (Dale 2016) shows how this technology is going to be the most important thing for communication in our time, as industries require timely responses for measures to be taken in due time. The use of this kind of a virtual assistant can improve efficiency and making sure that each piece of information is delivered to the concerned persons immediately.

2.2 Automation in Construction Industry

A semantic NLP-Based approach for Information Extraction from Construction Regulatory Documents for Automated Compliance Checking was done by (Zhang and El-Gohary 2016) that reiterates the importance of automation in construction processes. Here, a Natural Language Processing based approach is used to make the process of compliance checking a lot more efficient and therefore, aiding the construction industry broadly by saving time and effort. By using rules of Information Extraction, they were able to interpret the regulatory texts in Construction and laid them out in a format that made it straightforward and easier to shift through using computers. The methodology laid down by them can be used when interpreting other construction communication as well which can be used when conversing through a chat bot.

The research done by (Niu and Issa 2014), proposes bypassing the manual process of interpreting impact factors by using a rule-based NLP (Natural Language Processing) methodology supported by domain ontology from the text of a construction claim case history file.

2.3 Building Information Modeling (BIM)

BIM is basically a technology and process which is used to manage construction project from pre-construction to the post construction phase. Application of BIM technology in construction projects benefits the different stake holders such as improving communication between the stakeholders and facilitates in faster design decision. (Latiffi et al. 2013)

A research done by (Mohandes and Hossein 2013) shows how Building Information Modeling BIM can be a beneficial tool in improving the efficiency of construction process. BIM model help us in visualization of the project before it is practically erected. It can help in analyzing complex details. Its 4D model (with time) shows how quickly activities or overall project can be put together and it can assist in expanding construction schedule. Cost of the project or specific activities can be checked at any stage and future costs can be predicted using BIM. It can assist in suggesting routing for pipes, electrical wires, cables etc. This research further discusses how BIM can be useful in project maintenance and management. It improves efficiency of work and can be utilized by architects, specialist engineer or specialist consultants. So if we integrate our chat bot with BIM then a lot of information can be retrieved.

2.4 Chat Bot System for Construction Daily Report

Chat bots can be helpful in many ways in construction project related information sharing. One such use is the formation of daily construction report as shown by (Cho and Lee 2019). Different Instant messaging (IM) applications such as WeChat, WhatsApp etc. are being used among project stakeholders (general contractors, subcontractors, project manager, consultant, client etc.) to share updates or construction information. This information is in unorganized form and contractors or managers are required to compose daily reports using all this information. This is a time consuming task. So the proposed chat-bot can collect, interpret and organize this information and make a daily construction report out of it and share it with whoever is concerned.

METHODOLOGY

3.1 General

To develop a chat-bot for construction industry we have gone through the literature study to see where in construction chat-bots are being used. We determine the areas where chat-bot will be essential in construction. Then we perform the requirement analysis and collect data. We use natural language process NLP to create the chat-bot. The chat-bot will be trained to make it more professional and human-like. We can integrate our chat-bot with Excel sheet to extract information from it.

The methodology adopted for creating a chat-bot for information retrieval of a project is illustrated in the figure 1.

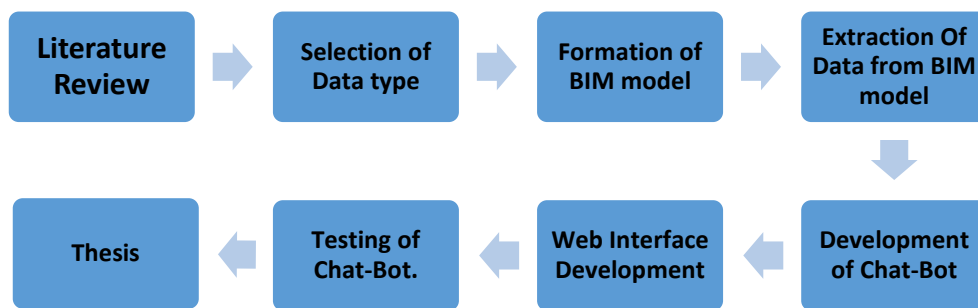


Figure 1- Project Methodology and Workflow

3.2 Selection of data type

The Construction industry is an information intensive industry. There is wide range of data involves in any construction project. There are some data which are frequently recalled by the contractor or the client. Some of these data sets are dimensions, specification and prices of different components. These type of data are required at different stages of project for instance during procurement of materials, quantity as well as specification of the material. Typical way of getting

