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Virtual Voice Banking Assistant

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ABSTRACT:

In today's rapidly digitizing world, access to financial services remains a challenge for elderly individuals and those with limited literacy. Traditional banking interfaces often rely on text-heavy menus and manual inputs, which can be intimidating or inaccessible to such users. In an effort to fill this gap, this project presents a voice-operated banking assistant that uses natural language processing and facial recognition technology to provide a user-friendly, secure, and easy banking experience. Secure authentication is facilitated by the use of Python-based face recognition, swapping cumbersome PINs or passwords for a swift facial scan. Backend operations, including transaction processing and data management, are handled efficiently using PHP and MySQL.

Keywords:

Voice Banking, Voice Recognition, Face Authentication, Natural Language Processing (NLP), Speech Interface.

I. INTRODUCTION

Banking institutions are increasingly relying on cutting-edge technology in today's dynamic and fast-paced digital world to enhance user experience, security, and accessibility for a variety of users. However, it has to be noted that most of the population, i.e., elderly citizens who are not very technologically savvy, illiterates who are unable to read and write, and rural residents who could be subjected to limitations in accessing good quality internet services, is confronted with a number of challenges in accessing the benefits of common digital banking screens. To bridge this gap, we propose a Voice-Assisted Banking System that enables seamless, voice-driven banking transactions tailored for these underserved demographics. This system allows users to perform basic banking tasks, such as checking account balances and transferring money via voice commands, in addition to texting. For people who lack the necessary technical knowledge, abilities, or formal education to fully benefit from these new banking technologies, such computer interfaces can require only basic skills like reading, typing, menu selection, and navigation.

Voice technology provides a great and revolutionary chance to increase the inclusivity of banking services to more people. Through the application of advanced natural language processing (NLP) abilities along with very advanced speech recognition technology, customers are able to receive a variety of banking services using easy voice commands in their own native language, including Telugu, Hindi, and English. Voice Banking Assistant is a revolutionary system utilizing these sophisticated technologies to allow customers to carry out simple banking transactions, including

checking account balance, transferring funds between accounts, and checking their transaction history, with just their voice. This facility provides much greater financial inclusion and accessibility for people who would not otherwise be able to access traditional banking environments.

II. RELATED WORK

In recent years, the banking sector has witnessed a significant transformation driven by AI-powered virtual assistance technologies. The creation of a voice-based banking chatbot system that uses natural language processing (NLP) to answer consumer questions like fund transfers and balance checks is one example of this development. By reducing wait times for customer service, it benefits both bank employees and customers [1]. Another study highlights how AI-powered virtual assistants are improving customer engagement by providing 24/7 assistance, immediate query resolution, and a customized experience. While emphasizing the vital significance of user trust, data privacy, and smooth system integration, these assistants efficiently handle routine banking tasks, relieving bank staff of some of their workload [2].

In addition, the difficulties faced by low-literate, low-income users to adopt mobile banking have been investigated, and it has been found that even with high phone penetration, difficult interfaces and text-based systems act as barriers. This research underscores the role of intuitive voice-based interactions and language options in improving accessibility and trust among such users [3]. Another study extends the use of voice technology by suggesting a voice-based ATM interface that makes use of text-to-speech systems and audio guidance. By enabling users to operate the ATM independently but with assistance, this interface enhances security and reduces fraud, and it is particularly beneficial for users who are illiterate or visually impaired [4].

Additionally, a project focusing on accessible voice banking systems combines telephony, Voice XML, and Cold Fusion technologies to allow voice-activated banking functions such as fund transfers and balance inquiries. Designed for older people and rural communities with no access to digital interfaces, the system provides secure login via Customer ID and PIN, extending inclusive financial services to excluded groups [5]. These studies collectively highlight the growing importance of AI, NLP, and voice interaction technologies in reshaping the landscape of inclusive, efficient, and secure banking experiences.

