Reviewing the Technological Horizon: An analysis of the Evolution and advancing capabilities of Virtual Assistants

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***Abstract*—This review article fully covers the creation and integration of JARVIS, a personalized voice assistant that incorporates gTTS, AIML, and Python technologies. The joint efforts result in a powerful and adaptable voice assistant with dynamic capabilities inspired by the Marvel World. The study expands on the function of virtual assistants in Industry 4.0, classifying applications as Physical Assistance or Virtual Assistance. Services provided, such as interaction with legacy systems and information handling, are described with restrictions such as information security problems. The report continues by emphasizing the lack of standardized nomenclature for virtual assistants and suggesting future research areas, including an investigation of developing AI models and services, including Industry 5.0 ideas.**

***Index Terms*—AIML, JARVIS, Virtual Assistants, Industry 4.0, Technical Assistance.**

I. Introduction

Virtual assistants have grown into sophisticated beings capable of managing varied jobs in today's digitized world, where voice searches outnumber text inquiries and mobile devices dominate web interactions. Another author introduces groundbreaking technology ushers in an intelligently conversational interface inspired by Marvel Studios' JARVIS figure. Based on Tony Stark's all-encompassing aid, this system incorporates Google's Artificial Intelligence, which has been developed and enhanced by a global community of engineers. Python serves as the system's backbone, acting not just as the primary interpreter but also as the fundamental Text-to-Speech engine for JARVIS [1]. This project highlights the confluence between cutting-edge AI and collaborative development, seeking to reinvent humancomputer interaction and mirror the revolutionary possibilities exemplified by JARVIS. Here we survey a paper where they offer a Python-based desktop virtual assistant that uses Natural Language Processing (NLP) methods to recognize human behavior [2]. This system, which focuses on recognizing spoken phrases using Automatic Speech Recognition (ASR), provides smooth user engagement, overcoming the issue of distinguishing speech from background noise. The research investigates how this speech recognition system can improve user productivity by handling common chores and reacting to orders via voice or text. Use the enter key to start a new paragraph. The appropriate spacing and indent are automatically applied. Then we look into the important Technical Assistance Design Principle, emphasizing both Physical and Virtual Assistance, in the context of Industry 4.0, which is defined by the integration of Information and Communication Technologies (ICT). Because there is no commonly agreed definition of "Industry 4.0," the research uses the 4.0 Design Principles as a methodical framework as shown in Figure 1. Virtual Assistance develops as a critical component, enabling quick information delivery via chatbots or Virtual Assistants (VAs).

The study emphasizes the growing significance of virtual assistants (VAs) in 4.0 contexts, with benefits like as real-time reaction and broad knowledge capabilities. Chatbots are key instances of intelligent Human-Computer Interaction

(HCI). Artificial Intelligence (AI) is becoming an intrinsic part of daily life through the creation of intelligent agents. Chatbots are computer programs that use Natural Language Processing (NLP) to reply intelligently to text or voice interactions. Aside from entertainment, they have applications in education, information retrieval, business, and e-commerce, and are gaining popularity because to benefits such as platform independence, seamless integration into users' social graphs, and dependable communication. Here we discusses the history, difficulties, and concepts surrounding chatbots, as well as a taxonomy of current chatbots, insights into their design, and the top development platforms [3]. Finally, the study emphasizes the need of continued research possibilities in this dynamic sector. Last, we explores at the ongoing use of personal voice assistants such as Amazon Alexa and Google Assistant, straying from standard methodologies by utilizing a user engagement-based method. The study focuses on late adopters, taking into account aspects such as slowness of adoption and skepticism, as well as utilitarian and hedonic attitudes, as well as contextual elements such as trust, privacy risk, and contentment. The study contributes to theory by elucidating how these factors impact continuing intention using data from 244 late adopters [4]. With the exception of the privacy issue, all submitted hypotheses are supported, and the findings provide useful insights for both theoretical understanding and practical applications in the expanding environment of personal voice-assistants.

A. *Purpose of the Survey*

This survey's goal is to provide a virtual assistant by comprehending the methods, tactics, and uses of virtual assistants that have been documented in numerous published works by numerous authors.
Virtual assistant surveys can be used to gather user insights, assess market trends, evaluate effectiveness, identify pain points, prioritize features, measure ROI, gather competitive intelligence, and guide future directions. Developers can tailor virtual assistants to user requirements and maximize their impact by understanding user needs, preferences, and expectations.

B. *Motivation*

A virtual assistant is a multifunctional digital assistant that is intended to improve and simplify different facets of daily life. Virtual assistants provide a wide range of services, from personal schedule management and communication tasks to real-time information retrieval and entertainment recommendations. They are indispensable for enhancing both personal and professional productivity because they are excellent at streamlining difficult tasks like editing documents, setting up meetings, and even managing smart home appliances. Virtual assistants have become essential tools that use artificial intelligence to enhance and optimize how people manage their routines and responsibilities. They can help with learning new skills, support health and fitness goals, and give quick access to information. In recent years, voice-assistants have become highly sought-after items in the IT business. Advances in Artificial Intelligence (AI), Machine Learning (ML), and NaturalLanguage Processing (NLP) have enabled modern voiceassistants such as Amazon Alexa, Apple Siri, Google Assistant, Microsoft Cortana, and Samsung Bixby to mimic human-like thinking and the intelligence of human conversations. Their allure arises from their ability to encourage natural and intuitive human-machine interactions, which are analogous to interpersonal conversations. From 11.9 billion US dollars in 2019, the global voice-assistant market is predicted to reach 35.5 billion US dollars by 2025. Despite this expanding opportunity, the number of consumers eager to become first-time voice-assistant owners has been decreasing after 2020 [4].

C. *Contribution of this survey*

The following are the significant contributions of the survey:
1. The survey introduces JARVIS, a virtual integrated voice assistant utilizing gTTS, AIML, and Python-based technology for personalized assistant development.
2. Explores the simplicity of voice assistants' usage, powered by advancements in Artificial Intelligence, Machine Learning, and Natural Language Processing.
3. Discusses the significant role of virtual assistants in the context of Industry 4.0, where digital systems provide real-time information to enhance flexibility and efficiency in production environments.
4. Provides a historical overview of the evolution of international interest in chatbots, recognizing their rapid evolution in fields such as Marketing, Education, and Health Care.
5. Introduces a user engagement-based approach to evaluate the continued usage scenario of personal voice-assistants, such as Amazon Alexa and Google Assistant.