these data is by reviewing drawings, BOQs or recall from BIM model. These data sets are selected for making an automated data retrieval system.

3.3 Development of BIM model:

Building Information modelling is a process of generation and management of digital representations of physical and functional characteristics of a building. BIM digitally constructs a 3D virtual / digital representation of the original building, which is called the BIM model. After completion, the Building Information Model has the accurate geometry and all the relevant data required for calculation, visualization and other processes in various construction.(Azhar 2011). BIM model can be used by different stake holders of construction projects. A BIM model is generated in Revit software for our project which can be seen in the figure 2. Physical as well as functional characteristics were assigned to the model.

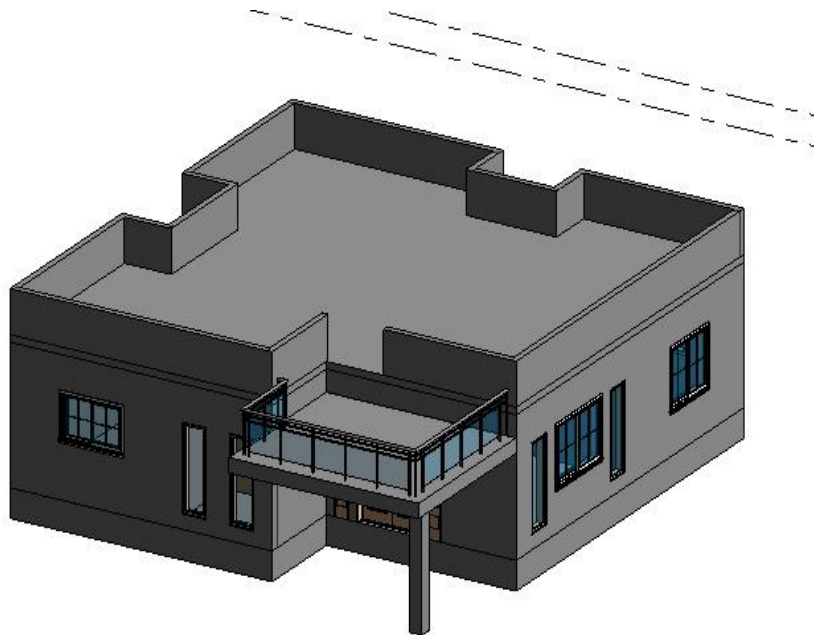


Figure 2– BIM Model of a House

3.4 Data extraction from BIM model

Chat-bots need access to data to answer queries. Our chat-bot is a text based chat-bot which means textual data is required to respond to queries. A BIM model can be equipped with a lot of data and there are different means of extracting data from it. In our project the data are extracted from the BIM model with help of Dynamo software in Excel sheet. Dynamo is a visual programming tool which makes it easier for a person who have little coding skill to extract simple to complex data effectively.(Ignatova et al. n.d.) Dynamo is included in the Revit and visual script is prepared to extract the required data in textual form in an Excel spreadsheet. This Excel spreadsheet is linked with the chat-bot and the required data is retrieved when a user asked in the chat-bot. The dynamo script for the data extraction is shown in the figure 3.

