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Utilizing Web-Based Speech-to-Text for Query Search Using Aqile Software Development Methodologies

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Abstract: Companies are increasingly using database-based data processing systems to store all information about their goods and products, so searching for queries on the system is one of the routine activities carried out by employees daily. The user must enter the keywords from the desired query in the search feature available on the system using the keyboard to perform the search process. It can only be accessed via a computer connected to the internet. Office However, sometimes there are several factors that make it difficult for employees to type in keywords, such as driving or having physical limitations, especially in the hands. This study aims to present an alternative to entering keywords not only through the keyboard but also by using voice by creating a query search system with the Speech-to-Text method so that users simply say the keywords from the desired data, and the system will be built based on a website so that they can be accessed from other devices such as smartphones, tablets, laptops or other devices. The method used in making this system is the System Development Life Cycle (SDCL) Prototype model and the system design modeling using the Unified Modeling Language (UML). This system will also be hosted on the Heroku platform, and in order to guarantee optimal operation of the system, a black box testing method is used, and the word accuracy test resulting from the Speech-to-Text conversion as well as the processing time required from the start of the system running to displaying the search results. It is hoped that with this system, employees will find it easier to enter keywords from the data they want through various devices quickly and with precise results.

Keywords: The search query, Speech-to-Text, Prototype, UML, Flask Framework, Heroku

INTRODUCTION

Along with the current developments in the world of technology, many companies have adopted database-based data processing systems to store all information on the goods or products produced in order to have accountability that can be accounted for and facilitate the search process when needed. Carrying out the process of searching for information on goods or products stored in the database, which can also be called a query (Syafitri, 2019), of course, an activity carried out by employees during their daily work were when doing a search, the user must enter keywords from the desired information on the search feature provided on the database-based data processing system via the keyboard.

However, sometimes there are obstacles or other factors that make it difficult for users to be able to type search keywords through the keyboard, such as wet hands, driving, or disabilities, especially in the hands, so there is a need for other alternatives so that users can still enter search keywords without having to type. In addition, a good search system can return search results quickly and accurately and has a high level of error tolerance. The ability of the server used can affect search speed, and the algorithm used in the query process can affect accuracy and error tolerance, such as lack of punctuation or wrong keywords, but with a more complex algorithm (Pratama, 2018).

The main purpose of an information retrieval system is to find information, data, or documents that are relevant and meet user needs. In conducting the search process, the information retrieval system performs three

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main processes, namely: indexing, filtering, and searching itself (Jollyta et al., 2020; Tonny James & Kannan, 2017).

In addition, the database-based data processing system used can only run through devices connected to the company's internal internet network, causing the query search process to only be carried out within the company environment through certain devices such as computers or laptops. From these problems, it is necessary to develop a query search system with the Speech-to-Text method as an alternative that can be used by users to enter the desired search keywords and build this system as a website-based system so that other devices such as smartphones or tablets can access this system, through the browser on the device via an internet connection..

LITERATURE REVIEW

In the research conducted with entitled "Implementation of Speech Recognition Systems Using SAPI 5.1 and Delphi 5"(Noertjahyana & Adipranata, 2003). This study uses SAPI or Speech Application Programming Interface version 5.1, which was developed and standardized by Microsoft as a speech recognition engine. Speech recognition in computer application is not new topic. Speech recognition research is still in active area with purpose to get fast and accurate result. In this paper, we implement speech recognition system using SAPI 5.1, Microsoft Speech Engine and Delphi 5 as programming language to create text application for English dictation. Using this engine, application developers can implement speech recognition systems using the desired engine and can switch from one engine to another without changing the application that has been made.

Others a research conducted by entitled "Speech Recognition with Hidden Markov Models for Recognition and Pronunciation of Hijaiyah Letters"(Nada et al., 2019). This research utilizes main lesson in reading the Al Qur'an is recognizing and reciting the letters Hijaiyah. Speech recognition and Hidden Markov Models were carried out to develop a sound-based machine interface system. Results of the study show that the results of the Hijaiyah letter test on the same level of accuracy are 100%, while the accuracy of correctness with different letters is only 54.6%

The next research conducted was entitled "Implementation of the Google Speech API on Android-Based Al-Qur'an Memorization Correction Applications" (Akbar et al., 2019). This study builds an Android application, Muroja'ah is a method of repeating new memorization and old memorization is be heard to other people. This method is very popular in Indonesia. Research describes how to build a Qur'an recitation application based on Android and integrate it with Google Speech.