D. *Organization of the paper*

The paper is divided into 3 sections. Section 1 contains an introduction. Section 2 contains the detailed overview, methodology and detailed understanding of virtual assistant . Finally, the conclusion is given in Section 3.

II. VIRTUAL ASSISTANT

A. *Overview on Virtual Assistant*

The fundamental characteristics of virtual assistants are what make them effective in interactions between humans and machines. A key component is Natural Language Understanding (NLU), which gives virtual assistants the capacity to interpret and understand user inputs similarly to how people speak. By identifying contextual details and user intent, this not only makes for a more natural and intuitive interaction but also makes it easier to respond in a nuanced

manner. In addition to natural language understanding (NLU), speech recognition technology is essential because it converts spoken words into text, enables hands-free communication, and increases the use of virtual assistants in situations where manual input is not feasible. Furthermore, personalization plays a crucial role in adjusting the responses and actions of the virtual assistant to each user's unique needs, habits, and preferences. This flexibility builds a rapport between the user and the computer in addition to improving the user experience by offering more tailored and pertinent support. Together, these fundamental characteristics essentially form the foundation of virtual assistant capabilities, enabling them to develop into complex, user-centered, context-aware interfaces that have a big influence on the field of human-computer interaction.

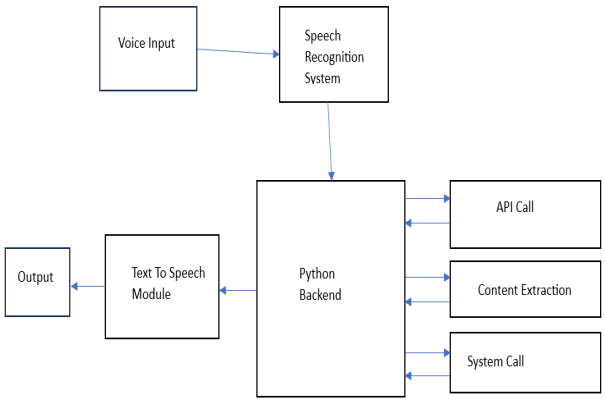

Fig. 1. Block Diagram

B. Methodology

The following are the methodologies that was adopted by the authors:

1.The primary functional component is AIML, which is supported by Python and gTTS compatibility mechanisms. The system processes the initial speech data through gTTS and turns it into text by using a global Request-Response Model, basic Python modules, [1]. and libraries such as Speech Recognition. After parsing the text into the AIML kernel, the Python interpreter feeds the intelligent result back into the Python script. In order to improve user experience, gTTS is used to transform the text back to audio, resulting in a momentarily saved audio file that is activated by Python. The Python script handles the last command data and outputs it in raw format to the terminal. This simplified process combines Python, gTTS, and AIML to create a coherent system that can comprehend a variety of inputs.

2. The Python-implemented desktop virtual assistant [2] has a simplified workflow. The speech recognition module is triggered by a spoken command from the user and transcribes spoken words into text. Requested data is retrieved from the program and sent to a client webpage via an API call. A syscall allows for easier connection with the operating system's kernel, and content extraction selects pertinent information from the webpage. API calls, system calls, content extraction, and the Python backend are all interconnected to form a coherent system. The input is processed by the Python backend and then sent to the text-to-speech module for a user-friendly output. This illustrates how well the many modules within the virtual assistant system integrate with one another. The flow diagram is shown in Figure 2.

3. The PRISMA approach was used in the Systematic Literature Review (SLR) on Virtual Assistants (VAs) in Industry 4.0. 52 pertinent studies were found through the use of automated tools in the industry applications-focused research. After rigorous exclusion criteria and manual analysis, eight studies that addressed research questions were chosen for in-depth analysis [9]. The Distribution of papers based on the technical assistant design principle is shown in Figure 3. It was acknowledged that there were fewer studies than expected; in the final round, 42% of the studies were excluded because they were not available in full text. The methodology made sure that all scientific output in the designated field was thoroughly and methodically reviewed.

4. The creation of chatbots requires a sophisticated methodology that incorporates a number of methods. In order to choose suitable algorithms, platforms, and tools that support both development and end-user expectations, developers must specify the chatbot's goal and category. Predefined neutral responses for user utterances that are not understood, an answer generation strategy, and accurate knowledge representation are essential design requirements [3]. A modular development approach is used, breaking the system down into its component pieces. The general chatbot architecture starts when a user sends a request through text/speech input applications or messenger apps. The request is then parsed by the Language Understanding Component, which determines the user's intention and related data. The chatbot determines what to do next after determining which interpretation is the most accurate: it can act immediately based on new information, remember, wait for more input, or ask for clarification.

5. To learn more about the preferences and usage patterns of Google Assistant and Amazon Alexa voice assistants, researchers used an online survey that was disseminated through Google Forms. These platforms were chosen due to their significant market share. After using screening questions to separate late adopters from continuous adopters, a final dataset of 244 responses was obtained [4]. The average age was found to be 31.25 years, the gender distribution was almost equal, and most of the respondents reported having a monthly household income of between 30,000 and 60,000 Thai Baht. The questionnaire underwent pre-testing and expert review after being modified from previously published material. In order to ensure the reliability of the study

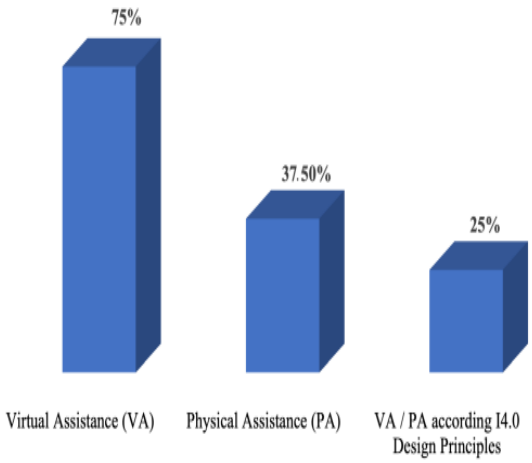

Fig. 2. Distribution of papers

results, Common Method Variance (CMV) concerns were addressed through meticulous survey design, marker-variable techniques, and statistical tests.