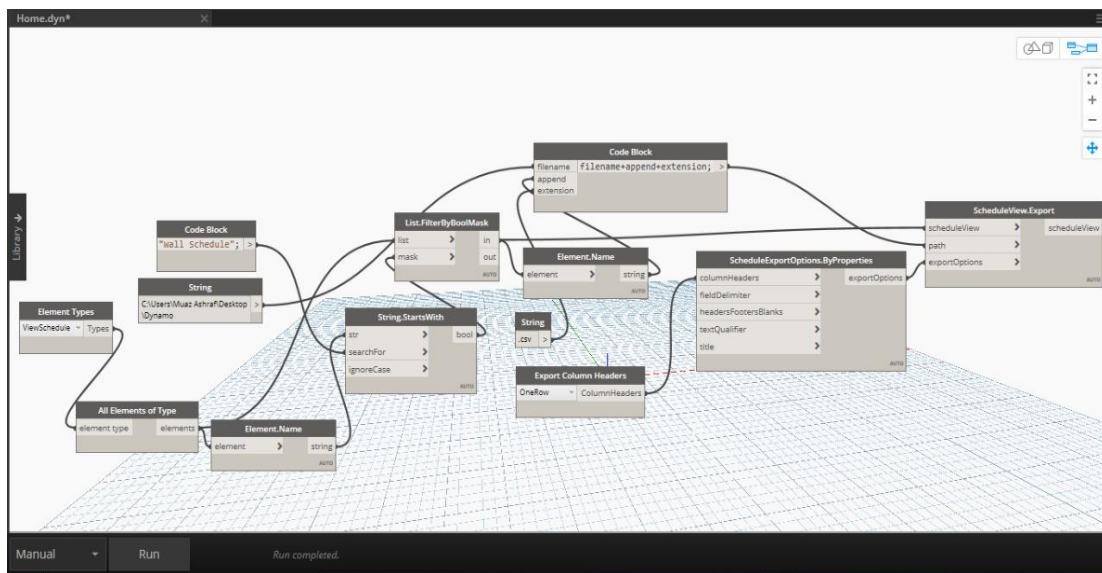


Figure 3 - Dynamo script for Data Extraction

3.5 Chat-Bot development

3.5.1 Natural Language Processing:

Natural language processing is part of computer science and artificial intelligence that processes natural language inputs. A natural language input is a language which is used by human and it does not include anything which is used by computers. The natural language inputs include idioms, assumptions of natural language (Potter et al. n.d.). Since in our project user will ask questions

from computer using chat-bot which is built using NLP, so NLP is the most important task of our project.

There are various steps involved in natural language processing NLP (Collobert et al. n.d.):

1. **Tokenization:** It is the first step in NLP. It is breaking of strings into tokens. Tokens are individual words. In tokenization entire text document, sentence or paragraph is broken down into individual words.
2. **Stemming:** It is the process of normalizing the word into its base form or root form. Stemming algorithm works by cutting off the end or beginning of the word taking into account a list of common prefixes, suffixes that can be found in an inflected word.
3. **Lemmatization:** It takes into consideration the morphological analysis of the word. To do so it is necessary to have a detail dictionary which the algorithm can look through to link the form back to its original word or root word which is also known as lemma. Lemmatization groups together different inflected forms of the word called lemma. Major difference between stemming and lemmatization is that output of lemmatization is a proper word. For example a lemmatization should map the word gone, going and went into “go”, which will not be the output of stemming.(Hilding 2019)
4. **POS tagging:** Grammatical type of a word is referred to as parts of speech (POS). POS tagging is the process of identifying a word as noun, verb, adjective, adverb based on its context.(CristinoMarcos2017)
5. **Named Entity Recognition:** It is the process of information extraction in which computer recognize a named entity into predefined categories such as name of persons, organization, locations, expressions of time, quantities, percentages etc.
6. **Chunking:** It is process of extracting meaningful phrases from unstructured text. It uses POS tagging, named entity recognition to structure the chunks in such a way to generate a purposeful text.

The different processes described above make it possible by a computer which understands only machine language to comprehend natural human language.