Another research entitled "Application of Web Speech API in Voice-Based Chess Game" (Parwata et al., 2019). This study utilizes Chess is a two-player strategy game played on an 8x8 squares chessboard. Chess engine has far surpassed even world chess champion, but the development of digital chess still focusing on creating an even stronger engine. Voice commands can move any legal pieces on the board simply using voice command in Bahasa or English. Web Speech API to recognize commands from users to move or move chess pieces from one position to another according to the possible moves available during the match. Speech recognition in computer application is not new topic. Speech recognition research is still in active area with purpose to get fast and accurate result. In this paper, we implement speech recognition system using SAPI 5.1, Microsoft Speech Engine and Delphi 5 as programming language.

METHOD

System Development Life Cycle (SDLC) is a system in which analysts, software engineers, programmers, and end users build information systems and computer applications(Gechman, 2019) that have brought a disciplined approach to the development of a system. This has an impact on reducing project time and costs. In addition, this method also brings consistency and continuity to system design and development

The prototype model itself is one of the widely used software development methods. With this method, developers and customers can contribute to each other during the software development process(Gechman, 2019; Tonny James & Kannan, 2017). A prototype is an early version of a software system for use in demonstrating concepts, testing design options, and finding out more about possible problems and solutions. Software prototypes can be used in the software development process to help address changes that may occur when:

1) In the requirements engineering process, prototypes can help obtain and validate system requirements.
2) In the system design process, prototypes can be used to find specific software solutions and to support user interface design.

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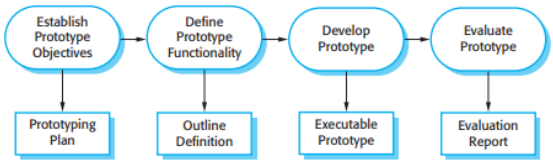

Fig. 1. Prototype Development Process(Gechman, 2019)(R. S. Pressman, 2010)

The prototype model is very suitable for use in developing this system because it allows users to see how well the system supports their work, evaluate errors or deficiencies in the system, or add new ideas to add features to the system.

Based on the results of surveys, interviews, and observations of the author, several problems can be identified as follows:

1) How to change or convert a user's voice to text?
2) How to build a search system that can be used/accessed from various devices?
3) How to build and connect a system that implements the Speech-to-Text method to be able to perform data searches on a database-based data processing system?

The Unified Modeling Language, or UML(Medvidovic et al., 2002; Misra et al., 2016), is a "language" that has become the industry standard for visualizing, designing, and documenting software systems. UML offers a standard for designing models of a system. UML defines notation and syntax/semantics. Each form has a specific meaning, and the UML syntax defines how these forms can be combined. Data collection was carried out by conducting surveys, interviews, and literature studies based on the identification of the problem to be resolved.

In building a query search system using the Speech-to-Text method, there are several requirements that must be prepared, including:

1) Functional requirements, including:
   a. The system can verify users via the available Login menu so that unauthorized users do not access them.
   b. The Speech-to-Text system is capable of working on various computers, tablets, or smartphones equipped with microphones.
   c. The system is able to work quickly and accurately in carrying out the process of searching for information or data needed by users.
2) Non-functional requirements, including:
   a. Software requirements are Windows 10 operating system, Python programming language, Flask Framework, jQuery, XAMPP, MySQL, Sublime Text IDE application, Heroku CLI, and Gunicorn.
   b. Hardware requirements are PC devices with specifications: Intel® Core™ i5-5200U CPU 2.20GHz (4 CPUs) ~2.2GHz, Memory: 4GB RAM, HDD 500GB, VGA: Intel® HD Graphics 5500

Making a Query search system with the Speech-to-Text method requires a Framework. The framework used to build this system is the Flask Framework(Miguel Grinberg, 2013). Flask is a framework by most standards small enough to be called a " micro-framework." Flask is designed as an extensible Framework from the ground up so that it can provide a solid core with basic services, while extensions provide the complement. Flask has three main dependencies: routing, debugging, and Web Server Gateway Interface (WSGI) from Werkzeug, template support by Jinja2, and command-line integration from Click. These dependencies were all written by Armin Ronacher, author of Flask. Flask has no direct support for accessing databases, validating web forms, authenticating users, or other high-level tasks. However, this service and many other key services that most web applications require are available through extensions that are integrated with the core package.