C. *Types of Virtual Assistant*

Due to their capacity to reduce waiting times, boost output, and offer individualized support, virtual assistants (VAs) are growing in popularity in both personal and professional contexts. There are numerous varieties of VAs available, and each has special advantages and disadvantages of its own.The Table I shows the Types of Virtual assistant and accuracy
There are five main types of virtual assistants:

1) ***Rule-based virtual assistants****:* The most basic kind of virtual assistants are rule-based VAs [15]. They decide how to react to user input based on a predetermined set of rules. Generally, basic tasks like checking the weather or setting alarms are handled by rule-based virtual assistants. Because rule-based VAs rely on clear rules and logic, they are comparatively simple to create and maintain.They are less flexible to new circumstances or modifications in user behavior because they are dependent on pre-established rules.Routine, well-defined tasks that are easily expressed as rules are a strong suit for rule-based virtual assistants.

2) ***Machine learning-based virtual assistants****:* Virtual assistants that are machine learning-based employ algorithms for machine learning to gain knowledge from data and enhance their capabilities over time [11]. Machine learning-based virtual assistants (VAs) can perform more complicated tasks, like making travel or appointment bookings, and are generally more accurate than rule-based VAs.Because ML-based VAs learn from real-world data, they can achieve higher accuracy levels than rule-based VAs.They can adjust to new circumstances and get better at responding over time thanks to ML algorithms.More difficult jobs, like sentiment analysis, natural language processing, and customized recommendations, can be handled by ML-based VAs.

TABLE I
TYPES OF VIRTUAL ASSISTANT AND ACCURACY

TYPES	ACCURACY	USECASES
Rule-Based VA	70-80%	Simple Task
Machine Learning Based VA	80-90%	Complex Task
Hybrid VA	85-95%	Medium Complexity Task
Conversational AI	90-95%	Natural conversations
Embodied AI	95-99%	Real-world Assistance

3) ***Hybrid virtual assistants****:* The advantages of rule-based and machine learning-based virtual assistants are combined in hybrid VAs. For simpler tasks, hybrid VAs employ rule-based systems; for more complicated tasks, they employ machine learning systems. Because of this, hybrid virtual assistants (VAs) can be more adaptive and flexible than rule-based or machine learning-based VAs.Hybrid VAs can effectively use rules to handle simple tasks while utilizing machine learning for more complicated ones.They provide a compromise between control and flexibility, supporting both ML-driven learning and pre-established rules.As new tasks and data are added, hybrid VAs can grow efficiently without sacrificing control over rule-based behavior.

4) ***Conversational AI****:* One kind of VA that can have lively, natural conversations with users is called conversational AI. Conversational AI VAs are capable of comprehending intricate queries and offering thorough responses. Though they are still in the early stages of development, conversational AI VAs have the potential to completely change how humans communicate with computers.Natural language processing is an area in which conversational AI VAs shine. They can comprehend subtleties and context in user interactions.They are able to respond in a way that is pertinent and consistent while maintaining context over several turns of conversation.Conversational AI VAs have the ability to customize conversations according to the user's preferences, previous exchanges, and contextual elements.

5) ***Embodied AI****:* One kind of VA with a physical body is called embodied AI. Embodied AI VAs are able to comprehend and react to the feelings and intentions of their users. Additionally, embodied AI VAs can help with practical tasks like driving or navigating a physical environment.Embodied AI VAs can use their physical bodies, actuators, and sensors to interact with the outside world.With the aid of cameras, microphones, and other sensors, they are able to see and comprehend their environment.Embodied AI VAs are able to modify their behavior in response to cues from their surroundings and interactions in the real world.

D. *Algorithms used for Virtual Assistant*

1) ***Named Entity Recognition****:* In Natural Language Processing (NLP), named entity recognition (NER) is an algorithm that is essential to virtual assistants. Entities like as

persons, places, organizations, dates, and periods that are mentioned in text must be recognized and categorized by NER. Virtual assistants are able to identify and classify entities from natural language, which allows them to comprehend user inquiries, respond appropriately, and take appropriate action.Consider equation 1

$$(t/s) = exp(xiyifi(t, s)) \text{ - - - - - - (1)}$$

where: t is the tag sequence, s is the sentence, xi is a weight parameter for the i-th feature function and yi(t, s) is the value of the i-th feature function for the tag sequence t and the sentence s

NER algorithms usually use a mix of methods to locate and categorize objects. Among these methods are:

1. Pattern matching is the process of comparing words or phrases to dictionaries of well-known things or established patterns. Using manually established rules to recognize entities based on contextual cues like adjacent words or capitalization is known as a rule-based method.
2. Techniques for machine learning (ML): Large volumes of annotated text data are used to train ML models so they can recognize the patterns and connections that set certain entity types apart.

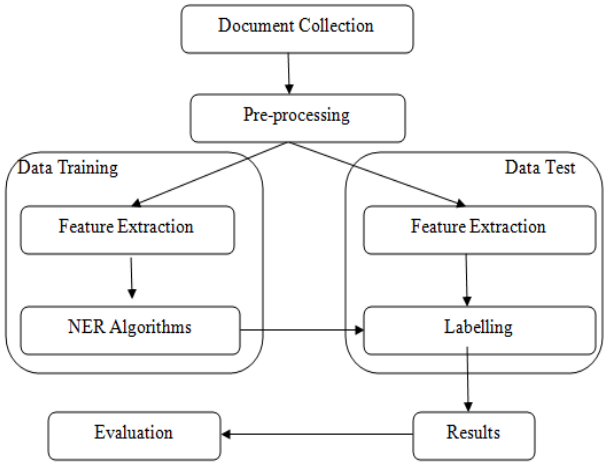

Fig. 3. Named Entity Recognition Approach

*2) **Natural Language Understanding**:* A fundamental feature of virtual assistants is natural language understanding (NLU), which allows them to interpret the meaning and intent of human discourse. Natural language understanding (NLU) is the collection of methods that enable virtual assistants to process and comprehend natural language input, including speech and text. Virtual assistants that are proficient in human language are able to interact with people in an efficient manner, fulfill their requirements.Consider equation 2

$$\tan h(Wt - 1 + Wx) \text{ - - - - - - (2)}$$

where: ht is the hidden state at time step t, wt is the weight matrix for the hidden-to-hidden connections, Wx is the weight matrix for the input-to-hidden connections and xt is the input vector at time step t