III. PROPOSED SYSTEM

A. Overview of the Proposed System:

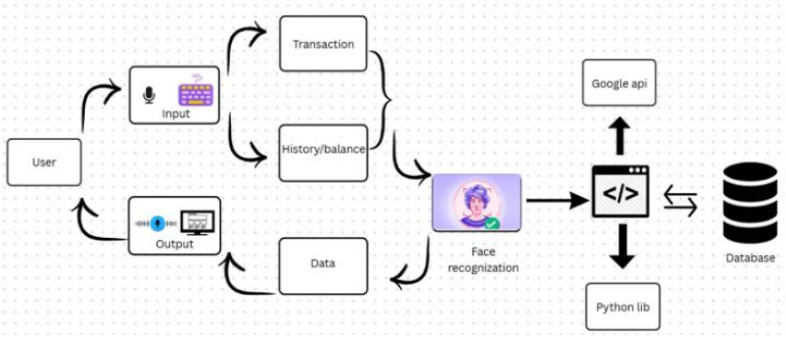
The designed Voice Banking Assistant is intended to bridge the digital bridge by creating a simpler and more intuitive interface to enable the user to manage their bank accounts through voice instructions. The application is designed with multilingual functionality like Telugu, Hindi, and English. By applying technologies such as speech recognition and secure face recognition processes, the assistant is able to carry out typical banking processes safely and effectively.

The two main modules of the assistant are one for end users and another for the backend functions of the bank. The user module translates commands, e.g., providing the name and credentials, into safe operations, and the backend authenticates the identity of the user, processes the request, and returns a voice-based response. This method not only enhances accessibility but also leads to improved user trust and satisfaction, particularly for marginalized groups.

Additionally, the system can be installed as a standalone application or integrated into already-existing mobile banking apps.

B. Overall System Architecture:

Voice commands from users requesting their balance or transaction history are understood by natural language processing. When users ask for information, the system uses facial recognition to authenticate them. After the user has been identified, whatever happens next is handled by backend processing using PHP, MySQL database query/update, and voice response synthesized



and returned.

Fig.1: System Architecture

C. Data Collection Module

This project collects facial information and generates a distinct 128-dimensional face descriptor for each user using Python, OpenCV, and the face recognition library. This descriptor is serialized into a JSON string and securely stored in a MySQL database, linked to the account holder's user ID. In addition to this, name, account number, mobile number, and choice of language as required account holder data, are kept in an independent users table. The users table helps manage banking operations, while the face data table stores biometric information for secure authentication. A fresh face image is taken, encoded, and compared with the stored descriptor during login or transactions in order to confirm identity. Backend processes like data storage and retrieval are done effectively with the help of PHP and MySQL, which provides quick, secure, and user-friendly access to bank services via voice and face recognition.

D. Language Selection Logic

Users can choose between Telugu, Hindi, and English. When a user clicks on a language button, the respective language code is stored in their browser's local storage for later use. For English and Hindi, the browser's text-to-speech functionality provides immediate auditory feedback confirming their selection in the chosen language. Interestingly, for Telugu, an audio pre-recorded message is played. When the user finished the confirmation (or audio play back), the user is automatically redirected to the php.html page. But the most important aspect is that the selected language is added to the URL. This allows a more personalized and localized experience,

since the php.html page can read the user's language selection, and serve or translate the content on the fly.

E. Face Detection Logic

The fronted encompasses a multilingual interface for bank transfers, along with voice inputs and face verification. Upon form submission, JavaScript captures a snapshot of the user's face and sends its descriptor, along with the "from account number," to. This PHP script retrieves from the database the stored face image (as a blob) for the given account and sends to the Python script the base64 encoded version and new descriptor. The Python software script will decode the saved image, retrieve and compute the face descriptor, and then compare the descriptor with the new descriptor using Euclidean distance. It then outputs a JSON response indicating whether the faces match, which the PHP script relays back to the JavaScript to authorize the transfer.

IV.METHODOLOGY

A. Voice Recognition Module
B. Authentication Module
C. Transaction Module

Module Description

Voice-Assisted Banking System has three main modules that offer safe and easy banking services:

A. Voice Recognition Module

This specific module is the core interface that is critical to linking the user to the system. It successfully leverages advanced speech-to-text technology to correctly record and interpret voice commands from the user. The module deftly transforms spoken commands into actionable commands that the system can carry out by employing sophisticated natural language processing (NLP) algorithms. By facilitating interaction without the need for typing or complicated interfaces, this novel approach makes the system extremely accessible and user-friendly, particularly for users in remote areas or even those who are illiterate.

Key Characteristics

- Capturing voice in real-time as it occurs.
- Command recognition and parsing
- Integration with language localization (e.g., Telugu).

