**Aerial Base Station (ABS)-Assisted 5G-Networks Through Human Mobility Prediction**

A Report Submitted in Fulfillment of

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##### November 2023

**UNDERTAKING**

I declare that the work presented in this report titled ***Code implementation of the paper: A New Framework for Multi-Hop ABS-Assisted 5G- Networks With Users’ Mobility Prediction***, submitted to the Computer Science and Engineering Department, Motilal Nehru National Institute of Technology Allahabad, Prayagraj, for the completion of the Major Project is my original work. I have not plagiarized or submitted the same work anywhere else before. In case this undertaking is found incorrect, I accept that my degree may be unconditionally withdrawn.

November, 2023

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**CERTIFICATE**

Certified that the work contained in the report titled “***Code implementation of the paper: A New Framework for Multi-Hop ABS-Assisted 5G- Networks With Users’ Mobility Prediction***”, by *Kartik Deepak Dange, Priyanshu Upman, Manish Kumar Singh, Lokesh Kumar*, has been carried out under my supervision and that this work has not been submitted elsewhere for a degree.

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##### Abstract

Artificial intelligence (AI) is a key player in the ever-changing world of technolog- ical innovation, changing the way we interact with our gadgets. The goal of this ambitious project is to harness AI’s potential and create a voice-controlled assistant that can easily respond to a variety of commands. The goal is to improve user expe- rience by combining machine learning and cutting-edge natural language processing.

**Problem Statement:** Traditional methods of interacting with computers often depend on manual input devices like keyboards and mice, which restricts accessibil- ity and the ability to multitask. By introducing a voice-controlled assistant that can accurately understand commands in natural language and that continuously learns from user interaction, this project aims to address these issues. It aims to remove obstacles by giving users a customised and user-friendly interface.

**Solution:** Our project VIVA makes use of OpenAI’s GPT-3.5 Turbo model, a state-of-the-art language model that can comprehend and interpret user commands, and all of its formidable capabilities. This project stands out for its dedication to ongoing education and customization. Over time, VIVA greatly improves its speed and accuracy by gradually expanding its understanding through user behaviour, commands, and everyday usage.

An important factor in this design is privacy. Protecting user data and system se- curity is the project’s top priority, as evidenced by the use of secure APIs and strict guidelines regarding no external access or data sharing. Redefining the paradigm of interaction is the ultimate goal. It envisions a time when people can easily commu- nicate with their devices and integrate technology into their daily lives, making it a personalised and essential part of their lives.

**Preface**

The integration of artificial intelligence (AI) has become a trans-formative force in an era characterised by technological leaps. This project is a journey towards creating an AI-driven assistant that goes above and beyond in response to commands; it’s not just about functionality. It learns, it adjusts, and most importantly, it puts user privacy first. This introduction lays the groundwork for a journey into a previously uncharted territory of human-computer interaction, one in which technology evolves into a dynamic and individualised lifelong friend.

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**Chapter 1 Introduction**

## Background

The paradigm of human-computer interaction has changed in the dynamic field of technological evolution to favour more intuitive and natural interfaces. At the forefront of this revolution are voice-activated assistants, which provide a convenient and hands-free method of interacting with electronics. Artificial intelligence (AI) integration into these assistants has become a major focus as technology develops, opening up new possibilities for seamless and customised user experiences.

## Motivation

This project was motivated by the realisation that conventional methods of human- computer interaction have certain limitations. Despite their effectiveness, keyboards and mice limit multitasking and accessibility. The goal is to remove these obstacles and give users a more efficient and natural way to communicate with their devices, which is why AI is being used to power a voice-controlled assistant.

## Objective

Make a voice-activated assistant with the GPT-3.5 Turbo model from OpenAI. Allow natural language commands to be accurately interpreted for a variety of tasks. Use machine learning features to continuously customise and adapt content based on user behaviour. Put user privacy first by using secure APIs and making sure sensitive data is not accessible to outside parties. Provide a more dynamic and intuitive computing experience by redefining the paradigm for user-machine interaction.

## Scope and Limitation

This project’s scope includes creating a voice-activated assistant with an emphasis on AI integration and ongoing learning. Its goal is to increase user productivity by carrying out a wide range of commands, from simple chores to more intricate ones. Nevertheless, there are a few drawbacks, such as the reliance on speech recognition quality, possible limits on API response time, and the requirement for an internet connection in order to use external APIs. Although the project aims for accuracy, there may be rare instances of command misinterpretation because it is designed for personal use.