Natural language understanding algorithms use a variety of methods to extract meaning from natural language. Among these methods are:

1. Lexical analysis is the process of recognizing and comprehending each word in a sentence.
2. Syntactic analysis is the study of a sentence's grammatical structure to determine the relationships between words and phrases. Semantic analysis: Determining a word or phrase's meaning from its context in a sentence.
3. Analyzing a user's goal and purpose while taking into consideration contextual details like the speaker's tone and the setting in which the discussion is occurring is known as pragmatic analysis.

*3) **Natural Language Generation**:* Virtual assistants cannot function without natural language generation (NLG), which gives them the ability to write text that is fluid, informative, and contextually relevant. Natural language generation (NGL) is the collection of methods that virtual assistants use to translate structured input into responses in natural language, enhancing the naturalness and interest of virtual assistant interactions.

NLG algorithms use a variety of methods to produce text that is meaningful and coherent. Among these methods are:

1. Content planning is the process of identifying the most important information to include in the response, including the main point, any supporting details, and any additional background that might be pertinent.
2. Lexical selection is the process of selecting the right words and phrases to convey a meaning while taking the user's vocabulary, formality, and style into account.
3. Sentence structure: Putting together grammatically sound sentences that adhere to semantic and syntactic conventions.
4. Text formatting: Using formatting strategies to improve the text's readability and clarity, such as paragraph breaks, capitalization, and punctuation.

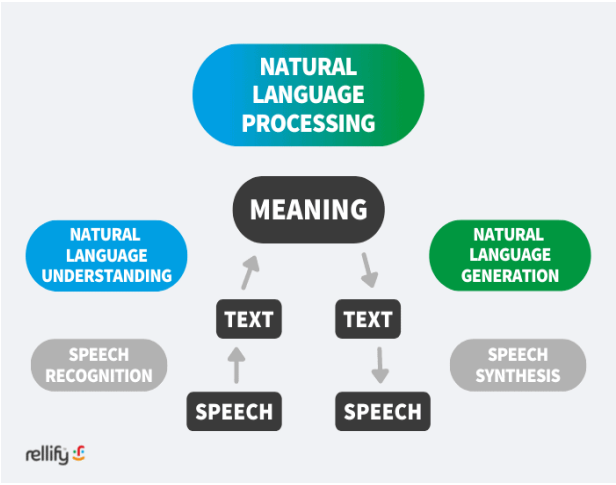

Fig. 4. NLG and NLU

E. Python for Virtual Assistant

pose programming languages because of its design philosophy, which prioritizes code readability and makes

extensive use of whitespace. It is the recommended platform for implementing AI because of its constructs, which make programming on both small and large scales easier. Python's built-in features are well suited to Artificial Intelligence (AI) needs, and it works well with many pre-built AI models, especially the more recent Python 3.6.8 Stable and 3.7.2 maintenance release. Notably, Python has a wealth of dynamic and AI-focused libraries, such as Matplotlib, Sci-kit Learn, PyTorch, Tensor Flow, and others [7].These libraries, which cover machine learning, neural networks, and other AI-related fields, enable developers to easily incorporate advanced AI goals. Python is a cornerstone for AI due to its robustness, versatility, and wide library support. A large fraction of AIML categories have been rebuilt in the JARVIS system, requiring the creation of new path and redirecting mechanisms in order to perform different tasks. In order to reduce processing latency, Application Programming Interfaces (APIs) are developed that utilize Python scripting techniques to multitask within the Linux operating system. The Google API, which is in charge of speech synthesis algorithms such as text-to-speech conversion, Google Maps integration, and browser redirection upon trigger, is the main API that has been put into practice. An additional important API supports Linux, enabling Python to dynamically interact with system functions like redistributing wallpaper and controlling volume. Python scripts are used for System Event Handling (SEH) and bash commands are used for root system manipulation in this API. YouTube is the target of the third API that JARVIS has integrated, giving them total control. E. Advantages of Virtual Assistant Virtual assistants offer a plethora of advantages that significantly enhance user experiences and streamline various tasks. One of their primary benefits lies in time efficiency, as these assistants automate routine activities, providing quick responses and saving users substantial time. Their multitasking capabilities enable them to handle multiple functions simultaneously, contributing to increased productivity. Additionally, virtual assistants, designed to understand natural language, facilitate intuitive interactions and round-the-clock accessibility. Their ability to automate tasks, retrieve information swiftly, and integrate with various devices leads to more personalized and efficient user experiences. Virtual assistants continuously learn and improve through machine learning, ensuring ongoing enhancements based on user interactions and feedback. Moreover, these assistants contribute to cost savings in business settings by automating customer service tasks. Overall, the advantages of virtual assistants encompass time savings, improved productivity, accessibility, personalization, and continuous improvement, making them valuable tools in diverse contexts.

F. Architecture of Virtual Assistant

A virtual assistant's architecture is an intricate system made up of multiple interconnected parts that work together to process user inputs and provide responses that are both pertinent and logical. Essentially, the UI uses text input for people who would rather type their questions and voice recognition technology for spoken commands. Understanding user intent is largely dependent on Natural Language Processing (NLP), where entity recognition and intent recognition help identify specific details and the purpose of requests, respectively [11]. Contextual continuity is guaranteed by dialog management, enabling smooth and cogent dialogue. The knowledge base requires data storage to keep pertinent information current as well as information retrieval from databases or APIs. Integration with third-party services and APIs is necessary for task execution in order to perform operations like sending or scheduling reminders.