B. Authentication Module

The system basically redefines the conventional way of authentication. By the use of face recognition. The new approach not only aims to significantly enhance security controls but also provides users with a more relaxed and convenient-to-use experience. In this revolutionary module, facial scanning systems is incorporated without disruption, playing the dual role of verifying and authenticating the identities of users effectively.

Key Features:

- Biometric verification by face.
- Secure transaction process.
- Protection from unauthorized access
- This module greatly increases the reliability of the system while lowering the strain on users to recall credentials

C. Module for Managing Transactions

Users are given the ability to carry out a number of fundamental banking tasks through the Transaction Module following successful authentication. This specific module executes and performs the backend processes required for vital services like balance inquiry, fund transfer, and a set of other vital banking activities. It continues to listen to commands given by the users, carefully checks the parameters received by it, like the account number, amount mentioned and the account holder to whom the transfer is to be made and then performs the respective operations via secure APIs or scripts that have been developed with the motive of ensuring security and efficiency.

Key Attributes:

- Voice fund transfer
- Account balance
- Transaction History

V. IMPLEMENTATION DETAILS:

A. Language Selection

By allowing users to select their preferred language, the Language Selection improves inclusivity and accessibility.

Upon starting the system or at the beginning of each session, users are prompted to select their language via voice commands such as “English” or “Telugu.” The system recognizes these commands using speech-to-text technology, processes them through natural language processing (NLP), and configures the interface accordingly. For use in subsequent interactions, this preference is subsequently saved in the user's profile within the database. This module guarantees a smooth and customized experience by providing localized responses in the user's chosen language, particularly for users who might not be fluent in more widely used languages.

B. Login or New Registration

The Login or New Registration process manages user account creation and login functions. The database's Users Table safely stores the personal information that new users are asked to provide, such as their name, phone number, and password. The password is encrypted for security purposes. For existing users, the module allows them to log in by entering their name and password. The system retrieves the user's details from the database, verifies the entered credentials, and grants access if the login details are correct. In this module, the authentication process is based on the credentials (name, phone number, and password).

C. Transaction

The transaction, an essential piece of the system, serves to provide the user a means for completing various banking tasks, such as checking their balance, transferring funds, and

checking their transaction history. After successful authentication, users can issue voice commands like “Transfer”. The system recognizes these commands through the Voice Recognition, extracts the necessary parameters, and validates them, such as verifying account numbers and ensuring sufficient funds. Secure API calls or database queries process these transactions, and the system provides real-time feedback, either confirming a transfer or displaying balance details. The module gives users prompt answers to their banking needs while guaranteeing that every operation is safe and effective.

D. Face Authentication

By enabling users to verify their identities through facial recognition, Face Authentication strengthens the security of the banking system. The system captures the user’s face through a camera and uses OpenCV and face recognition libraries to process and compare the captured image against stored facial data in the database. The user is given access if the face encoding matches previously stored data. This method eliminates the need for traditional PINs or passwords, offering a more secure and seamless login experience while protecting against unauthorized access.

E. Balance Inquiry and Transaction History

With voice commands, users can quickly access their current account balance and transaction history through the Balance and Transaction History feature. After logging in, the user only needs to provide their "account number" to request their balance and transaction history. The system verbally responds with the current balance amount after retrieving it from the MySQL database. Additionally, users can inquire about their transaction history, and the system provides a spoken summary of recent transactions, including details such as amounts and dates, directly from the Transactions Table in the database. Users can easily stay informed about their financial situation and previous activities thanks to this module.

VI. ALGORITHM:

A. FACE AUTHENTICATION

STEP 1: Read the base64-encoded image (stored_image_b64).
STEP 2: Read the new face descriptor (new descriptor).
STEP 3: Decode stored_image_b64 into raw image bytes (stored bytes).
STEP 4: Convert stored bytes into an OpenCV image (image).
STEP 5: Use a face recognition model to extract the face encoding (stored descriptor) from image.
STEP 6: If no face encoding is found in the image:
    Return JSON: {"match": false}
    End process
STEP 7: Calculate the Euclidean distance between stored descriptor and new descriptor.
STEP 8: Compare the distance:
    If distance < 0.6 → match = true
        Else → match = false
STEP9: Return result as JSON: {"match": true} or {"match": false}
STEP10: End