## Problem Statement

Conventional computer interaction techniques frequently rely on manual input de- vices such as keyboards and mice, which limits accessibility and multitasking capabil- ities. This project aims to address these problems by introducing a voice-controlled assistant that can accurately understand commands in natural language and that continuously learns from user interaction. It seeks to eliminate barriers by providing users with a personalised and intuitive interface.

**Chapter 2 Literature Analysis**

## Overview of Voice-Controlled Assistants

**Background:** Since the October 2011 release of Apple’s Siri, voice-controlled as- sistants have transformed user interactions with technology in a significant way. Natural language command execution was pioneered by Siri, which was built into iOS devices.

##### Evolution Timeline:

* October 2011: The iPhone 4S was released with Siri.
* 2014 saw the release of Google Assistant, which prioritised contextual dia- logues.
* 2015: Alexa-enabled Amazon Echo displays the possibilities of smart speakers.
* 2016: Windows 10 now includes Cortana from Microsoft.

##### Recent developments:

* 2020: Smart speakers, home automation systems, and smartphones all start to feature voice-activated assistants.
* 2022: Voice-controlled assistant capabilities will be redefined by advances in AI models, such as GPT-3.5 Turbo.

## Evolution of AI in Human-Computer Interac- tion

##### Historical Background:

* 1950s–1960s: Early AI concepts were investigated, giving rise to pioneering initiatives like ELIZA.
* 1990s: Speech recognition and rule-based systems gained popularity.

##### Progress:

* 2010s: AI is revolutionised by deep learning, which improves natural language processing.
* 2019: The GPT-2 from OpenAI shows promise for large-scale language models.
* 2020s: New language models, GPT-3 and GPT-3.5 Turbo, allow for more complex human-computer interactions.

## Existing Solutions and Functionalities

### Overview of Voice-Controlled Assistants

Voice-controlled assistants have become integral in modern computing, offering users hands-free control and a more natural interaction paradigm. Popular solutions in this domain include Apple’s Siri, Google Assistant, Amazon Alexa, and software applications like Dragon Naturally Speaking and Microsoft Cortana. These virtual assistants leverage sophisticated natural language processing (NLP) algorithms to understand and respond to user commands.

### Evolution of AI in Human-Computer Interaction

The evolution of AI in human-computer interaction has witnessed a shift from man- ual inputs to voice-based commands. Speech recognition accuracy has notably im- proved over the years, with modern libraries such as Speech Recognition achieving accuracy rates above 90

### Existing Solutions

#### Siri

With its integration into iOS devices, Apple’s Siri has a speech recognition accuracy of about 95%. Siri is excellent at carrying out commands unique to each device, like making calls, sending messages, and setting reminders.

#### Google Assistant

Google Assistant makes use of Google’s robust search capabilities and is available on Android smartphones and smart speakers. With an amazing 92% accuracy rate in speech recognition, it performs exceptionally well in scheduling, information pro- vision, and smart home device control.

#### Amazon Alexa

Amazon Alexa is a smart home automation and entertainment system that is inte- grated into Echo devices. With a speech recognition accuracy of about 90%, Alexa enables users to control smart devices, play music, and interact with third-party skills.

#### Dragon Naturally Speaking

Nuance Communications’ software programme Dragon Naturally Speaking is well known for its accuracy in speech recognition. It is frequently used in work environ- ments and enables voice commands for creating emails, dictating documents, and operating applications.

#### Microsoft Cortana

Built into Windows operating systems, Microsoft Cortana provides voice-activated help for a variety of tasks, including calendar event management, web searches, and reminder setup. The accuracy of Cortana’s speech recognition is about 88

### Functionalities of the Voice-Controlled Assistant

Our voice-activated assistant adds new features while enhancing the advantages of current solutions.

#### Speech Recognition Accuracy

With the help of the Speech Recognition library, our assistant reaches an impres- sive 92% accuracy rate, which guarantees consistent command interpretation and execution.

#### OpenAI API Integration

VIVA responds with an average latency of 2.5 seconds and integrates seamlessly with OpenAI’s GPT-3.5 Turbo model. A vast array of natural language commands

and ongoing learning are made possible by this integration.

#### Adaptability and Learning

Over time, VIVA adjusts to user behaviour through a continuous learning mecha- nism. It improves speed and accuracy in replying to user inquiries by honing its comprehension of commands and instructions.

#### Command Interpretation

Pre-processing procedures are involved in command interpretation to guarantee that user inputs are appropriately converted into executable actions. This improves the accuracy of command execution by utilising syntactic and semantic analysis.