Machine learning, which includes both training data and ongoing learning, improves the virtual assistant's comprehension of language and ability to generate responses. For voice-based interactions, response generation consists of text-to-speech, and for text-based communication, message generation. User authentication and data encryption are included in security and privacy measures, and a feedback mechanism collects user input to improve performance. Typically, the deployment infrastructure makes use of server infrastructure for effective backend processing and cloud services for scalability. This all-encompassing architecture guarantees that virtual assistants can efficiently handle user interactions, offer insightful information, and carry out tasks in a variety of domains.

G. Advantages of Virtual Assistant

Virtual assistants (VAs) are remote workers who provide administrative, technical, or creative assistance to clients from their home offices. VAs offer a variety of benefits to businesses and individuals, including: 1. Cost savings: VAs are typically less expensive than traditional employees, as they do not require office space, benefits, or equipment.

2. Increased productivity: VAs can help businesses and individuals free up their time by taking on administrative tasks, such as scheduling appointments, managing email, and making travel arrangements. This allows businesses and individuals to focus on their core competencies.

3. Improved accessibility: VAs are available to work during non-traditional hours, which can be helpful for businesses and individuals with international clients or customers. 4. Access to specialized skills:VAs can be hired for their specific skills and experience, such as writing, editing, web development, and social media management.

5. Flexibility: VAs can be hired on a project-by-project basis or for ongoing support. This flexibility allows businesses and individuals to adjust their staffing needs as needed.

6. Improved work-life balance: VAs can help businesses and individuals reduce stress and improve their work-life balance by taking on time-consuming tasks.

H. Disadvantages of Virtual Assistant

Virtual assistants (VAs) offer a range of benefits to businesses and individuals, but there are also some potential drawbacks to consider. Here are some of the disadvantages of using VAs: 1. Communication and cultural barriers: Working

with a VA remotely can lead to communication challenges due to language barriers, cultural differences, and time zone differences. It's essential to establish clear communication channels and provide thorough instructions to ensure accurate task execution.

2. Limited supervision and control: Unlike traditional employees, VAs are not always easily accessible for in-person meetings or immediate feedback. This can make it more challenging to provide direct supervision and ensure that tasks are completed to the desired standards.

3. Security and data protection: When entrusting sensitive information or data to a VA, businesses must take appropriate measures to safeguard it. This may involve implementing secure communication protocols, establishing clear data handling guidelines, and ensuring that VAs have access only to the information they need to perform their tasks.

4. Lack of knowledge about your business: VAs may not have a deep understanding of your business's specific processes, procedures, and culture. This can require additional onboarding and training to ensure they can work effectively within your company's framework.

5. Difficulty in building rapport: Working remotely can make it more challenging to build rapport and trust with your VA. Regular communication, clear expectations, and positive feedback can help foster a strong working relationship.

6. Potential for job displacement:As VA services become more popular, there is a risk that traditional office jobs may be replaced by remote VA roles. However, this can also be seen as an opportunity for businesses to re-evaluate their staffing needs and consider adopting a more flexible workforce model.

Despite these potential drawbacks, virtual assistants can still be a valuable asset for businesses and individuals who are willing to put in the effort to manage communication, establish clear expectations, and implement appropriate security measures. The benefits of cost savings, increased productivity, improved accessibility, and access to specialized skills often outweigh the challenges of working remotely with VAs.

I. Application

A virtual assistant can be applied in various contexts, and its usage can be detailed in a point-wise manner:

1.Personal Assistance:The virtual assistant can manage your calendar, set reminders, and schedule appointments. It can also provide notifications for upcoming events.: It can help filter and organize emails, draft responses, and prioritize messages based on your preferences,Keep track of to-do lists, set priorities, and provide reminders for important tasks

2. Information Retrieval:Perform internet searches to gather information on a wide range of topics.It Provide current weather conditions and forecasts for specific locations.Also it answer questions on various subjects, acting as a quick reference tool.

3. Communication: Send and receive messages, making communication hands-free and efficient,Initiate or answer phone calls,and even transcribe voicemails,Translate text or spoken language between different languages.

4. Entertainment: Suggest music or podcast based on preferences,Provide entertainment through jokes, fun facts, or riddles,Recommend books, movies, or TV shows based on user preferences.

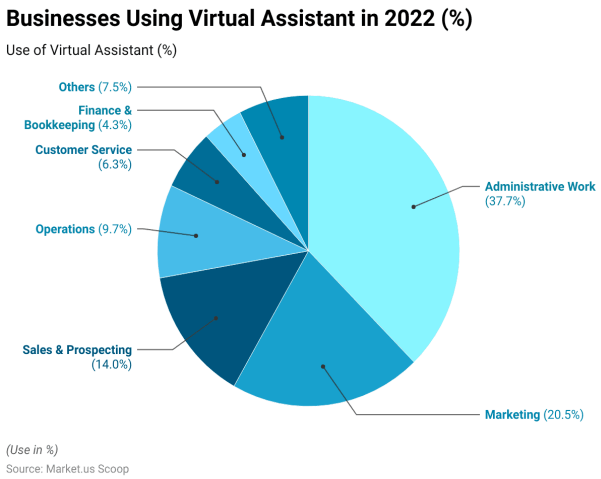

Fig. 5. Application of Virtual Assistant as per 2022

5. Navigation and Location Services:Provide directions, estimated travel time, and real-time traffic updates,Share your current location or find nearby points of interest.

6. Smart Home Control:Control smart home devices like lights, thermostats, and security systems,Create shopping lists, order items online, or find the best deals.

7. Productivity and Work:Create, edit, and format documents or send emails,Coordinate and schedule meetings, set reminders for deadlines,Assist in gathering information for research projects.

8. Health and Fitness:Provide workout routines or suggest fitness activities,Offer information about the nutritional content of foods.

9. Financial Management:Log and categorize expenses, provide summaries of spending habits, Set reminders for bill payments and monitor financial transactions.

10. Learning and Education:Assist in learning new languages through vocabulary and pronunciation exercises. Provide explanations on various topics, quiz preparation, and educational resources.

11. Accessibility Features:Assist individuals with disabilities by accepting voice commands for various tasks. Aid in communication for those with hearing or speech impairments.