B. VOICE RECOGNITION

STEP 1: Activate the microphone and start recording the user's speech input.
STEP 2: Apply noise reduction to improve clarity of the captured audio.
STEP 3: Use a Speech-to-Text (STT) engine (e.g., Google Speech API or Vosk) to convert the recorded audio into text (transcribed text).
STEP 4: Preprocess transcribed text by converting to lowercase and removing unwanted punctuation
or filler words.
STEP 5: Identify the user's intent by using rule-based keyword matching (e.g., "balance", "transfer",
"statement").
STEP 6: Extract required details (like amount, recipient name) using string operations or regular expressions.
STEP 7: If intent or required details are missing:
Return JSON: {"success": false, "reason": "Invalid or incomplete command"}
End process
STEP 8: Perform the matched banking operation and generate a voice response using a Text-to-Speech (TTS) engine.
Return JSON: {"success": true, "response": "Transferred amount ₹500 successful! "}
STEP 9: End

VII. RESULTS AND ANALYSIS:

A. Multilingual Support:

It clearly indicates support for multiple languages, specifically English, Hindi, and Telugu, with a "Select a Language" screen. This aligns with BBVA's bilingual approach and addresses the diverse linguistic landscape of regions like India, where SBI's YONO also offers multilingual support. Offering multiple language options enhances user inclusivity.

B. Voice-Based Interaction:

This showcases a microphone icon and waveforms, suggesting voice input and output functionalities. The "Speak Transfer Command" button in Image 3 further emphasizes voice-driven transactions. This is a core feature of the mentioned existing projects, allowing users to perform banking tasks hands-free.

C. Account Login:

It displays a login screen with fields for "User ID" and "Password" written in Telugu ("ఖాతాదారుని పేరు" and "పాస్‌వర్డ్"). While voice login isn't explicitly shown, the overall theme suggests that voice could potentially be integrated for authentication in the future, similar to some advanced voice assistants.

D. Multilingual Bank Transfer:

This makes it obvious that the interface is called "Multilingual Bank Transfer." The "Speak Transfer Command" button, a face verification prompt, and fields for account numbers and an amount ("Verifying your face...") are displayed. This indicates a multimodal approach, combining traditional input with voice commands and biometric security, potentially making online money transfers more accessible and secure. Face verification, which is increasingly common in modern banking apps, adds an extra degree of security.

E. Account Summary and Recent Transactions:

It presents an "Account Summary" with a balance displayed in Indian Rupees (₹). It also shows a list of "Recent Transactions" with details like ID, From Account, To Account, Amount (all ₹1.00 in this example), and Timestamp. While voice interaction isn't directly visible here, a voice command like "Show my recent transactions" or "What is my balance?" could be a natural extension of the voice interface. Similar voice-based account information retrieval features are provided by U.S. Bank's Smart Assistant and SBI's YONO.

- SBI's YONO: Similar in its focus on the Indian market and offering multilingual support, YONO also integrates various banking services into a single app with voice assistance for basic tasks. Although it stresses voice as the main interaction method for transfers, this concept seems to be in line with that objective.

- Voice-activated bill payment and account management are the main goals of U.S. Bank's Smart Assistant project. By adding multilingual support and a multimodal strategy with face verification for transfers, this idea builds upon that.

- BBVA's Bilingual Assistant: The clear emphasis on multiple languages in this concept directly mirrors BBVA's approach to cater to a diverse user base.

- Tencent's We bank: While this concept doesn't explicitly show platform integration, the focus on user-friendliness and accessibility hints at a potential for integration within popular apps or as a standalone user-friendly application.

Potential Benefits:

- Enhanced Accessibility: Voice commands can significantly benefit users who have difficulty with typing or navigating traditional interfaces. Multilingual support further broadens accessibility.