API or Application Programming Interfaces (Freeman, 2022a, 2022b) are tools that allow application developers to integrate two different parts of an application or applications simultaneously. The purpose of using the API is to speed up the application development process by providing separate functions so that application developers do not need to write similar functions (Sandi, 2017). Web Speech API was introduced in late 2012, and this API allows web developers to provide speech input and Text-to-Speech output features in web browsers. Privacy is one of the important aspects of this API, so before allowing a website to access voice through a microphone, the user must agree / grant access permission. (De Rosa, 2014).

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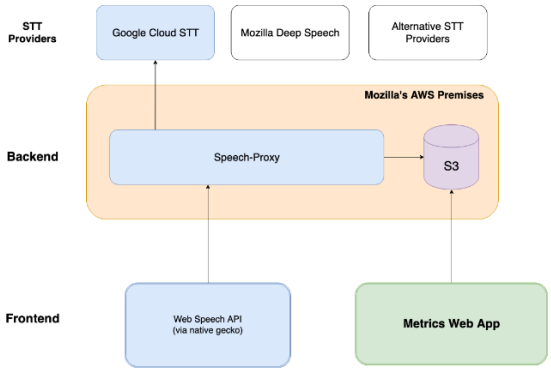

Fig. 2. Web Speech API Architecture(Mozilla, 2020)

Heroku (Kemp & Gyger, 2013) is a multi-tenant architecture built on virtual machines on Amazon Elastic Compute Cloud (Amazon EC2) and is a PaaS (Platform as a Service) platform. This platform greatly assists application developers in building applications by eliminating the need for servers, system administration, and stack maintenance.

RESULT

In building this system, modeling is needed to able to know the details and functions of this system. Therefore, UML (Unified Modeling Language) modeling is used before entering the next stage, namely coding.

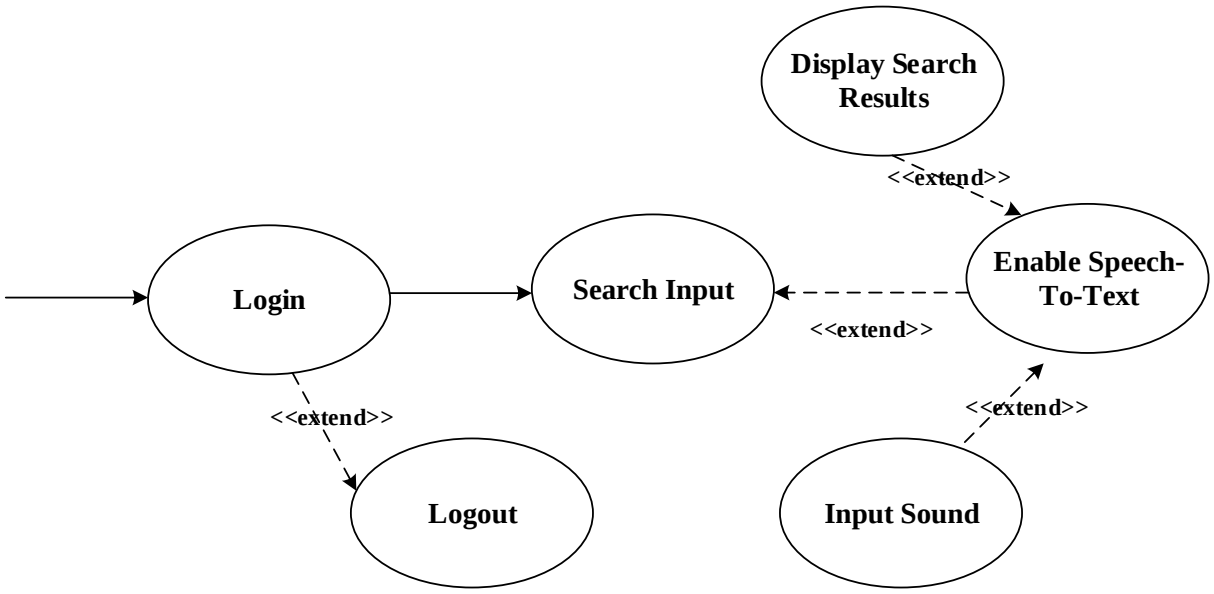

Fig. 3. Use Case Diagrams

In Figure 4. there is a proposed use case diagram where there is one actor, namely the user, who can access or have a functional relationship with the system. Users have a functional relationship with the system in the form of logging in, logging out, and searching through the system that was built.

