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Chatbot-Powered Interactive Robot Mascot

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***Abstract*—The Chatbot Robot Mascot Project is a paradigm effort integrating the findings of robotics, artificial intelligence, and human-computer interaction in the development of an interactive robot that may converse in natural language with users. The project with the ultimate goal of developing a responsive and autonomous mascot suitable for education, events, public spaces, and customer service environments integrates an advanced AI-driven chatbot into a physical robotic figure. the project is based on NLP technology with which the robot can understand and output human-like dialogue. It uses current machine learning techniques like speech recognition and deep learning for an integration of a chatbot that can process user input and deliver personalized responses in interesting conversations. This robot also contains advanced sensory systems. It accommodates a camera and microphone system in it, which helps identify facial features or the context of speech and emotion behind facial expression. Thus, the responses are expected to adjust according to the user's emotional state and context for more natural and empathetic interaction. But that is not all; multimodal interaction is also brought whereby the robot incorporates facial expressions and physical gestures along with speech to make the presence more immersive and human-like. Its design features an L-model component so that it can learn over time; its interactions are thus tailored to each user's preferences and history. Cloud-based analytics along with data processing enhance further its adaptability, leading to continuous improvement in engagement and quality of interaction. The mascot of the chatbot can be quite flexible, as it may be used as an educational tool for classes or even be used as a brand ambassador at marketing events or customer support staff in commercial places. This flexibility positions it as a powerful tool for improving user engagement, brand interaction, and customer support. Behind functionality, the project also would look at improving and exploring HRI, in other words, where robots can surpass what ordinary circumstances enable to make human lives more flavorful and richer. Finally, the Chatbot Robot Mascot Project invites an end where AI-driven robots are not only companions or teachers but facilitators as well for human interaction across industries.**

Keywords- Neurocognitive Multimodal Communication, Immersive Interaction, Channel Connector, Bot Insights, NLP-Natural Language Processing, Agent Escalation.

I. INTRODUCTION

Advances in artificial intelligence and robotics are quickly opening exciting possibilities for improving the user experience through the incorporation of humans into technological systems. A novelty in the form of an Interactive Robot Mascot integrates robotics, natural language processing, machine learning, and human-robot interaction to create a robot that meaningfully interacts with users in dynamic ways. It's not more of an automation tool but rather a friendly, interactive mascot that could even develop rapport with users and create rich, personalized experience while meeting the most practical roles in varying scenarios.

The robot is designed to process and understand natural language. With the AI chatbot underpinned, it lets end-users interact with the robot. It's not more of an automation tool but rather a friendly, interactive mascot that could even develop rapport with users and create rich, personalized experience while meeting the most practical roles in varying scenarios.

With advanced machine learning, it makes the chatbot more skillful at understanding and responding to every end-user's specific needs step by step, making every interaction unique and interesting. It lets a robot not only conduct text or voice conversations but also recognizes emotional signals such as changes in tone of voice or facial expressions. In this way, the robot can empathize and respond appropriately and contextually, customize its behavior according to the emotional state of the user or particular needs.

The robot is not a regular chatbot because it was conceived and created by human hands with expressive facial features, body language, and gestures - a fully interactive, natural addition to the emotional nuances of the interaction. Whether through eye contact, a smile, or waving, the robot communicates words but also actions that embellish the user experience as if the interaction is even more personal and valid.

This mascot is designed so it can be versatile and adaptive-workable in numerous roles that cut across different contexts. It would become a virtual assistant answering questions and giving explanations for the students within educational setups. At an event or expo, it would be a brand ambassador that would guide attendees through product details and casual conversation. In the customer service perspective, the robot can be used to inquire, troubleshoot problems, and offer real-time support in a friendly and approachable manner. Its ability to adjust to different tasks makes it a great tool for helping build engagement in any environment.

The robot also continues to evolve. With cloud-based analytics and data processing, information gathered at every turn builds understanding through refinement of answers and the ability to understand users better. This allows it to adapt according to individual preferences and gives them better, more relevant experiences with time.

A future where robots can be both functional and personable companions will be seen on earth. The Chatbot Interactive Robot Mascot would play the role of an educational assistant, a customer service agent, or even a brand representative. That is something that truly changes the way AI-powered technology can actually provide more humanly interactive capabilities, making the use of technology so intuitive, empathetic, and enjoyable.