12. Security and Privacy:Assist in generating and storing secure passwords. Provide guidance on privacy settings for various online accounts And offering automated responses. Through health monitoring and medication reminders, they provide support in the healthcare industry.Their usefulness includes aiding with navigation and travel, translating languages,providing support for education, and optimizing online shopping and e-commerce. These assistants in enterprise applications help to increase organizational efficiency by handling administrative duties and scheduling.

They improve accessibility as well.

J. Comprehensive Existing Work Survey

1) ***A Voice Based Assistant using Google Dialog flow and Machine Learning****:* Artificial Intelligence,Natural Language Understanding, IBM Watson ,Google Dialogflow,Speech Recognition Techniques were used. In this project, the Google DialogFlowdeveloped application ERAA is capable of a number of functions, including gaining access to installed apps like Gmail, Instagram, and WhatsApp. It was created with the aid of Flutter, which made using the application easier, and it is user-friendly. They were able to create a visually appealing user interface by utilizing the graphics packages included in Flutter. It is capable of carrying out the fundamental functions expected of the perfect personal assistant.

2) ***Desktop Voice Assistant Using Natural Language Processing****:* Techniques and Algorithms like Speech Recognition, Python Backend, System Calls,Google-Text-To-Speech were used. In this study,they created a voice assistant that can execute any kind of task in response to user commands without making any mistakes. Additional features have been added, such as the ability to only hear the user speak and to be insensitive to noise in the surrounding area.

3) ***Desktop Assistant AI Using Python****:* Desktop Assistant, Python, Machine Learning, Text to Speech, Speech to Text, Language Processing,Voice Recognition, Artificial Intelligence, Internet of Things (IoT), Pyttsx3, Speech Recognition,SQLite Techniques were used . In this paper, they talked about a voice-activated personal assistant running on Python. Currently employed online, this assistant does routine tasks like opening desktop applications, streaming music, checking Wikipedia,and getting weather updates. The current system's functionality is restricted to operating solely online.

4) ***The Voice Enabled Personal Assistant for Pc using Python****:* Python, Query, Pyttsx3, Speech Recognition, SQLite were used. The design and development of a voice-activated personal assistant for the PC using the Python programming language is covered in detail in this paper. In the modern lifestyle, this voice-activated personal assistant will be more efficient at saving time than it was in the past. Additionally, this assistant can perform a wide range of tasks with a single voice command, such as restarting or shutting down our PC or reading the most recent news.

5) ***Smart Voice Based Virtual Personal Assistants with Artificial Intelligence****:* Python, Text-to-Speech,Speech-to-Text, Voice Recognition technique were used. This paper describes the architecture and deployment of an intelligent personal voice assistant. With support from the Visual Studio Code community, the project is constructed with opensource software modules that are readily available and can be updated in the future.

6) ***AI Based Voice Assistant Using Python****:* Speech Recognition, Python, Speech-to-Text, Text-toSpeech were used. They have used Python to create a voice assistant in this paper. With the help of the PyCharm community, open-source software modules are used to build the project. One way to make this project even better would be to incorporate voice control into Google search queries.

7) ***Personal Assistant with Voice Recognition Intelligence****:* Techniques like Google Voice Search, Voice Pattern Detection, Keyword Learning were used. The "PARI" program, which was created specifically to assist Native Americans and the blind in improving their voice commands, is the subject of this paper. It can also recognize voice commands in the absence of an internet connection. It can connect to a network and control multiple apps with voice commands, among other features for mobile devices. Important features like Voice Pattern Recognition and Keyword Learning are included.

8) ***Intelligent Voice Assistant****:* wake-word, voice assistant, voice recognition, Alexa, API Application Program Interface, localization were used. The user can command this intelligent voice assistant to do things for them. The system's voice recognition tool must first be awakened in order for it to accept and carry out the command. This includes a number of skills that have been created in Marathi and Hindi, including time, weather, facts, positive thoughts,nearby hospitals, and a city guide. You can create these skills with an Amazon Developer account.

9) ***Voice Recognition based Intelligent Wheelchair and GPS Tracking System****:* This is an intelligent wheelchair system that uses voice recognition for individuals with physical disabilities who are unable to operate their wheelchair manually. This is how the system operates: the patient uses voice commands to control the wheelchair, and a GPS module in the wheelchair tracks the patient's location and sends the data to a smartphone application (app) via Firebase. A patient's voice can be recorded using the Voice Module V3, which then recognizes the patient's voice and follows their instructions.

10) ***Effects of an intelligent virtual assistant on office task performance and workload in a noisy environment****:* This study, involving forty-eight adults, explored the impact of Intelligent Virtual Assistants (IVAs) on office task performance. Tasks included email, timers, and searches, with varying noise types. Verbal noise significantly affected IVA use, and participants preferred IVAs for less complex tasks. These insights guide IVA design, emphasizing the importance of noise types and task complexity. Future research could explore tasks, demographics, and learning curves for a more nuanced understanding of IVA performance in office environments.

11) ***Artificial intelligence for the metaverse****:* The survey employed a comprehensive method to investigate the role of artificial intelligence (AI) in shaping the metaverse. The approach involved exploring AI-based techniques, including machine learning algorithms and deep learning architectures, across various technical aspects such as natural language processing, machine vision, blockchain, networking, digital twin, and neural interface. The study also examined AI-aided applications in healthcare, manufacturing, smart cities, and gaming within virtual worlds. By synthesizing findings, the survey aimed to provide a foundational understanding of AI's

impact on the metaverse. The goal was to assist both experts and non-experts in applying, developing, and optimizing AI techniques to enhance virtual environments and improve the quality of metaverse applications.

12) ***A Robust Methodology for Building an Artificial Intelligent (AI) Virtual Assistant for Payment Processing****:* The study adopts a step-by-step approach to enhance Natural Language Understanding (NLU) behind an AI virtual assistant designed for a payment process. The NLU component is crucial for robustly interpreting customer utterances. Utilizing deep learning algorithms, the system leverages NLP, NLU, and NLG techniques to engage in dynamic and contextually relevant conversations with customers. The AI virtual assistant demonstrates its effectiveness by successfully processing sample interactions, achieving a high completion rate (approximately 75%) in tasks related to completing payments. The study highlights the importance of sophisticated techniques in understanding customer intent and generating coherent responses in today's evolving landscape of human-machine interactions.

