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Voice Guided Smart form filling and Printing Terminal

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ABSTRACT

The process of filling official forms is a common requirement in a number of public service centers. However, the traditional method of form filling is often a time-consuming and error-prone process. This problem may be particularly daunting for the elderly population, visually impaired people, and those with poor literacy skills. Furthermore, the problem may be compounded by the fact that the majority of forms are available in only one or two languages. To overcome the aforesaid challenges associated with the process of filling forms, a Voice Guided Smart Form Filling and Printing Terminal is proposed in this paper. This system is a self-service system that helps to simplify the process of filling forms. It helps the users fill the pre-stored forms by voice commands. It is a user-friendly system that helps the users to fill the forms easily. It is available in multiple languages to cater to a larger audience. Once the required information is gathered through voice interaction, the system fills the selected form and generates a printed copy of the same for immediate collection

1. INTRODUCTION

In different public service domains, including banks, hospitals, government offices, railway stations, and service offices, users are required to fill up different types of forms for registration, verification, and service purposes. Normally, the traditional method of filling up forms involves users reading and filling up the form accurately in the appropriate areas. However, filling up forms manually might turn out to be a challenge for elderly people, visually impaired users, and those with low literacy skills. Furthermore, language and format difficulties might also create problems in the process

The manual process of filling out the forms will also result in an increased burden on the staff members who are often required to assist the users in filling out the forms. This not only delays the service process but also leads to a long waiting time in a crowded public setting. Often, the forms are required to be rewritten when they are incorrectly filled out. Hence, there is a need for automated systems that can assist in the simplification of the process of filling out the forms. Recent developments in Artificial Intelligence, speech recognition, and Natural Language Processing have helped in the effective interaction between humans and computers. Voice interfaces allow users to interact with computers in a natural way by using their own speech, rather than conventional methods such as typing and clicking. This is achieved by using speech recognition technology, which allows the computer to understand the language used by users and thus enables effective interaction

with computers. These technologies have been widely used in smart interfaces, service kiosks, robots, and for people with disabilities [1], [7].

It has also shown promise in proving itself useful in improving accessibility and user convenience. For instance, a voice-based assistant can help a user accomplish tasks such as sending an email or searching the web without having to manually input anything. It has also been shown through research that a speech-based system offers a more intuitive and user-friendly interface, especially for people who may have difficulty using other methods of inputting data [8], [11]. It also helps in reducing the cognitive burden of the user through step-by-step guidance in an interactive manner. It has also shown promise in proving itself useful in improving accessibility and user convenience. For instance, a voice-based assistant can help a user accomplish tasks such as sending an email or searching the web without having to manually input anything. It has also been shown through research that a speech-based system offers a more intuitive and user-friendly interface, especially for people who may have difficulty using other methods of inputting data [8], [11]. It also helps in reducing the cognitive burden of the user through step-by-step guidance in an interactive manner.

Besides these accessibility features, voice-enabled systems can help improve efficiency within service centres as well. Smart kiosks with speech recognition and processing capabilities can help automate tasks such as data entry, registration, and form generation. These systems help reduce dependency on human resources and improve efficiency in service centers [6], [10]. By automating tasks such as these, organizations can improve efficiency and reduce costs. While there are many technological advancements in various areas within service centres, many organizations are still using conventional systems such as paper-based or manually assisted form-filling systems. These systems are inefficient, prone to errors, and inaccessible to certain users. The absence of automation in this area is a major problem that needs to be addressed through intelligent systems to simplify the form-filling process. In order to overcome these challenges, this paper suggests a Voice Guided Smart Form Filling and Printing Terminal that is a smart self-service system that enables users to fill out a form by interacting through voice. The system enables users to select a form that is required by interacting through voice. The system is able to use speech recognition and natural language processing techniques to convert user responses into text format and fill out the form accordingly. Once all the necessary information is collected from users, the system is able to print out a form for users to use. The proposed system is able to provide accessibility to elderly users and visually impaired users, prevent errors while filling out a form, and minimize waiting time at service centers. The proposed system is able to provide a convenient solution for users by incorporating speech recognition technology, multilingual capabilities, and form printing capabilities that are suitable for a new generation of service centers.