3.5.2 Recognition of user's Intent

After applying NLP our chat-bot is able to understand text that has been entered by user. Chat-bot manipulate the text and recognize the intent of the user. For example: If the user write "HELLO", "How are you?" etc. then chat-bot will interpret it as greetings.

In order to make chat-bot understand user's intent more effectively we need to train it by defining rules to it or providing examples. We need to define user's intent as categories and provide training to it to how to respond to a certain category. When a new query is asked by user the chat-bot will determine its similarity to a predefined user's intent which was provided in training. If the user will ask queries like "how much" then chat-bot will recognize as progress intent. However there are some libraries available such as Rasa NLU which makes it easier to train chat-bots. Rasa Natural Learning Understanding is a python library which can be used to train chat-bots to infer intents without writing extensive codes in the Chat-bot program for the training.

3.5.3 Chat-bot's work process

A chat-bot is a computer program which interacts with users using natural language. (AbuShawar, Sistemas, and 2015 n.d.),(Chatbot: What is a Chatbot? Why are Chatbots Important? - Expert System n.d.) It is designed to answer the queries of a user either in textual form. There are mainly two types of chat-bot available, the rule based chat-bots and the machine learning based chat-bots. The basic difference between rule based chat-bot and machine learning chat-bot is that the latter gets better with the time as it gets train itself. While the rule based chat-bots are based on some pre-determined rules and it is trained to respond only some specified queries related to selected data sets.(Madhu et al. n.d.)

Our chat-bot is a ruled based chat-bot. it is developed to respond to queries related to the selected data sets present in the Excel sheet. The chat-bot is developed in two parts:

1. Back end
2. Front end

For the back end part, python programming language is used for the coding. Python has rich collection of libraries and these libraries are pre written codes which are incorporated into a program for specific functions. Different python libraries such as Rasa NLU, Pandas and NumPy has been used for the development. Rasa Natural Learning Understanding is a processing tool

which takes input from a user and tries to infer intent and extract the available entities.(Xhoxhaj et al. n.d.). Panda is an open source library and it is used for high performance data manipulation and analysis. NumPy is another library which aids support for large multidimensional arrays and matrices. All the processing of the chat-bot is done in the back end part.

The front end is basically the web interface in which a user enter his/her queries. The front end is coded in HTML and JavaScript. Whenever a user input queries, these are put back to the back end. After the processing of queries at back end, the response is forwarded to the front end where it is shown in the web interface. The chat-bot work flow is illustrated in the figure 4.

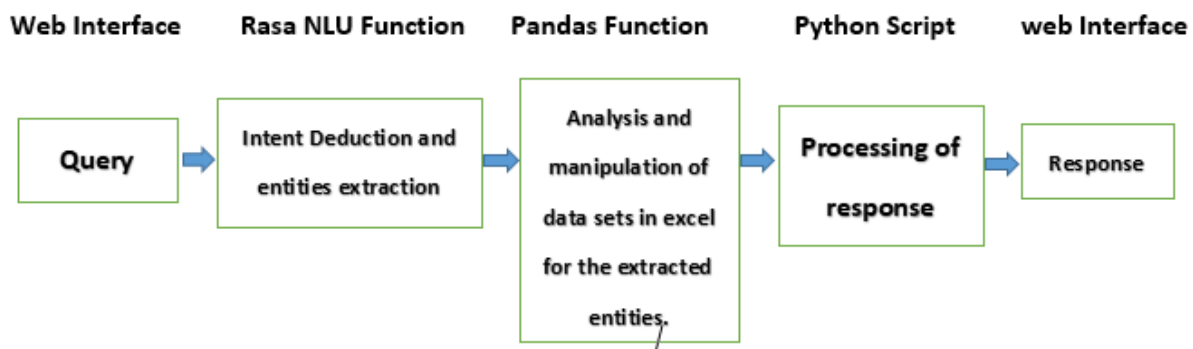


Figure 4 – Chat-bot Work Flow.