II. RELATED WORKS

This is the character of functionality in an AI-powered Chatbot Interactive Robot Mascot that makes it possible to interact the robot at various point of engagement, recognize emotions and personalizes the interaction. This makes it possible for the robot to understand and produce languages like a human being; recognition of emotion through facial expressions and voice tone makes it possible for the robot to personalize a response that matches the emotional level of the user.

It also provides multi-modal interaction, which provides a mix of speech, vision, and gestures to make the robot communicate in more human-like ways. It further offers autonomous decision-making by applying artificial intelligence so that the robot decides what action or response best suits a given situation to provide highly dynamic and personalized experience for the users.

As online gaming grows to become a huge social and entertaining platform for children and adolescents, the risks associated with predatory behavior, harassment, and cyberbullying will increase. Traditional safety mechanisms will not suffice to deal with these challenges, and thus, there is an urgent need to integrate such advanced technologies as Artificial Intelligence into the gaming environments.

This would enable the chatbot AI to provide real-time detection and proactive intervention, safety features being tailored according to needs, and even behavioral analytics to see to a better protection of young players against any potential threat. This might be one big step by the gaming industries toward a safer environment for kids and adolescents to play.

This paper will explore the impact of varying personalities by which chatbots communicate to the resonance of consumers with the brand. Four dimensions are used: behavioral loyalty, attitudinal attachment, sense of community, and active engagement. The central hypothesis is that when there is a humanlike personality that is represented, then there would be considerable effects for resonance created between the chatbot and the consumers. These four sub-hypotheses elaborate on the different dimensions of chatbot personality-empathy, tone, and conversational style-how they relate to consumer behavior and attitudes toward brands.

This study is going to offer practical implications for marketers by offering a personalized interaction that involves customers through consumers, a raise in brand loyalty, and an emotional bonding between customers and brands. To put it succinctly, research contributes to long-lasting and meaningful consumer-brand relationships achieved through experiences prepared by customized chatbots.

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In this study, the authors introduce a multi-sensor context-aware chatbot that makes use of image and sound data to enhance the facilitation of communications. By using a GRU architecture instead of the conventional LSTM model and a VGG16 network that employs feature extraction for images, the chatbot ensures increased accuracy in its responses and decreased misunderstanding. An integration of visual and auditory information allows the chatbot to better understand input from users in more dynamic environments. Experimental results show that the integration of sensory data indeed seems very useful for a companion robot in establishing more natural and accurate interactions.

It is actually Bot to Bot architecture-a system that lets developers build voice-controlled applications in a high-level language across the cross-compatibility of different robotic hardware platforms. The paper explains how Bot to Bot uses natural language processing and robotic control to convert voice commands to structured intents through intermediate representations: verbal bites, robot assembly, and robot control primitives. Our long-term objective is the specification of a vocabulary for human-robot communication, and we are releasing our code as open source to facilitate further research.

The research explores and unveils the meanings, behaviors, opinions, and preferences of people with neurodevelopmental disorders in an innovative interactive framework and tries to understand the unique perspective and interaction of an individual regarding how he uses various stimuli and environments.

The nature of the research design aims at identifying patterns in behavior and preference, more specifically how the people perceive different types of interaction, technology, or settings. The results should inform the more inclusive designs of interventions, tools, and technologies that are better suited to the needs of individuals with neurodevelopmental disorders and can advance understanding and support.

This paper will explore deployment, use patterns, and user evaluations of the AI chatbot in OU Libraries. It also includes interviews with the library staff and stakeholders engaged in deployment at the setting that provides some depth to its setup. In addition, log data will be analyzed to get an insight on user-interaction patterns, for example, frequently asked questions as well as problems the chatbot cannot answer.

This study also examines the main determining factors in user evaluation, such as accuracy, responsiveness, and overall usefulness. Insights gained will help in giving recommendations that maximize the functionality of the chatbot, the user experience of, and integration with library services.

There is always a driving force behind educational growth: customer experience. In the Finnish context, Haaga-Helia University has employed a chatbot known as HUGI based on keyword recognition and machine learning for answering questions in both Finnish and English while providing 24/7 service and keeping students informed. However, for updates, HUGI will still need the attention of humans. The aim of this thesis is to better the processes for updating and maintenance of HUGI, increase its capabilities for autonomously meeting student needs, and also create a roadmap of future improvements.