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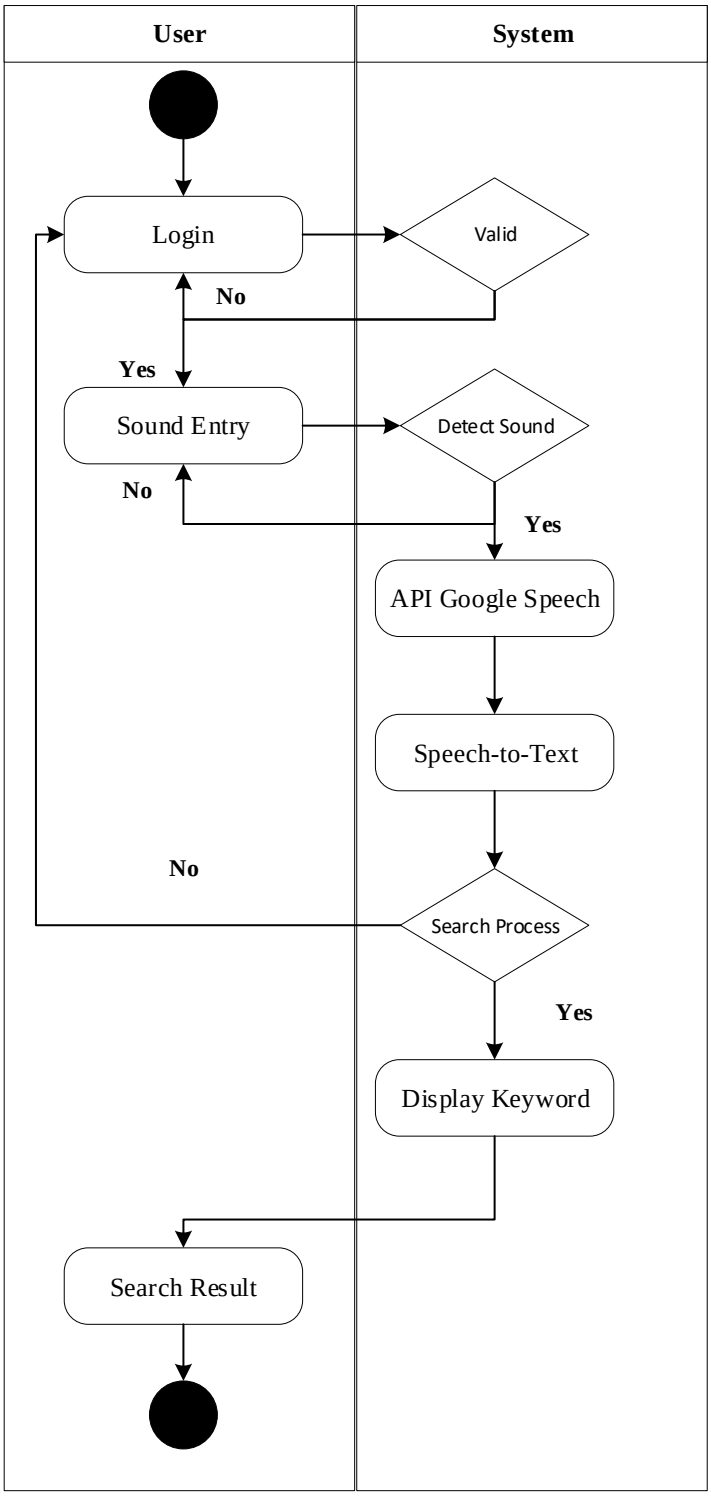

Fig. 4. Activity Diagrams

Furthermore, to find out the activities carried out by the user in using this system, an activity diagram is needed that explains the process carried out by the system, starting from entering input in the form of sound made by the user and then converted into words and processed by searching the database as can be seen in Figure 5.