2. Literature Survey

a. Related Works And Identified Gap

The recent developments in speech recognition technology, natural language processing, and human-computer interaction have led to the development of intelligent systems with speech recognition technology, which can facilitate user interaction with digital platforms in an effective manner. Sharma and Verma discussed the role of machine learning in improving the performance of speech recognition systems in Internet of Things devices in their research article [1], which indicates the potential of using machine learning techniques in improving the performance of speech recognition systems in a real-time environment. Lee et al. proposed a multilingual speech recognition system intended for use in interactive public service systems in their research article [7].

Voice-enabled interfaces have also been integrated into various assistive technologies. Tripathi and Shashank[11] proposed an email system based on voice interaction that was meant for visually impaired users. This technology allowed the visually impaired to use digital communication systems. The proposed work by the authors showed the potential of voice interaction in assisting users who face difficulties while using digital

communication systems. In another study, Kiran et al.[8] proposed a voice-based virtual assistant using natural language processing.

Research studies have also investigated the application of speech-driven technology in automated service kiosks. For instance, Garcia et al. [6] presented a concept for a speech-enabled smart kiosk system that enables users to access digital services through voice interaction. Likewise, Singh and Patel [10] presented a voice-enabled public service kiosk system that incorporates artificial intelligence and speech recognition technology to facilitate automated services. Schultz et al. [18] highlighted the significance of developing a multilingual speech database for the development of automatic speech recognition technology.

Although considerable work has been done on voice-based interaction systems, much of this research has been carried out on voice-based interaction systems such as virtual assistants, robotics, or service kiosks. However, only a small amount of research has been carried out on voice-based interaction systems related to automating the form-filling process. In addition, much of these systems are not integrated with voice recognition technology, multilingual support systems, or automated document generation systems. As such, there is a need to propose an integrated voice-based interaction system that is able to support voice interaction, multilingual support systems, automated data entry systems, and instant form printing systems. The proposed voice-based interaction system is called the Voice Guided Smart Form Filling and Printing Terminal.

From the existing literature, the following major gaps were identified:

1. Most of the existing studies are centred on general voice assistants, robotic controls, or speech-based communication systems. However, very few systems are specifically designed for the automation of form filling operations using voice interaction [8], [10].
2. Most of the existing voice-based systems are able to recognize speech and convert it into text; however, none of them are able to provide form completion and printing operations as is necessary [1], [6].
3. Some of the speech-based applications are intended for a specific language, and this creates a barrier for users with varying linguistic backgrounds in a multilingual society [7], [18].
4. Although assistive technologies are available, existing systems are based on manual input methods, and this may be a problem for elderly people and visually impaired users [11].
5. In traditional form filling operations, it is often necessary for a member of staff to assist users, which can cause a problem by creating additional work, waiting times, and inefficiency in a public service setting [6], [10].
6. Research has rarely incorporated voice interaction, natural language processing, automated form filling, and instant form printing into a single system for self-service public applications [1], [7], [18].

The proposed Voice-Guided Smart Form Filling and Printing Terminal assists users in filling forms in a simple manner through voice commands. This system is useful to elderly people, visually impaired persons, and those who face difficulties in understanding languages. This system minimizes errors and waiting time.

b. ***Critical Limitations In Prior Studies***

While previous studies have significantly advanced the development of Vehicle-to-Vehicle communication systems, certain limitations persist within the system.

1. Most of the voice-based systems that were made before mostly use machine learning and deep learning models to recognize speech and turn it into text. These methods work well for general purposes, but they aren't made for structured applications like filling out forms, where data needs to be entered field by field [1], [3].
2. A lot of current systems use cloud-based speech recognition APIs to process voice input. These systems give quick and accurate results, but they need a strong internet connection to work well. This makes them less useful when there isn't a strong network or when there isn't a network at all [9], [10].
3. Several previous studies have suggested voice-based data entry systems; however, they lack features for automated form generation and printing. This makes them less useful for real-world public service applications that need to print out documents [5], [9].
4. Most earlier implementations that used embedded platforms only focused on controlling hardware and voice commands. They didn't pay enough attention to user interface design and usability. This makes it hard for older people and those who aren't very tech-savvy to use the systems [6], [7], [8].
5. Most previous works do not offer a comprehensive system that amalgamates speech recognition, natural language processing, hardware interfacing, and system software into a unified platform. Consequently, the overall performance and efficiency of the system are diminished [11], [12], [15].

The limitations listed above show that there is a need for a better voice-based form filling system that can recognize speech accurately, work offline, be easy to use, and automatically create forms. The proposed Voice-Guided Smart Form Filling and Printing Terminal aims to get around these problems by making it easy to enter data by voice, supporting fast data processing, and allowing forms to be filled out and printed right away. This will make the system more accessible and work better overall.