Figure 5– Example of Chat-bot Work Flow.

Referred to the figure 5, a query “what is the dimension of wall 1?” is entered by a user in the web interface of the chat-bot. The query comes to the backend part of the chat-bot. Now the query is break down and the intent is deduced with help Rasa NLU library which is imported in the codes. This return two entities ‘dimension’ and ‘wall 1’ and concludes that the user require dimensions

of wall 1. Now the chat-bot analyzes the Excel sheet for the values of dimensions of wall 1 with the help of Pandas library. The values are assigned to the dimension variables and the response is forwarded to the user interface where the user can see the response.

3.6 Final testing and bug fixes

The testing and bug fixing is an important step in computer software development. After the development of chat-bot, web interface and integration of chat-bot with an Excel sheet. The chat-bot is tested by entering a number of queries and the responses are checked against the data present in the Excel sheet. Testing is performed for the following purposes:

- To measure the performance of the chat-bot.
- To rectify any minor coding error in case chat-bot does not respond properly.
- To optimize the speed of the chat-bot.
- To analyze whether the web interface is user friendly or not.

3.7 Practical data retrieval system

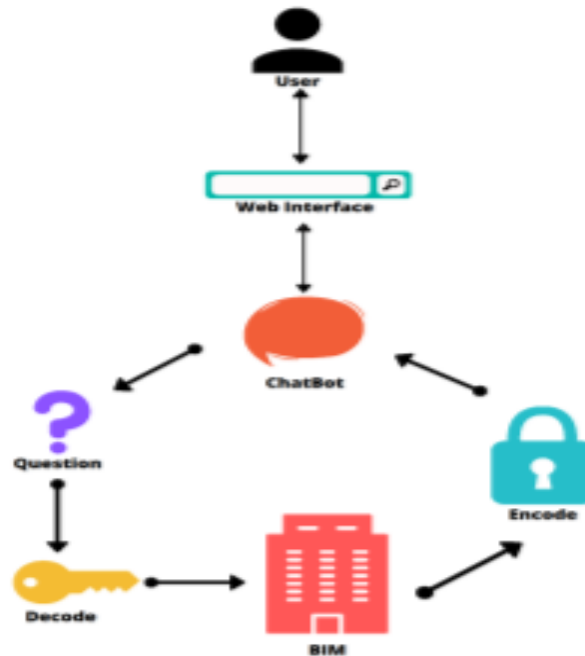


Figure 6– Practical Data Retrieval System

The practical data retrieval system is demonstrated in the figure 6, where a user interface is developed for the chat-bot. There is two function of this user interface 1) It is used to enter user queries to the chat-bot 2) It displays the output to the user. Whenever there is any query, the just enter the query in the user interface. The interface will process the query to chat-bot. The chat-bot will decode the sentence of the query and interpret by using Natural Learning Process. Upon interpretation, it will retrieve the required data from the Excel spreadsheet. The spreadsheet is generated automatically from a BIM model by using Dynamo script. After getting the required data, the chat-bot will encode the response in the way that the user can understand. After encoding the response, the chat-bot forwards it to the user interface and the response is displayed for the user in the interface.

RESULTS

4.1 General

After the formation of chat bot, we integrated it with BIM. Our BIMBOT can use Excel spreadsheets as a source of data. These excel sheets are generated automatically from BIM model through Dynamo. This BIMBOT can analyze and interpret this data. When we ask for any information this BIMBOT use artificial intelligence and analyze and interpret the data in Excel spreadsheets and provide us with the required information in conversational manner. It works very quickly and reply us in seconds. This BIMBOT is also artificially intelligent in the sense that if we make any spelling mistakes or if we ask same question differently, it still reply us with right answer. So there are no pre-defined questions. Its domain of data is the Excel spreadsheets.