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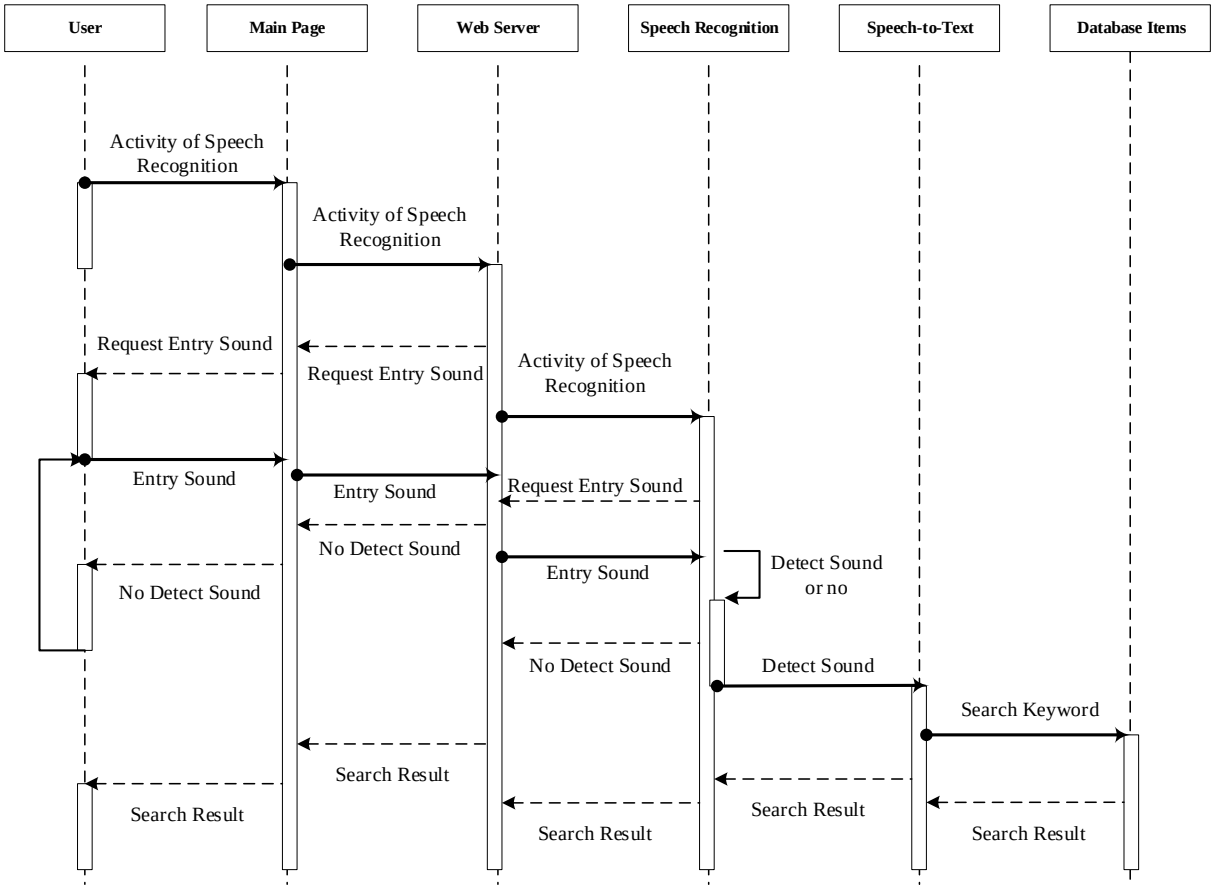

Fig. 5. Sequence Diagram of Speech-to-Text process and search

In Figure 6, there is a sequence diagram that explains that after the user activates Speech Recognition, the Web Speech API (De Rosa, 2014; Parwata et al., 2019; Sandi, 2017)will be activated and will ask the user to provide input in the form of speech from the keywords that the user wants to search for. Then, Web Speech API will perform the Speech Recognition process to recognize the user's speech and convert it as text which will then be used as a keyword search query in the database.

DISCUSSIONS

1. Login Page View

The login page is needed as a user validation stage to find out whether the user has the right to access the system or not so that it is not used by people who do not have access.

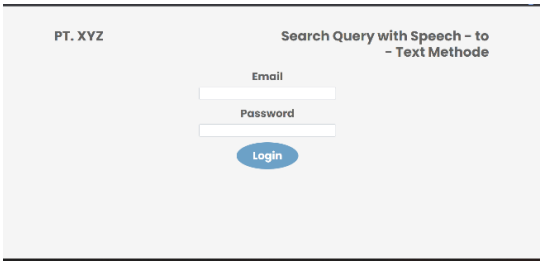

Fig. 6. Login Page

2. Main Page View

The main page of this system will display the company logo and " Search Query with Speech-to-Text Method " as the identity of the system that was built so that it can be recognized and accompanied by a search bar that can be used manually and a microphone button to activate the Speech Recognition process. Then it will be converted by Speech-to-Text to be a search keyword.