Proposed System and How It Address the Gaps

The Voice-Guided Smart Form Filling and Printing Terminal that has been suggested is meant to fix the biggest problems with current voice-based and manual form-filling systems. The combination of speech recognition, natural language processing, a user-friendly interface, and automatic form generation makes it a more reliable and efficient system for making the form-filling process easier.

1. **Accurate Voice Input Using Speech Recognition** The proposed system uses cutting-edge speech recognition technology to turn voice input from users into text. This method is more accurate and makes fewer mistakes than filling out forms by hand or using basic voice systems. It lets users easily give information by voice command, which makes data entry faster [1], [3].
2. **Offline and Online Processing Capability:** It is important to note that the system can handle speech processing both online and offline. Online APIs are very accurate, but offline models make sure that the system works even when there is no internet connection. This makes the system more reliable and lets people use it in areas with little or no network [9], [10].
3. **User-Friendly Interface Design :** The proposed system has a simple, interactive user interface that helps users fill out the form step by step. This system is easier to use for older people and people who aren't tech-savvy than earlier systems that required technical knowledge. This makes it more usable overall [7], [8].
4. **Automatic Form Filling and Printing** Automatically, the system fills the selected forms using the inputted voice, which is then printed out instantaneously. This makes manual writing unnecessary and avoids errors, thereby speeding up the process [5], [9].
5. **Hardware and Software Integration**: The system combines both hardware and software technologies in its construction. The hardware includes Raspberry Pi, a display, as well as other

input/output gadgets. The software includes the usage of Python and speech processing [11], [12], [15].

6. **Improved Accessibility and Efficiency :** It makes services easily accessible to those that have visual impairment, older people, and those having language barriers through voice interaction. The system speeds up the whole process by reducing waiting and staff dependency

To overcome the limitations of existing systems, the proposed solution integrates speech recognition, user-friendly interface design, automated form filling, and printing into a single platform. It also supports offline functionality and improves accessibility, making it a practical and efficient solution for modern public service applications.

3. METHODOLOGY

Voice-Guided Smart Form Filling and Printing Terminal

The Voice-Guided Smart Form Filling and Printing Terminal, which will be discussed later in this research, has been suggested to make the form-filling process easy and automated. This system makes the user interface voice-based; hence, a person could use speech-based interaction with this technology. The system constantly captures the user's speech inputs and analyses the speech to retrieve useful information, such as personal information needed to fill out forms. The system is capable of capturing and recognizing the user's speech data and processing it with the help of speech recognition and natural language processing approaches. After gathering the necessary information, the form is filled by the system automatically, and a printed copy is obtained.

a. System Architecture

The proposed system is designed to be integrated to make the form filling process easier for the users. The terminal will be able to receive voice commands from the user and generate forms accordingly. The components that will constitute the form filling terminal are the microcontroller/embedded system (such as Raspberry Pi), a microphone, display unit, and printer module. The microcontroller will be responsible for managing all system operations and handling the user inputted data. The microphone will be used to receive the user's voice command and will convert them into text by means of speech recognition to recognize the required form data. The system also contains software modules that perform natural language processing to analyse user input effectively. The display unit will guide the user throughout the operation process, whereas the printer module will be used to print out the desired filled form.

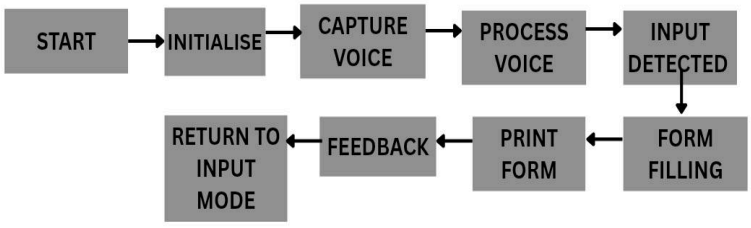

Fig 1: Flow Diagram of the Proposed Voice Guided Smart Form Filling and Printing Terminal

a. Model Training

For better accuracy in the system, we can make use of a lightweight machine learning algorithm that will help us identify and categorize different kinds of voice input related to the form field like name, address, age, and other necessary information through the microphone input. First of all, we need to collect our voice data through our USB microphone that will be plugged into the Raspberry Pi. In case of normal input, we need to collect our data based on users' natural speech while responding to the system prompts. Apart from that, for increasing the reliability of our process, data collection can also include different kinds of accent or speaking speed of the user's voice.