Kuri is a home robot designed specifically for providing an interactive companionship. Once installed with sensors and cameras, it was able to fill the role of navigating the home, face recognition, and even accepting voice commands. Not exactly a chatbot, its relationship to human emotions and facial expressions set it more highly favored on issues concerning personalized interactivity. Its ability to turn its head, blink, and tilt its eyes was to create a more attentive, robot-like demeanor in the home.

Developed by Hanson Robotics, the world's most advanced humanoid robot is Sophia. The robot has been designed to interact with humans using AI-driven conversations and has grabbed headlines with the ability to talk realistically, display emotions, and even participate in real-time learning. The robot basically utilizes advanced NLP, facial recognition, and available knowledge bases to interlink with users and understand their emotions. A conversational style and a realistic facial expression place her among leading candidates to be discussed with respect to the future of human-robot interaction.

III. Proposed Methodology

A. *Problem Definition:*

An interactive mascot robot, powered by a chatbot, will be made which will entertain the users by having natural, emotionally intelligent conversations that incorporate adaptation to various modes of communication. The responses must be empathetic and personalized and contextual across different interactions.Such a system needs to address ethical issues related to privacy, security, and bias in order to ensure building trust. The mascot has to be friendly and intelligent in order to create a deeper level of emotional engagement and brand resonance, hence improving the user experience related to multiple usage contexts and scenarios.

B. *Dataset:*

For developing a mascot with an interactive robot powered by a chatbot, several aspects of the system would need to be trained, including NLP models, emotion detection, speech recognition, and multimodal integration with text, speech, and gestures. Below are some key categories of datasets needed for different functionalities. such an interactive robot mascot will need a vast array of datasets for different parts of its entity. A dataset of natural language processing, emotion detection, speech recognition, gesture recognition, and multimodal interaction is needed to make the mascot really responsive, intelligent, and engaging.

C. *Data Preprocessing and Feature Selection*

Data preprocessing and feature selection also fall under what it takes to build a chatbot-Powered interactive robot mascot. These will ensure that the data is both clean and adequate while necessary for training AI models (for instance, NLP, emotion recognition, speech-to-text, and multimodal interaction).
Text Data:
Tokenization, removal of stop words, and lemmatization ensure text homogeneity.
Named Entity Recognition helps extract entities from context which are important: names, places, etc.
Speech Data:
Noise removal and voice activity detection clean audio for use in speech recognition.
Feature extraction (MFCC) - Audio transmuted into machine readable data
Emotion Detection:
Facial recognition and audio features such as pitch and tone detect emotional expressions from the users
Gesture Data:
Pose estimation and motion tracking to identify body language and gestures for the multimodal interaction.

Text Features:
TF-IDF, word embeddings, for instance, BERT, and N-grams are able to capture meaningful patterns in the text.
Speech Features:
MFCC, pitch, and intonation help identify emotional states and the content of speech.
Emotion Features-Facial landmarks and sentiment scores provide emotional context for personalized responses.
Gesture Features:
Positions of the joint and motion trajectories help identify gestures for interactive responses.
The data is transformed into a format-suited training chatbot models as well as robot models, in order to enhance the response quality and increase the level of engagement after preprocessing and feature selection.

D. *System Architecture*

This can enable the given system architecture to express an overall framework of a comprehensive system by considering a fusion of user interaction, natural language processing, robotic control, and intelligent behaviour systems. The architecture is comprised, primarily on the User Interaction layer, since it serves as the entry point for the users. This enables the system to talk with users seamlessly since it can communicate using any input method installed as voice, touch, or an interface of other forms.

The Frontend Interaction Layer of application layer involves any web, mobile, or touch-based user interfaces. Since this is a middle layer, it takes inputs from users and passes them through to the backend systems for further processing while also showing responses formed by the system.

The control layer runs parallel with the frontend of the robot's operating system, often called Robot OS, and sensors. The layer collects data sensed by the environment, which is provided through sensors, to offer accurate control over functions inside the robot. Data flows along with inputs coming from users; inputs are routed towards the backend for processing by the NLP Engine/Chatbot Server.

It actually acts as the brain of the system that utilizes AI-backed natural language processing techniques to know what the user wants, what is meant, and compose the relevant responses for the context Also, it tries to give meaningful human-like interactions from the system.

Processed commands from the user are then forwarded to the Robot Behavior Engine, taking the commands for action or response. Such an engine would dictate how the robot was to move and behave in patterns, consistent with the expectations of the user and environmental constraints.