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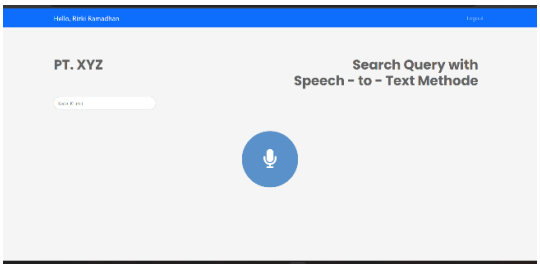

Fig. 7. Main page

3. Speech-to-Text Process and Search

On this page, the user can activate the Speech Recognition process, which will then display the information " I'm listening," as shown in Figure 9.

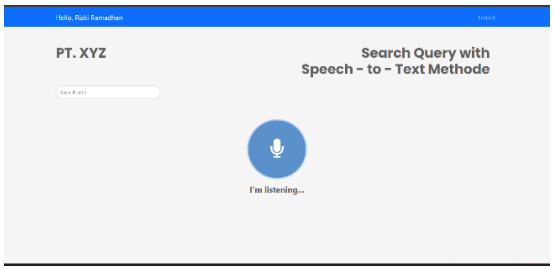

Fig. 8. Speech-to-Text Enabled

After the system captures the words spoken by the user through the Speech Recognition process, next up, Speech-to-Text will process the conversion of the user's voice into text, and the description " I'm listening " will be replaced with the resulting text and used as keywords for the search process as shown in Figure 10.

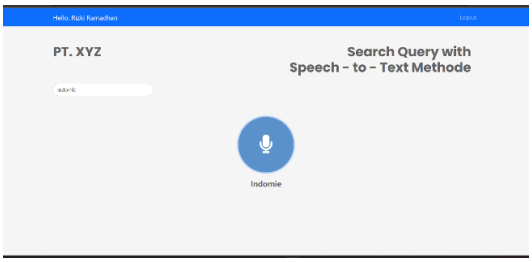

Fig. 9. Speech-to-Text Processing and Search

4. Search result display

After the system has finished processing Speech-to-Text from the user's speech and converts it into search keyword text, the system will then carry out the query search process in the database, which then displays the search results in table form, as shown in Figure 11.

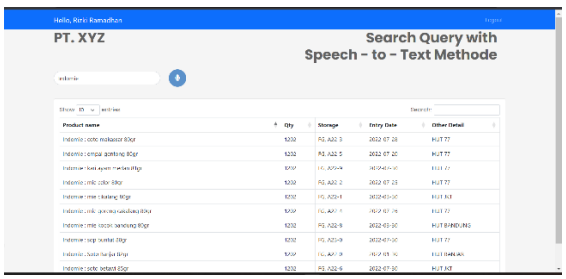

Fig. 10. Search result

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5. LAUNCHES THE WEBSITE TO HEROKU

To be able to launch a query search system with the Speech-to-Text method based on this website, we need a hosting platform that can run a system based on the Flask Framework, and one of them is Heroku. To be able to deploy the system to Heroku, there are several steps that must be done, namely:

1) Installing Gunicorn

Green Unicorn or Gunicorn is a Python-based WSGI (Web Server Gateway Interface) HTTP server for UNIX. Gunicorn servers are widely compatible with various web frameworks, use light server resources, and work fairly quickly (Chesneau, 2017).

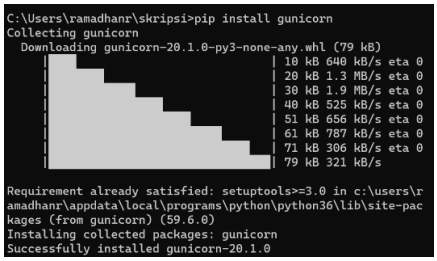

Fig. 11. Gunicorn Installation Process via command prompt

2) Create a " Profile "

The profile is a file that will be detected by the Heroku platform to find out what web server is being used and the main file of the system to be launched.