13) ***Artificial Intelligence Virtual Assistants (Chatbots) are Innovative Investigators*** *:* The research primarily focuses on evaluating the impact of artificial intelligence virtual assistants or chatbots on recruitment development. The author investigates how virtual assistants facilitate candidate engagement and streamline the enrollment process. The study is grounded in a comprehensive examination of secondary sources, including theoretical articles, peer-reviewed research papers, and websites. Findings suggest that AI virtual assistants are highly efficient tools in the recruitment process, aiding in formulating effective business strategies for production. The research underscores the potential for further exploration in the integration of AI in business practices and identifies prospective research opportunities in the field of virtual assistants or chatbots.

14) ***A Wizard of Oz Study Simulating API Usage Dialogues With a Virtual Assistant*** *:* In this study, the authors address the scarcity of virtual assistants tailored for specialty tasks like software engineering due to the limited availability of experimental datasets. They conducted a series of Wizard of Oz experiments designed to create a dataset for training a virtual assistant, specifically targeting assistance for programmers in utilizing APIs. Thirty professional programmers participated in the experiments, interacting with a simulated virtual assistant operated by human experts without their awareness. The dialogue acts in the corpus were annotated along four dimensions: illocutionary intent, API information type(s), backward-facing function, and traceability to specific API components. The observations from these experiments provide a diverse range of interactions, offering valuable insights for developing dialogue strategies for virtual assistants tailored to API usage in software engineering.

15) ***Enabling Intelligent Environment by the Design of Emotionally Aware Virtual Assistant****:* In this study, a Deep Neural Network (DNN) based emotionally aware campus virtual assistant was developed to leverage the advancements in 5G and Artificial Intelligence of Things (AIoT). The research introduces Chinese Word Embedding to enhance dialogue tolerance and semantic interpretation, a crucial aspect for effective communication. Unlike traditional emotion identification methods, which involve tokenizing, part-of-speech analysis, and keyword capture, this study employs a convolutional neural network on spectrograms generated through Fourier Transform for direct emotion classification. The system is presented in an App mode, providing a user-friendly and cost-effective interface. Additionally, the virtual assistant offers a simple voice response interface, eliminating the need for users to navigate complex web pages or app menus for information retrieval.

16) ***Implementation of a Virtual Assistant for the Academic Management of a University with the Use of Artificial Intelligence****:* In response to the challenges faced by private universities amid the global pandemic, this study emphasizes the critical issues affecting these institutions both academically and financially. The academic struggles, including learning difficulties and a consequent rise in dropout rates, directly contribute to financial strain. Compounding these challenges are the economic impacts of the pandemic, leading to a significant decline in student enrollment for private education. To mitigate these issues and provide essential support, the integration of technologies such as Chatbots utilizing artificial intelligence is proposed. This technological intervention aims to streamline administrative tasks, particularly in disseminating information about academic courses, alleviating the burden on university resources, and enhancing the overall user experience. The implementation of Chatbots is seen as a strategic measure to not only address administrative challenges but also to attract and retain students during these difficult times.

17) ***Usage-Based Learning in Human Interaction With an Adaptive Virtual Assistant****:* This study proposes a more adaptive approach to virtual assistant interactions, contrasting with conventional systems like Siri, where links between natural language requests and predefined realizations are established during conception. Instead, the suggested adaptive solution enables users to provide natural language instructions or demonstrations when the virtual assistant encounters an unfamiliar task. The adaptive virtual assistant is designed to operate across a broad digital environment encompassing various application domains and providers, enhancing its versatility to better cater to user needs. Drawing inspiration from human language developmental studies, the research builds upon previously developed robotic systems, extending the adaptive capacity to human interactions with a virtual assistant. The system learns the mapping between verbal commands and basic action semantics within specific domains, gradually acquiring higher-level mapping by integrating procedural knowledge learned through user interactions, demonstrating flexibility across new domains such as e-mail and Wikipedia.

K. Virtual Assistant in Future

One avenue for future development involves refining the natural language processing (NLP) capabilities to achieve