After collecting all the information, it is then classified into various groups including Name Input, Address Input, Numeric Input such as Age and Phone Number, and other Form Fields. The dataset has audio signals and their corresponding text labels. After collecting and categorizing the data, we then divide the data into two; training and testing data. As a prerequisite to training, pre-processing of audio data is done by noise reduction, removing silence, feature extraction through MFCC, and normalization where all inputs should be uniformed without any error arising from signal variations. Lightweight algorithms can be used when training the models, such as Decision Tree, Random Forest, and Support Vector Machine, since they consume relatively little computational resources that suit our Raspberry PI device. At the training stage, learning takes place whereby patterns in the audio inputs are recognized and mapped onto the corresponding texts needed during the completion of forms. Performance evaluation is carried out after training the model through various metrics, including accuracy, precision, recall, and F1 score.

b. Voice Data Acquisition

To start with, the voice input process involves the use of the system's audio input interface to receive voice inputs from the user via the microphone attached to the Raspberry Pi. The microphone captures the voice input from the user at fixed intervals to provide the voice data to be used in form filling. Input serves different purposes in the system. For example, users fill information regarding their names, address, age, and any other information requested by the system verbally. The system continually looks out for the user's input and processes the voice signals received from the microphone. The system constantly checks the voice data input and processes the signals using speech recognition software. The system compares the voice signal input against patterns and translates it into text. If the voice signal received does not meet the set expectations of the system, it prompts the user to input his/her answers again.

Preprocessing is also a stage, and there are several things that are done:

- The collected voice data is processed to remove any unnecessary noise or signals. At times, the microphone may pick up background noise or unclear speech, which is then eliminated for accurate voice detection.
- The audio signals are normalized as part of the preprocessing stage. This involves making sure that the volume of all voice inputs is uniform. It will be easier for the system to process various voice inputs without facing any issues due to different volumes and styles of speech.
- In addition, it is made sure that the data set has a variety of voice inputs to ensure that the model can accurately detect any user response under varying circumstances. These include the normal condition of speech along with variations such as different accents, speech rates, and some background noise.

c. Data Handling and Storage

Handling the user's data correctly is crucial for the system. After the conversion of voice to text, the system analyzes the data and gets the needed information like the person's name, age, and address. All the obtained information is structured and filled into the right form fields. If the data isn't provided correctly by the user, the system prompts him/her to try again. Lastly, the validated data fills the form and prints it out.

d. Input Processing and Validation

The input processing component meticulously evaluates the voice input collected through the microphone and identifies whether the voice input is legitimate and sensible. In particular, it assesses the converted text to determine its legitimacy by comparing it to the appropriate templates and inputs. For instance, when the individual inputs a name, the program assesses whether it conforms to the required pattern. Likewise, numerical inputs such as age and telephone number are scrutinized for their validity. If the input fails to be clear or conform to the required pattern, the program prompts the user to respond again. Anytime the program identifies a legitimate and complete input, it moves on to the next phase.

e. Form Data Preparation

As soon as the system gets the voice input, it swiftly collects all the necessary information like the name of the user, age, address, etc. It then arranges all the data in a systematic order according to the selected form. This is done by mapping the information to its respective fields. The system makes sure that all the information has been placed at the right place and there is no data omission. It also verifies whether all the mandatory fields have been filled out correctly. Maintaining the structure of the data makes it easier for the system to process the information quickly.

f. System Communication and Output

The processed information is processed by the system and is used to produce the output using connected devices. There are no requirements for any communication networks from outside the system since all the actions take place locally on the Raspberry Pi device. Once the processed information is ready, it is automatically transferred to the connected printer via the USB connection. This makes sure that there will be quick and effective output production without the need to use any internet connection. The system is designed in such a way that it can operate effectively even when there is no network connection available at all. Once the process is done, the printer prints the form almost instantly. Also, the user is notified that everything is completed successfully