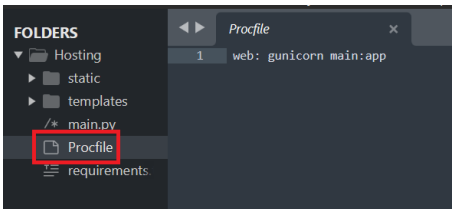

Fig. 12. Profile

3) Create requirements.txt

Requirements.txt contains a list of libraries and modules Python is required to be able to run the system that will be launched on the Heroku platform.

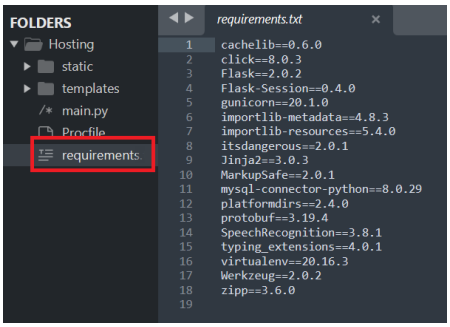

Fig. 13. requirements.txt

4) Create and synchronize databases with the system.

One thing that must be done before launching the system is to add the ClearBD add-ons to the Heroku account as a database to accommodate user data that can access the system and query items and products that will be processed later. Cleared add-ons to the Heroku account, the database is then connected to the system built by changing the localhost database that was previously used to the ClearDB address.

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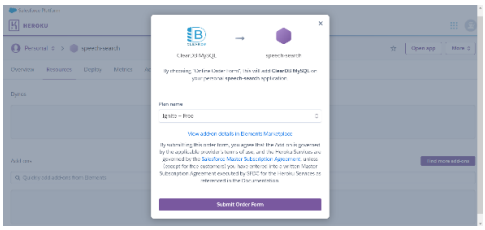

Fig. 14. Cleared Add-ons

```
8
9   mydb = mysql.connector.connect(
10      host="us-cdbr-east-06.cleardb.net",
11      user="beaf8cdc[redacted]",
12      password="4731[redacted]",
13      database="heroku_2eb5e9417629e8f"
14  )
15
```

Fig. 15. Change the database from Localhost to ClearDB

5) System launch

Once all the additional files and databases needed for the system launch have been prepared, the next process is to send and launch the system via the command prompt by following the commands on the Deploy menu on the Heroku dashboard.

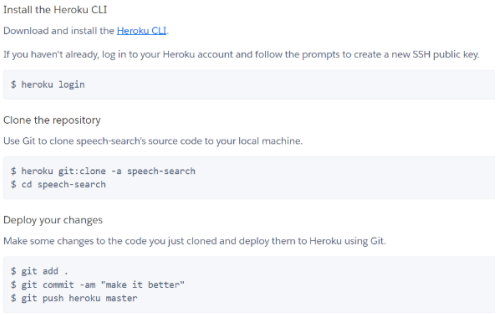

Fig. 16. Command To Deploy System Via Command Prompt

6. Test Results With Black Box Method

Table 1. Test Results Using the Black Box Method

Description	Test procedure	Expected output	Results
Access the website	Entering the website URL in the browser	Show login page	Valid (as expected)
Login	Entered the wrong email address and password	Stay on the login page	Valid (as expected
Login	Enter the correct email address and password	Display the main page of the website	Valid (as expected)
Perform a search with the Speech-to-Text method	Pressing the “ microphone ” image on the home page of the website	Displays the message “ I'm Listening ” and the resulting word from the Speech-to-Text process	Valid (as expected)
Showing search results	After the Speech-to-Text process, wait for the website display to turn into search results.	Displays “ keywords ” generated from the Speech-to-Text process in the search bar and search results.	Valid (as expected)
Re-do the search process with the Speech-to-Text method	Pressing the small microphone image on the search results page	The message “ I'm Listening ” reappears and changes back to the word generated from the Speech-to-Text process	Valid (as expected)

7. Accuracy and Time Test Results

Table 2. Accuracy and Time Test Results

Spoken word	Speech-to-Text Conversion	Search process	Results	Time (ms)

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Hello	Hello	Data not found	Valid	795 ms
Cheese	Cheese	Data found	Valid	795 ms
Mineral water	Mineral water	Data found	Valid	797 ms
Oil	Oil	Data found	Valid	757 ms
Nescafe	Nescafe	Data Found	Valid	765 ms
Pepsi	Pepsi	Data found	Valid	769 ms
Apple	Apple	Data found	Valid	743 ms
Ice cream	Ice cream	Data found	Valid	785 ms
Beef	Bus	Data found	Invalid	837 ms
Pasta	Pasta	Data found	Valid	810 ms
			Average time	785.3 ms

The speed test in table 2 uses the unit of time in milliseconds (ms) which can be seen through the Inspect-Network feature provided by the browser. In this test, the browser used is Google Chrome(Orochi & Kabari, 2021), as can be seen in Figure 18.