4.2 Mechanism

4.2.1 Spreadsheets

BIMBOT extracts information from the Excel spreadsheets. To generate the Excel datasheets firstly we have to make a model on BIM. With the help of Dynamo Excel spreadsheets are created. Our spreadsheets are limited to only doors and windows as of now. The figure 7 and the figure 8 show the informations extracted from the BIM Model with the help of Dynamo script.

| | A | B | C | D | E | F | G |
|----|-----------------|-----------------------|-------|---------|---------|-------------|-------|
| 1 | Window Schedule | | | | | | |
| 2 | Type Mark | Family | Count | Width | Height | Sill Height | Cost |
| 3 | | | | | | | |
| 4 | W1 | Window-Sliding-Double | 1 | 6' - 0" | 4' - 0" | 3' - 0" | 5000 |
| 5 | W2 | Window-Sliding-Double | 4 | 5' - 0" | 4' - 0" | 3' - 0" | 16000 |
| 6 | W3 | Window-Sliding-Double | 3 | 5' - 0" | 3' - 0" | | 14100 |
| 7 | W5 | Window-Double-Hung | 2 | 2' - 2" | 2' - 6" | 4' - 0" | 4600 |
| 8 | W6 | Fixed | 4 | 2' - 0" | 6' - 0" | 1' - 0" | 14800 |
| 9 | Grand total: 14 | | | | | | 54500 |
| 10 | | | | | | | |

Figure 7– Schedule of Windows

| | A | B | C | D | E | F | G |
|---|----------------|---|-------|-----------|-------------|---------|-------|
| 1 | Door Schedule | | | | | | |
| 2 | Type Mark | Family | Count | Height | Thickness | Width | Cost |
| 3 | | | | | | | |
| 4 | D1 | Door-Interior-Single-1_Panel-Wood | | 2 7' - 0" | 0' - 1 3/8" | 3' - 0" | 15000 |
| 5 | D2 | Single-Flush | | 4 7' - 0" | 0' - 2" | 3' - 0" | 25200 |
| 6 | D3 | Door-Exterior-Double-Full Glass-Wood_Clad | | 1 7' - 0" | 0' - 1 3/8" | 5' - 0" | 15000 |
| 7 | G | Door-Exterior-Side_Lite-Full Arch Glass-Wood_Clad | | 2 7' - 0" | 0' - 1 3/8" | 1' - 0" | 5400 |
| 8 | Grand total: 9 | | | | | | 60600 |
| 9 | | | | | | | |

Figure 8–Schedule for Doors.

So here is a schedule for doors and windows in excel spreadsheets. We have here different types of doors and windows. For example, single flush door, full glass wood clad door etc. We also have the count or number for a specific type of doors or windows. For example, there are 4 single-flush doors. Then we also have the perimeters of door and windows which include height, thickness and width. And finally we have cost of each unit of a specific type of door or window.

4.2.2 Web interface

We can converse with BIMBOT on a web interface. BIMBOT responds us with greetings. Its web interface is shown in the figure 9.



Figure 9– Chat-bot Greeting.

4.2.3 Conversation and information retrieval

Here comes the final step for which we have created this BIMBOT. When a user asks some queries, BIMBOT interpret the question and search for answers in spreadsheets and reply with the right answer. From our spreadsheets, user can ask for quantity, perimeters and cost for a specific door or windows type and BIMBOT will give the right answer. It is artificially intelligent in a way that it interprets the question asked in different manners. In the following figure 10, it can be seen how it responds.