The knowledge base & data store will form the thinking part of the system and make it smart. The knowledge base & data store stores contextually relevant, historical, and learnt patterns that build interactions and gradually improve decision making over time.

There exist speech processing and the text-to-speech engine forms of architecture that enable the interaction to be more complete, facilitating vocal communication. The module is in charge of speech-to-text conversion purposes, relating processing and vice versa: with the view that the system would be able to orally respond to the users' queries. All of these modules communicate bi-directionally with each other to ensure information flows in the right order, thereby enabling it to run efficiently and respond in a responsive way.

This architecture is good for applications combining conversational AI and robotics while at the same time offering a solid basis upon which to build advanced interactive systems that will be adaptable in different contexts and user needs.

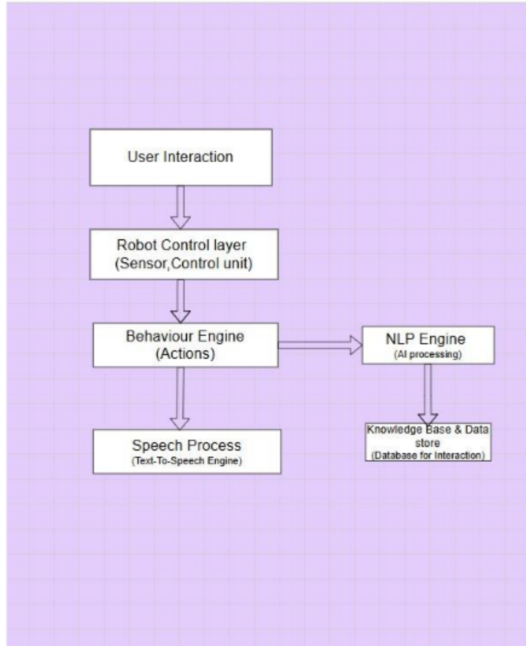

Figure 1: System Architecture

E. Performance Metrics:

Intent Recognition Accuracy: Percent of correct user intent identified which could be discerned through the chatbot.

Accuracy = Total Intents Correctly/ Identified Intents

Intent Recognition Precision: Precision is the proportion of correctly identified intents out of all intents identified as a specific category.

Precision (Intent Recognition) = TP/TP + FP

where TP is true positives and FP is false positives.

Customer Satisfaction Score (CSAT): Average score given by users as feedback to rate their satisfaction.

CSAT =Sum of Satisfaction Score/
Maximum Possible Score

Error Rate: The percentage of user inputs that resulted in incorrect or inadequate chatbot responses.

Error Rate = Error Responses / Total Inputs

Action Success Rate: The percentage of successfully completed commands executed by the robot.Results and Discussion.

Action Success Rate =Successful Actions / Total Actions

IV. RESULT AND DISCUSSION

A. *Experimental* Setup:

Single Board Computer (SBC): Power computer that can run the chatbot application and process the data from sensors. Memory (RAM): At least 4 GB of RAM to run smoothly. Storage: The minimum amount of storage is 32 GB SSD or MicroSD in order to store the data, models, and logs. Rasa NLU: an open source framework for intent recognition and entity extraction. Dialogflow or Microsoft LUIS: Cloud-based solutions that use NLP for intent recognition, entity extraction and also context management. Hugging Face Transformers: It is a library employed for the pre-trained deep learning models like BERT, GPT-2 to recognize more complex language structures. Google Cloud TTS, Amazon Polly or IBM Watson TTS for converting text-to-a-human-like voice response. Google Speech-to-Text, Microsoft Azure Speech, or DeepSpeech to translate spoken language to text. SQLite, MongoDB, Firebase: one or more lightweight databases to store user interactions, logs, and data for improving chatbot response.

Observations:

It is an advanced system combining hardware, AI, natural language processing, and user interaction capabilities. The results from interaction with such a robot, hence its deployment, are critical in understanding functionalities, improving the user experience, performance, and areas requiring further improvement. The chatbot-powered interactive robot mascot is a sophisticated system combining hardware, AI, natural language processing (NLP), and user interaction capabilities. In that sense, observations from the deployment and interaction with such a robot will provide insight into what is working, what is not, and any future improvement.