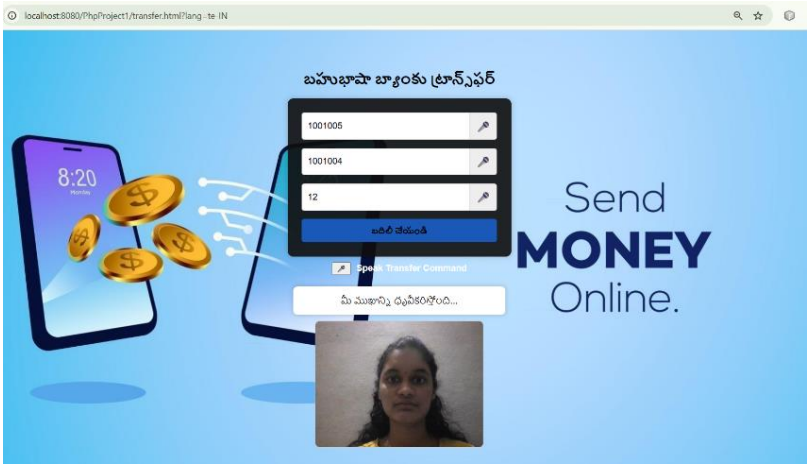
- Increased Convenience: Performing banking tasks through voice commands can be faster and more convenient for many users.

Improved Security: The integration of face verification adds a strong layer of security to transactions initiated through voice.

User-Friendly Interface: The visual design appears clean and intuitive, complementing the ease of voice interaction.

Fig.2: Language Selection

The outcomes A multilingual voice interface with selectable languages is shown in Fig. 2, suggesting modular localization for text and possibly speech processing. Waveform displays suggest audio playback and input/recording capabilities, supported by a microphone icon. The system likely uses speech-to-text engines and NLP tailored for English, Hindi, Telugu.



and

Fig.3: Transaction

Figure 3's live camera feed, which displays a person's face with the caption, "Verifying your face...", strongly suggests the use of face descriptors for biometric authentication. Most likely, a pre-enrolled face descriptor template stored in the system is compared to a numerical face descriptor that is extracted in real time from the captured image. User verification and transaction authorization would follow successful matching above a predetermined similarity threshold. This technology necessitates complex computer vision algorithms for accurate and efficient face descriptor generation and comparison, alongside robust security measures for protecting the sensitive stored facial data.

Fig.4: Balance and Transaction history

The user can view their current account balance of ₹44786.75 and has the option to use "Speak Again" or "Speak Account Number" functionalities. A list of recent transactions is shown below this (Fig. 4). It includes information like a unique ID for each transaction, the sender's account number, name, and bank name in the "From" column, the recipient's account number, name, and bank name in the "To" column, the transaction amount (₹1.00 for all listed transactions), and the timestamp that corresponds to each transaction's date and time.

VIII. DISCUSSION:

A. Speech Recognition Accuracy

The technical functionality of the multilingual voice interface in Image 1 heavily relies on the accuracy of its Speech Recognition engine for English, Hindi, and Telugu. To ensure a positive user experience, high accuracy must be achieved. For each supported language, this calls for complex acoustic models that have been painstakingly trained on large and varied audio datasets. These models must take into account accents, speaking styles, subtleties in pronunciation, and potential background noise that might be present in real-world usage scenarios. The system's capacity to comprehend user intent and carry out commands accurately is directly impacted by how accurately it transcribes spoken words.

B. Response Time

Response time is one of the most crucial performance indicators for this voice-activated application. Users expect a minimal lag time between completing a command and the system initiating the relevant action or providing feedback. Several technical factors influence this delay. The complexity of the speech processing pipeline, which includes acoustic modelling, language modelling, and semantic interpretation, contributes to the overall response time. Network latency becomes an important consideration if the speech processing is done on distant servers (cloud-based).

C. Potential Challenges and Limitations

The primary obstacles hindering the development of this multilingual voice interface revolve around achieving high speech recognition accuracy across Telugu, Hindi, and English, especially with respect to different accents and noisy environment. A scalable backend infrastructure is necessary to handle increasing user loads, and ensuring that users have a responsive experience with fast response times is another significant challenge. Furthermore, it takes careful thought and strong implementation to address the crucial security and privacy issues associated with handling sensitive voice data, such as safeguarding against illegal access and adhering to data privacy laws.

IX. CONCLUSION

In summary, the Virtual Voice Banking Assistant has been effective as a helpful means of connecting the illiterate segment and contemporary banking services. It offers a secure and simple user interface where individuals can perform basic banking transactions without reading or writing. The project has effectively tackled a massive problem in financial inclusion by using voice technology. Future advances in artificial intelligence and machine learning can help improve the system and extend its reach, making banking services accessible to even more people in poor communities. According to the research, it could have a big impact on industries like banking, where accessibility and security are the main concerns.

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