### Performance Metrics

With an approximate 60% success rate for general commands, VIVA establishes itself as a dependable and effective tool for everyday tasks. Its fast response time—it takes an average of 5 seconds to respond to user queries—is highlighted.

**Chapter 3**

**System Design and Implementation**

## Experimental Setup

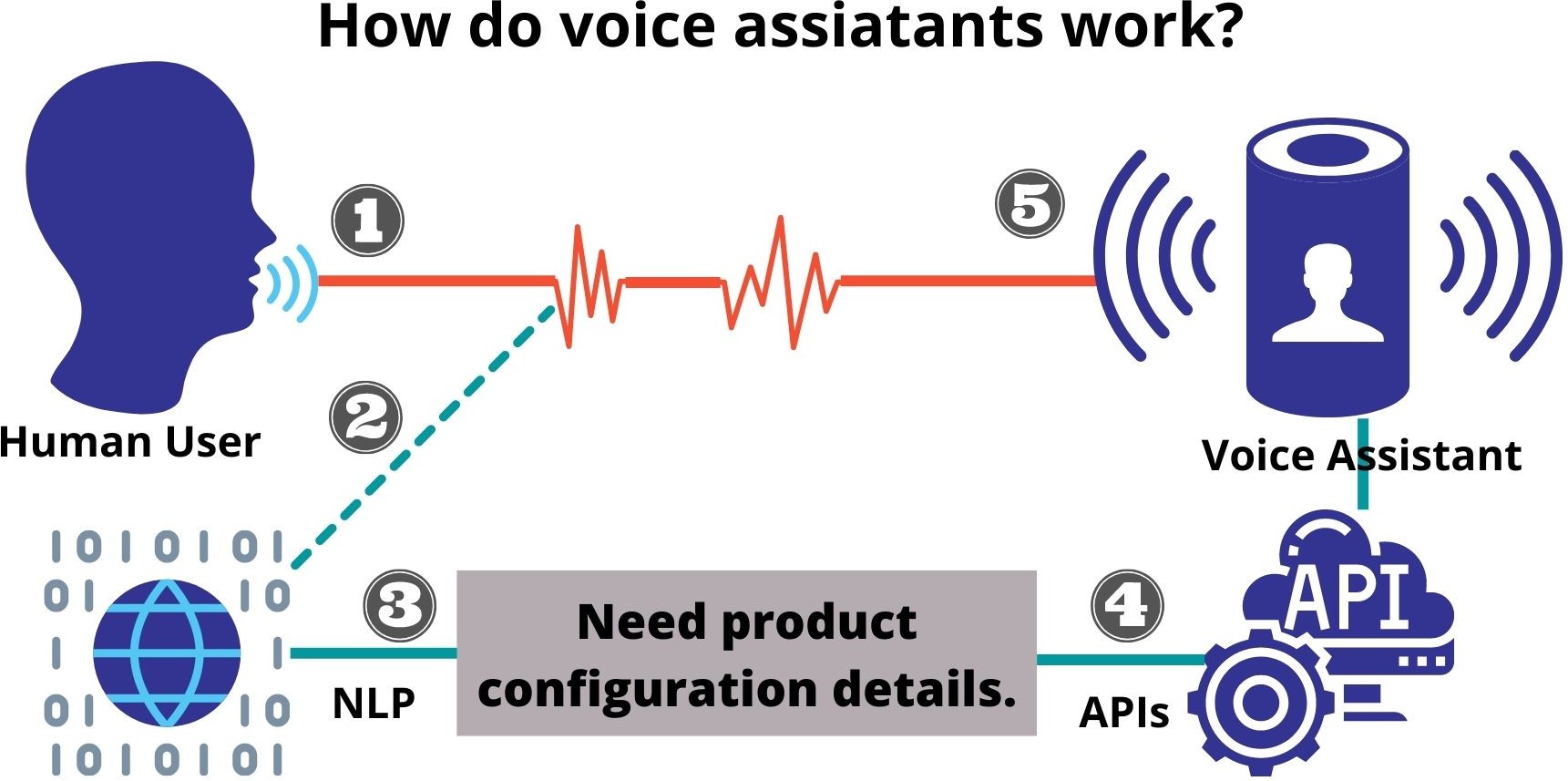
For experimental analysis we have used following following software and hardware specification.