TABLE II
EXISTING WORKS WITH THEIR APPROACHES

Paper	Year	Problem Addressed	Scope of the Proposed Approaches
haghighat*et al.,* [17]	2023	Impact of Intelligent Virtual Assistants (IVAs) on office task performance, focusing on the influence of verbal noise and user preferences for less complex tasks, with implications for guiding future IVA design based on noise types and task complexity.	Examining the interplay between verbal noise, task complexity, and user preferences in the context of Intelligent Virtual Assistants (IVAs), with implications for guiding the design of future IVAs to enhance office task performance.
huynh *et al.,* [18]	2023	A comprehensive method to investigate the role of artificial intelligence (AI) in shaping the metaverse.	To assist both experts and non-experts in applying, developing, and optimizing AI techniques to enhance virtual environments and improve the quality of metaverse applications.
sam *et al.,* [19]	2019	Step-by-step approach to enhance Natural Language Understanding (NLU) behind an AI virtual assistant designed for a payment process.	Highlights the importance of sophisticated techniques in understanding customer intent and generating coherent responses in today's evolving landscape of human-machine interactions
khan*et al.,* [20]	2020	Evaluating the impact of artificial intelligence virtual assistants or chatbots on recruitment development.	The research underscores the potential for further exploration in the integration of AI in business practices and identifies prospective research opportunities in the field of virtual assistants or chatbots
eberhart *et al.,* [21]	2020	The authors address the scarcity of virtual assistants tailored for specialty tasks like software engineering due to the limited availability of experimental datasets.	Series of Wizard of Oz experiments designed to create a dataset for training a virtual assistant, specifically targeting assistance for programmers in utilizing APIs.
chiu*et al.,* [22]	2020	A Deep Neural Network (DNN) based emotionally aware campus virtual assistant was developed to leverage the advancements in 5G and Artificial Intelligence of Things (AIoT).	The virtual assistant offers a simple voice response interface, eliminating the need for users to navigate complex web pages or app menus for information retrieval.
villegas*et al.,* [23]	2021	In response to the challenges faced by private universities amid the global pandemic, this study emphasizes the critical issues affecting these institutions both academically and financially	The implementation of Chatbots is seen as a strategic measure to not only address administrative challenges but also to attract and retain students during these difficult times.
delgrange*et al.,* [24]	2021	Adaptive approach to virtual assistant interactions, contrasting with conventional systems like Siri, where links between natural language requests and predefined realizations are established during conception	The system learns the mapping between verbal commands and basic action semantics within specific domains, gradually acquiring higher-level mapping by integrating procedural knowledge learned through user interactions, demonstrating flexibility across new domains such as email and Wikipedia
schmidt*et al.,* [25]	2018	In this project, the Google DialogFlow developed application ERAA is capable of a number of functions, including gaining access to installed apps like Gmail, Instagram, and WhatsApp	Create a visually appealing user interface by utilizing the graphics packages included in Flutter. It is capable of carrying out the fundamental functions expected of the perfect personal assistant.
patil *et al.,* [26]	2021	They created a voice assistant that can execute any kind of task in response to user commands without making any mistakes	Features have been added, such as the ability to only hear the user speak and to be insensitive to noise in the surrounding area.
kumar *et al.,* [27]	2020	A voice-activated personal assistant running on Python.	Currently employed online, this assistant does routine tasks like opening desktop applications, streaming music, checking Wikipedia,and getting weather updates. The current system's functionality is restricted to operating solely online.
mahesh *et al.,* [28]	2023	The design and development of a voice-activated personal assistant for the PC using the Python programming language is covered	This assistant can perform a wide range of tasks with a single voice command, such as restarting or shutting down our PC or reading the most recent news
pandey*et al.,* [29]	2020	The architecture and deployment of an intelligent personal voice assistant.	Constructed with opensource software modules that are readily available and can be updated in the future.
subhash *et al.,* [30]	2020	Have used Python to create a voice assistant	Incorporate voice control into Google search queries
kulhalli *et al.,* [31]	2017	The "PARI" program, which was created specifically to assist Native Americans and the blind in improving their voice commands	Important features like Voice Pattern Recognition and Keyword Learning are included.
polyakov *et al.,* [32]	2018	The system's voice recognition tool must first be awakened in order for it to accept and carry out the command.	This includes a number of skills that have been created in Marathi and Hindi, including time, weather, facts, positive thoughts,nearby hospitals, and a city guide.
aktar *et al.,* [33]	2019	This is an intelligent wheelchair system that uses voice recognition for individuals with physical disabilities who are unable to operate their wheelchair manually	A patient's voice can be recorded using the Voice Module V3, which then recognizes the patient's voice and follows their instruction

even more nuanced understanding of user intent and context. This can be achieved by leveraging advancements in deep learning architectures, potentially integrating newer models that surpass the current state-of-the-art. Furthermore, incorporating more sophisticated machine learning techniques, such as reinforcement learning, can empower virtual assistants to adapt and improve their responses over time based on user feedback. This adaptive learning mechanism could lead to a more personalized and user-centric interaction, tailoring responses to individual preferences and evolving language trends [9] .The integration of multimodal capabilities is another exciting avenue for exploration. Combining ChatGPT with image recognition and processing modules could enable virtual assistants to interpret and respond to visual cues, opening up possibilities for more interactive and context-aware engagements. This could prove particularly beneficial in scenarios where users convey information through a combination of text and images.

In the context of security and privacy, future work should focus on implementing robust mechanisms for user authentication and data protection. Advancements in privacy-preserving AI techniques could be integrated to enhance confidentiality while still providing personalized assistance [18].Moreover, expanding the knowledge base and improving the assistant's ability to handle complex queries across diverse domains remains a key area for future research. Integrating external data sources and staying updated on the latest information trends will be crucial for ensuring that virtual assistants remain reliable sources of information [8].Lastly, the continuous collaboration between research and industry is essential for practical implementation. Bridging the gap between cuttingedge research, as exemplified by models like ChatGPT, and real-world applications will be vital for creating virtual assistants that are not only intelligent but also seamlessly integrated into users' daily lives.Refer Table II for existing virtual assistant

In summary, the future of virtual assistants, especially with the integration of advanced models like ChatGPT, involves refining NLP capabilities, exploring multimodal interactions, advancing machine learning techniques for adaptability, addressing security and privacy concerns, expanding the knowledge base, and fostering collaboration between research and industry to bring about tangible improvements in the virtual assistant landscape.

III. Conclusion And Future Work

Finally, the work presented introduces JARVIS, a novel system that integrates gTTS and Python to interpret AIML and create a dynamic environment for Python interpretation. This system makes the Linux user interface more interactive and user-friendly by utilizing the power of AIML and the Google API. This work contributes a lighter and more portable AIML 1.0, effective speech recognition methods through the use of the Google API, and the use of Python's dynamic and functionally rich nature for seamless AI integration. The research highlights how novel the Linux-AI integration is, utilizing well-known foundational technologies like Python for GUI development and interpretation, and the Google TTS engine. The authors suggest future research directions in their outlook. Among them is the potential of making JARVIS open-source software available, developing its AI capabilities beyond AIML, adding a holographic face projection, turning it into a dynamic self-learning AI system, and investigating uses in industrial and household automation. The research also makes suggestions for possible Raspberry Pi integration to advance JARVIS, much like Google Home and Amazon Alexa. Changing gears, the paper briefly discusses the wider field of Python-based virtual assistants for desktops, stressing their efficiency in managing schedules and their superiority over conventional Personal Digital Assistants (PDAs) because of their greater usability and resource efficiency. Lastly, the paper explores the topic of Industry 4.0 (I4.0) and Virtual Assistants (VAs), emphasizing how these innovations are revolutionizing the industrial sector. The thorough literature review that was carried out.

Future work in the realm of virtual assistants, particularly integrating advanced models like ChatGPT, holds immense potential for enhancing user experiences and expanding the capabilities of these digital companions.

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