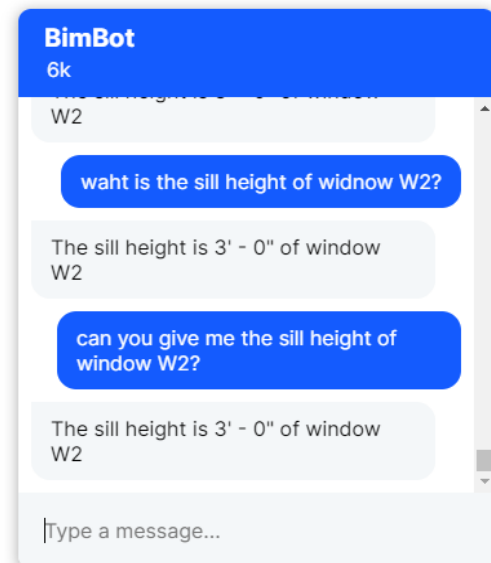


Figure 10– Chat-bot Testing 1

Similarly, if we make any spelling mistakes it recognizes our intent. Like in the following figure

11.

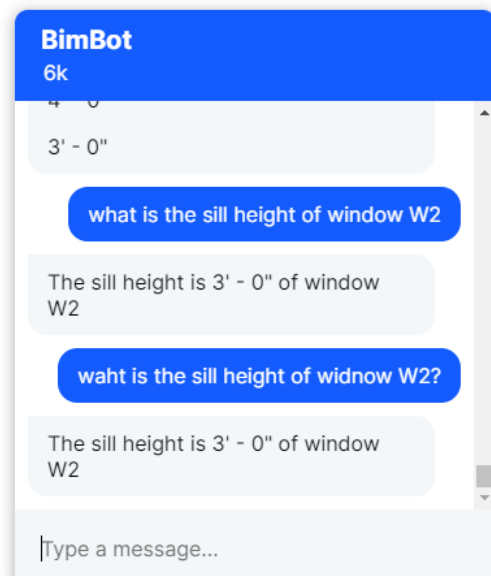


Figure 11– Chat-bot Testing 2

We put incorrect spellings for ‘what’ and ‘window’, but it recognized our intent and responded correctly.

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The scope of our project was to develop a fast data retrieval solution that can be utilized in construction projects. The Chat-bots are sophisticated data retrieval computer application that have been used in different businesses. Our objective was to develop the similar chat-bot that can be used in construction projects for retrieving data.

Following conclusions can be drawn from the project:

1. A quick data retrieval chat-bot is developed which is linked with a BIM model. The chat-bot returns the required data at much quicker time upon entering the queries on the chat-bot user interface.
2. The chat-bot is intelligent enough to understand the user input even if there are typo or grammatical mistakes in the sentence.
3. The chat-bot is designed to answer the queries related to procurement such as price of a building member, number of different building members or types of building members.
4. The type of queries and number of queries, the chat-bot can answer depends on the database developed for the chat-bot and its integration in chat-bot coding. Larger the database and their integration with chat-bot, the higher number of queries that can be answered by the chat-bot.
5. The database from which the chat-bot retrieved data to answer queries is developed using Dynamo visual programming language. A Dynamo script is developed to export data from the BIM model to an Excel spreadsheet. Using the Dynamo has made the data extraction process automatic and time efficient.

5.2 Recommendations

5.2.1 Expanding the chatbot scope to other areas:

The Chat-bot developed in our project can answer the procurement related queries. The scope of chat-bot can be expanded beyond the areas other than procurement such as project monitoring and control and contracts administration. This can be done by incorporating the codes into the chat-bot program and linking the new database related to the concerned areas with the chat-bot.

5.2.2 Connecting chatbot with internet

The chat-bot consists of the back-end program (server), the front end program (user interface) and the database in the form of Excel spreadsheet. A user can access to this chat-bot only from the computer in which the chat-bot program is stored. There is a possibility that it can be accessed remotely by developing its web interface and connecting it with internet so that it can be accessed any time remotely.