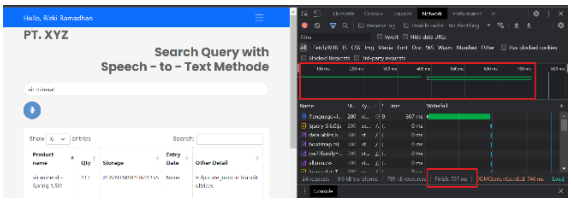

Fig. 17. System Speed Test Results

Of the ten words spoken in this test, there are words that are not converted into text correctly by the system. Namely, the spoken word is " beef " but is converted to " bis " by the system.

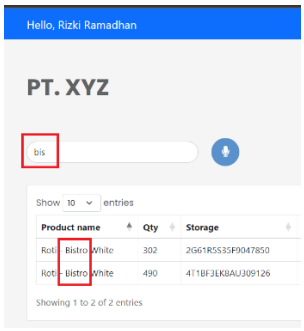

Figure 18. Inaccurate Speech-to-Text results

Inaccurate Speech-to-Text conversion results certainly have consequences for the query search process in the database because the system is designed to recognize and search for data that has or contains keywords from the conversion process. As shown in Figure 18, it can be seen that the Speech-to-Text conversion results become “ bis” so that the search results display information about “ Bistro ” because that word also contains the word “ bis ” in it.

Based on the results of testing, the accuracy and time required in the Speech-to-Text process to the search process are in table 2. It can be seen that the Speech-to-Text process only experienced a one-word conversion error out of 10 words spoken during the testing process and impacted the search results displayed by the system, but this does not seem to affect the speed of the system in completing the entire Speech-to-Text process to the search process which consistently lasts under 1 second or 1000 millisecond.

CONCLUSION

Based on the results of research and testing of the system built, some conclusions can be drawn as follows: (1) Web Speech API has a high level of accuracy and is fast in performing Speech-to-Text conversions so that search results are accurate and don't take a long time, (2) The hosting service from Heroku really helps users in the process of launching a website-based system because of its ease of use, and (3) Because the system has been successfully launched on Heroku, this website-based system can be accessed from other devices by simply entering the URL of this system in the browser used by the user.

Many companies have adopted database-based data processing systems to store all information on the goods or products produced in order to have accountability that can be accounted for and facilitate the search process when needed. A good search system can return search results quickly and accurately and has a high level of error

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tolerance. System Development Life Cycle (SDLC)(R. S. Pressman, 2010) is a system in which analysts, software engineers, programmers, and end users build information systems and computer applications. This has an impact on reducing project time and costs. In addition, this method also brings consistency and continuity to system design and development.

A prototype is an early version of a software system for use in demonstrating concepts, testing design options, and finding out more about possible problems and solutions. In building a query search system using the Speech-to-Text method, there are several requirements that must be prepared. Making a search system with the Speech-to-Text method requires a Framework. The framework used to build this system is the Flask Framework. Flask has no direct support for accessing databases, validating web forms, authenticating users, or other high-level tasks.

In Figure 4. there is a proposed use case diagram where there is one actor, namely the user, who can access or have a functional relationship with the system. The system was built so that it can be recognized and accompanied by a search bar that can be used manually and a microphone button. After the system captures the words spoken by the user through the Speech Recognition process, next up, Speech-to-Text will process the conversion of the user's voice into text. The description "I'm listening " will be replaced with the resulting text and used as keywords for the search process.

The speed test in table 2 uses the unit of time in milliseconds (ms) which can be seen through the Inspect-Network feature provided by the browser. Inaccurate Speech-to-Text conversion results have consequences for the query search process in the database. The system is designed to recognize and search for data that has or contains keywords from the conversion process. System only experienced a one-word conversion error out of 10 words spoken during the testing process.

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