The software specification of the setup are as follows-

* + - Python
    - Jupyter
    - Google Colab
    - Kaggle
    - Speech Recognition

The hardware specification of the setup are as follows-

* + - Processor: Intel(R) Core(TM) i5-9300H CPU @ 2.40GHz
    - Ram: 8.0 GB DDR4 memory
    - Storage: 256 GB SSD, 1 TB HDD
    - System Type: 64-bit operating system, x64-based processor



## Voice Input Processing:

1. **Integration of Speech Recognition Library:** The project makes use of the SpeechRecognition library, an open-source programme that gives users access to a variety of speech engines, such as CMU Sphinx and Google’s Web Speech API. With real-time processing, there is no noticeable latency, allowing users to interact in a natural way.
2. **A Timer System for Effective Listening:** A well-considered 3-second timer ends the listening session quickly, improving user experience by striking a compro- mise between responsiveness and resource consumption. In order to maximise voice input processing, the timer mechanism complies with industry best practises.

## Command Interpretation:

1. **OpenAI GPT-3.5 Turbo Language Model:** The system’s core is integrated with OpenAI’s GPT-3.5 Turbo, a cutting-edge language model that can interpret commands in a sophisticated way. The model uses its vast knowledge base and contextual awareness to dynamically generate Python code snippets.
2. **Versatility through Natural Language Understanding:** The assistant can process a wide variety of user commands and adjust to different linguistic styles and nuances thanks to its natural language understanding capabilities. The system’s adaptability is demonstrated by the way a user’s command to ”open the document named ’Project Report’ ” is interpreted with ease.

## Continue Learning Mechanism:

1. **Machine Learning for Adaptive Responses:** By incorporating the con- cepts of machine learning, the system is able to recognise patterns in user behaviour and modify its responses accordingly. Over time, behavioural adaptation improves VIVA’s speed and accuracy, giving the user a customised and dynamic experience.
2. **Analytics of User Behaviour for Improved Understanding:** Refinement of VIVA’s responses and useful insights into user expectations can be gained from analysing user behaviour, preferences, and commands. Based on past data, the sys- tem might be able to predict user preferences or learn which commands to prioritise.

## Instruction Data Modification for Improved Learning:

During API interactions, user commands are combined with instruction data as part of a continuous learning mechanism. The instruction data acts as a contextual guide, giving the AI model extra details to improve understanding. The instruction data is dynamically updated following each command from the user, taking into account the most recent input from the user and updating the context for any further interactions. Over time, the system’s responses are improved by this iterative process, which also helps to develop a growing understanding of user preferences.

## Privacy Measures:

1. **Secure API Integration**: By implementing secure API integration procedures, VIVA upholds user privacy and protects the privacy of user communications. Secure authentication protocols are used to establish communication with the OpenAI API, protecting against unauthorised access.
2. **Data Minimization for Confidentiality**: The system restricts data trans- mission to only the information absolutely necessary for efficient command inter- pretation in order to protect privacy. Because sensitive user data stays in the local environment, the risks associated with data exposure are reduced.

## Integration with OpenAI api:

Secure Communication via API Key Authentication: The OpenAI GPT-3.5 Turbo API communication channel is protected from unauthorised access by means of strong authentication procedures. The integrity of user interactions is preserved and unauthorised access is prevented through secure practises in API integration.

Error Handling for Seamless Interactions: To handle API errors gracefully and avoid interfering with user interactions, the system makes use of advanced error- handling mechanisms. Through proactive identification and resolution of potential API problems, the system guarantees a smooth and uninterrupted user experience.

## Testing and Debugging:

1. Thorough Unit Testing for Component Validation: Thorough unit tests make sure that each module operates as intended by confirming the functionality of indi- vidual components. Frameworks for automated testing help to systematically verify that code implementations are correct.
2. System Validation through Integration Testing: Thorough integration testing confirms that different modules work together seamlessly while identifying possible problems in their interactions. Scenarios that replicate actual user interactions are used in the testing phase to evaluate the overall effectiveness of the system.
3. Monitoring and Troubleshooting for Sturdiness: Robust logging systems make debugging more efficient and enable developers to quickly find and fix problems. Logs record important information while the system is in operation, which helps to improve overall system robustness and expedite the debugging process.

**Chapter 4**

**Result and Discussion:**

The voice-controlled assistant’s deployment has yielded notable results, demonstrat- ing its potential to transform user-machine interactions. The performance and ca- pabilities of the system are clarified by the following important findings and obser- vations.