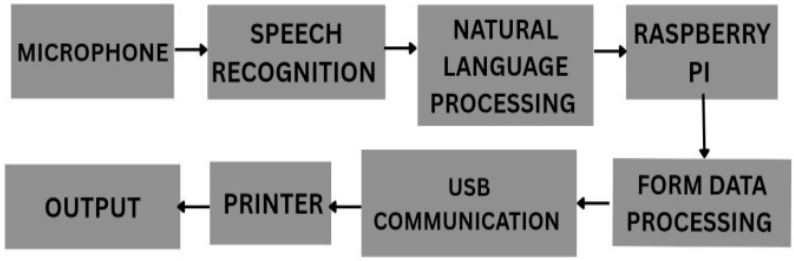

Fig 2: System communication system

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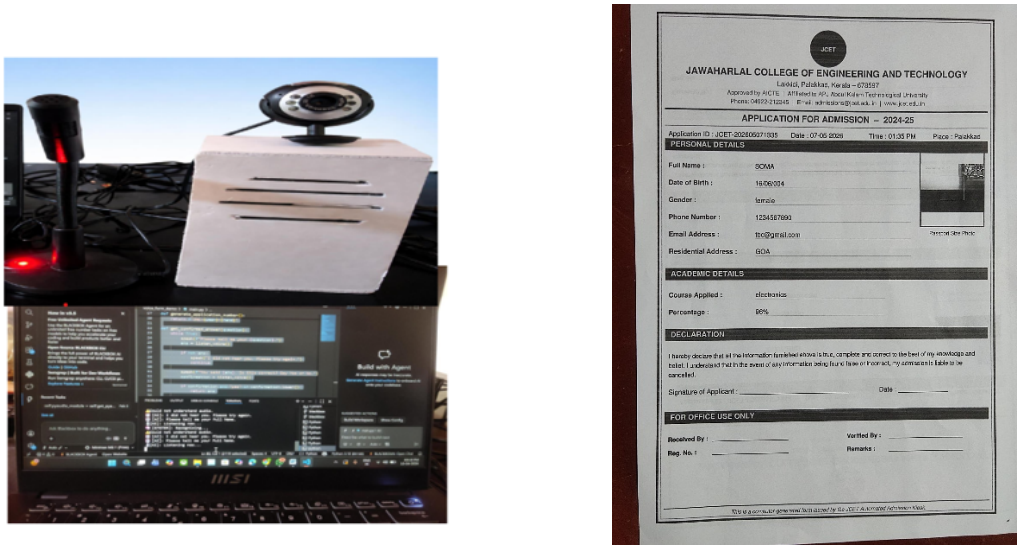
4. RESULTS AND DISCUSSION

The Voice-Guided Smart Form Filling and Printing Terminal, which was developed in our research, uses Raspberry Pi computer along with a USB microphone, speech module, and printer for system operations. Testing was done after finishing the hardware installation and software programming to test the performance of the system under certain conditions like clear speech, presence of background noise, accents, and differences in speed when speaking. The testing procedure focused on the capacity of the system to correctly identify and convert speech to text in order to automatically fill out the forms and print them. The testing procedure indicated that the USB microphone can correctly capture the speech under normal circumstances. Speech recognition module can efficiently translate the speech into texts in forms of name, age, and address with a high degree of accuracy. However, small mistakes have been experienced in the system when translating speech due to certain factors.



(a) (b)

Fig (a) Prototype of the proposed system(b) sample form

After being fed into the system, the transformed text was automatically used to fill out the form by the Raspberry Pi. The system ensured that all the necessary fields have been filled before producing the result. After completing the form, the printer received the request and produced the hardcopy effectively without any lag. The system gave feedback to the user using the built-in speaker and LCD display throughout the process. Overall, the performance of the system was quite impressive in its live operation. It saved efforts from users, decreased the likelihood of making mistakes while filling out the forms, and also increased usability for them.

5. CONCLUSION

In this paper, an innovative proposal of Voice-Guided Smart Form Filling and Printing Terminal has been made as a convenient approach that can help fill out the forms with the help of voice command. With this system, users can simply give the necessary details such as names, age, and address through their voices, which will be converted into text by the system itself and filled up in the form. According to the findings from experiments, the system seems to have performed well with regard to voice detection, data processing, and printing of forms with no significant delay. It works completely independently and doesn't involve any complex manual entry methods for functioning. This system can prove useful in various settings such as governmental agencies,

banks, and public utility agencies. Several improvements may be incorporated into this system in the coming days. First, speech recognition technology could be upgraded in order to handle noisy surroundings and multiple languages. Besides, cloud-based storage could also be added in order to facilitate data backup and recovery. Moreover, the system could be connected with web portals for submitting forms digitally.

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