REFERENCES

- AbuShawar, B, E Atwell - Computación y Sistemas, and undefined 2015. "ALICE Chatbot: Trials and Outputs." *scielo.org.mx*.
http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1405-55462015000400625
(July 10, 2020).
- Azhar, Salman. 2011. "Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry." *Leadership and Management in Engineering* 11(3): 241–52.
- "Chatbot: What Is a Chatbot? Why Are Chatbots Important? - Expert System."
<https://expertsystem.com/chatbot/> (July 10, 2020).
- Cho, J., and G. Lee. 2019. "A Chatbot System for Construction Daily Report Information Management." *Proceedings of the 36th International Symposium on Automation and Robotics in Construction, ISARC 2019* (Isarc): 429–37.
- Collobert, R et al. "Natural Language Processing (Almost) from Scratch." *jmlr.org*.
<http://www.jmlr.org/papers/volume12/collobert11a/collobert11a.pdf> (July 10, 2020).
- Cristino Marcos, Víctor. 2017. *Title: Introduction to Natural Language Understanding and Chatbots*. <https://upcommons.upc.edu/handle/2117/121246> (July 10, 2020).
- Dale, Robert. 2016. "The Return of the Chatbots." *Natural Language Engineering* 22(5): 811–17.
- Hilding, Pontus. 2019. *Making Chatbots More Conversational Using Follow-Up Questions for Maximizing the Informational Value in Evaluation Responses*.
<http://www.teknat.uu.se/student> (July 11, 2020).
- Ignatova, E, S Zotkin, I Zotkina - IOP Conference Series: Materials, and undefined 2018. "The Extraction and Processing of BIM Data." *iopscience.iop.org*.
<https://iopscience.iop.org/article/10.1088/1757-899X/365/6/062033/meta> (July 11, 2020).
- Latiffi, Aryani Ahmad, Mohamad Syazli Fathi, Suzila Mohd, and Narimah Kasim. 2013. "Building Information Modeling (BIM) Application in Malaysian Construction Industry
Suzila Mohd UNIVERSITI TEKNOLOGI MALAYSIA Building Information Modeling

- (BIM) Application in Malaysian Construction Industry.” *International Journal of Construction Engineering and Management* 2013(4A): 1–6. <http://journal.sapub.org/ijcem> (July 11, 2020).
- Madhu, D, CJN Jain, ... E Sebastain - 2017 international, and undefined 2017. “A Novel Approach for Medical Assistance Using Trained Chatbot.” *ieeexplore.ieee.org*. <https://ieeexplore.ieee.org/abstract/document/7975195/> (July 10, 2020).
- Mohandes, Saeed Reza, and Omrany Hossein. 2013. “Building Information Modeling in Construction Industry-a Review.” *International Research Journal of Engineering and Technology (IRJET)* (October): 1324–29.
- Niu, Jia, and Raja R.A. Issa. 2014. “Rule-Based NLP Methodology for Semantic Interpretation of Impact Factors for Construction Claim Cases.” In *Computing in Civil and Building Engineering - Proceedings of the 2014 International Conference on Computing in Civil and Building Engineering*, American Society of Civil Engineers (ASCE), 2263–70.
- Potter, DW, KR Powell, ... KW Humphreys - US Patent, and undefined 2008. “Natural Language Processing Interface.” *Google Patents*. <https://patents.google.com/patent/US7409337B1/en> (July 11, 2020).
- “Rule-Based Chatbots vs. AI Chatbots: Key Differences.” <https://www.hubtype.com/blog/rule-based-chatbots-vs-ai-chatbots/> (July 11, 2020).
- “The History of Chatbots | Onlim.” 2017. : 3. <https://onlim.com/en/the-history-of-chatbots/> (July 10, 2020).
- Xhoxhaj, Erland et al. swisstext.org *Four Different Ways to Build a Chatbot About Movies Rule Based Question Answering Modelling Conversation Context Learning Dialogues End-to-End Microservice Architectures*. https://www.swisstext.org/docs/2017/Presentation/neureiter/SwissText_Poster.pdf (July 10, 2020).
- Zhang, Jiansong, and Nora M. El-Gohary. 2016. “Semantic NLP-Based Information Extraction from Construction Regulatory Documents for Automated Compliance Checking.” *Journal of Computing in Civil Engineering* 30(2): 1–42.