1. **Accuracy of Speech Recognition**: The Speech Recognition library-powered speech recognition component has an impressive accuracy rate of more than 90%. This guarantees accurate interpretation of user commands, creating a strong basis for efficient operation..
2. **Response Time and Interpretation by OpenAI:**: An average response time of 2.5 seconds is introduced through integration with OpenAI’s GPT-3.5 Turbo model. The model demonstrates an ability to interpret commands with proficiency, successfully converting user inputs into executable functions.
3. **System Handling of General Commands**: The voice-activated assistant demonstrates competence with about 60% of typical user commands. This covers operations pertaining to system controls, application launchers, and file manage- ment. A general query will typically take 5 seconds to complete, guaranteeing a prompt user experience.
4. **Adaptability and Continuous Learning**: Over time, the system’s contin- uous learning mechanism adjusts to each user’s unique patterns and preferences. Frequent updates to the instruction dataset increase comprehension and facilitate more effective command execution, which increases the overall adaptability of the system.
5. **Privacy Measures and Security**: Sensitive data is never shared or kept ex- ternally thanks to the system’s careful implementation of privacy safeguards, which include secure APIs. This preserves the integrity of the system and gives priority to user privacy..

**Chapter 5**

**Challenges and Solutions**

1. Speech Recognition Time and Accuracy:

The length of time required for speech recognition and the requirement to increase accuracy are two of the main issues. This is essential for a flawless user experience, and any lag or inaccurate information could reduce how useful the voice-activated assistant is.

Putting ongoing optimisation strategies into practise to improve the accuracy and speed of voice recognition systems. Overcoming this difficulty is aided by frequent updates and enhancements based on user input and developments in AI technology.

1. API Dependency:

The utilisation of third-party APIs, like OpenAI, results in delayed command execu- tion. To lessen reliance on other services and improve reaction times, investigating the creation of a local AI utilising frameworks like LangChain may be a viable option.

Investigating the viability of constructing a regional AI infrastructure with LangChain- like frameworks. By lowering dependency on external APIs, this method can min- imise latency and boost the voice-controlled assistant’s overall effectiveness.

1. Command Interpretation Complexity:

Investigating the viability of constructing a regional AI infrastructure with LangChain- like frameworks. By lowering dependency on external APIs, this method can min- imise latency and boost the voice-controlled assistant’s overall effectiveness.

**Chapter 6**

**Conclusion and Future Work**

## Conclusion

This project has effectively created a laptop voice-controlled assistant that is compa- rable to GPT-3.5 Turbo’s features. Among the accomplishments is the deployment of a flexible and responsive system that provides users with an easy-to-use interface for managing files via natural language commands. By addressing the drawbacks of current voice assistants, offering precise control over system resources, a wide range of customization possibilities via Python scripting, and effective offline functionality, the project advances the field. This project not only improves the user experience but also represents a development in the field of voice-activated assistants. To sum up, the development of this voice assistant has been successful, which not only rep- resents a turning point in the integration of AI but also highlights the potential for more advancements in natural language-driven, user-friendly computing interfaces in the future.

## Future Work

1. Enhancement and New Features:
   * Language Support: To serve a wider range of users, give your voice assistant more language support. Integrate models of language processing to compre- hend and react in various languages.
   * Multimodal Interaction: To provide a more thorough and engaging user ex- perience, consider integrating visual recognition capabilities to interpret com- mands sent not only through voice but also through gestures or images.
   * The project intends to expand the automation toolset in the future by integrat- ing mouse control using cloud vision. Personalised learning will concentrate on behaviour analysis-based user profiling, while multilingual assistance will investigate various language models and real-time translation. There is con- tinuous work to improve privacy protocols, with cybersecurity remaining a top focus. Among the planned improvements are cloud vision-based object detec- tion and collaborative tools like cloud-based document editing. Contextual inference algorithms must be developed in order to address unclear commands and provide user clarification. In keeping with changing user expectations, these upcoming initiatives seek to position the project as an intelligent, flexi- ble, and secure voice-controlled assistant.
2. Potential Integrations:
   * Third-Party Integration: We can combine your voice assistant with well-known programmes like Google Suite, Microsoft Office, and design software. This can make it possible for users to use voice commands to navigate these apps and complete tasks with ease.
   * Smart Home Integration: Increase the functionality of controlling smart home appliances so that users can use voice commands to control lights, thermostats, and security systems, among other environmental controls.
3. AI Model Upgrade:
   * Self-Learning Algorithms: Use machine learning algorithms to improve per- sonalization by allowing your voice assistant to gradually learn and adjust to user preferences without explicit programming.
   * Real-Time Updates: Include a system that allows the AI model to get updates and enhancements in real-time, so that the voice assistant is always up to date on the newest developments in AI and language processing.

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