A box plot is a great representation to show the spread of the attribute against a diagnosis or category if it is continuous numerical data. Suppose we have a set of data, where we would like to analyze how different features perform regarding the diagnosis in a chatbot-enabled interactive robot mascot. We consider various features including response time, movement accuracy, or even engagement-that is, how highly the user was involved in interaction with the robot. analyze the performance of different features (like response time, movement accuracy, or user engagement) with respect to the diagnosis (e.g., whether the interaction was successful or encountered errors, or if the robot performed optimally or suboptimally).

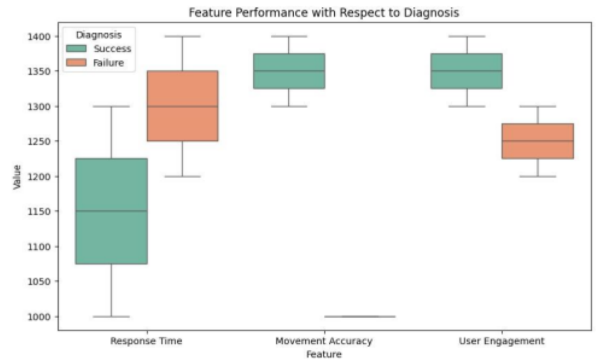

Figure 2: Box Plot

You can see your model learn to do this and, later on, detect some pitfalls such as overfitting or underfitting that may be optimized for higher performance during real-time interactions. This is, in fact, crucial for improving the behavior and efficiency of your chatbot-based interactive robot mascot. Visualization of training and testing data in machine learning is presented as graphs of accuracy, loss, or any other pertinent measures at intervals in time, expressed in terms of epochs or iterations.

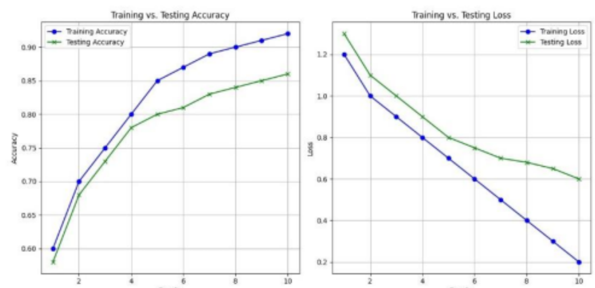

Figure 3: Testing vs Training

A confusion matrix is a detailed way of measuring the performance of a classification model, such as natural language understanding for a chatbot-powered interactive robot mascot. This tool gives insight into how well a classification model distinguishes between different intents or categories-for example, greetings, movement commands, questions. Here, a confusion matrix will come in handy, as it will help to evaluate how accurate the model is at actually making correct classifications beyond the other cases in which it makes mistakes. The confusion matrix gives an overview of the robot mascot powered by the chatbot and its performance on different intents. The confusion matrix can be easily spotted with a heatmap visualization, pointing out misclassifications and areas that can improve the NLU model of a chatbot.

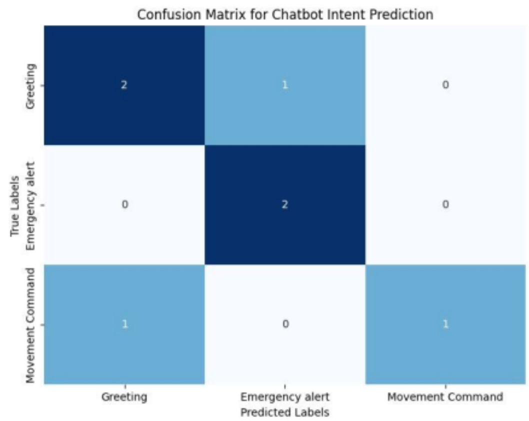

Figure 4: Confusion Matrix

V. Conclusion and Future Work

Designed to create more engaging and personalized experiences with users, these interactive robot mascots combine AI, robotics, and human-computer interaction. They can have a dynamic response via the integration of NLP, speech recognition, gesture detection, and emotion recognition into the pipeline. Emotion recognition in the NLP pipeline would increase the robots' empathy capabilities because, as such, it would take into account each different aspect of users' emotions through facial expressions, tone of voice, or body language. The real use of gesture control through 3D recognition systems would also be able to further improve interaction capability by being able to decipher higher numbers of gestures and expressions. Such developments would therefore lead to more responsive, adaptive, and engaging robots with more natural human-like interfaces within different contexts.

These robots will be more integrated into our daily lives in the future, providing better and deeper interactions, and supporting a wide variety of applications, ranging from personal assistants to companions for the elderly or educational tools for children. This design addresses the current limitations of such designs and focuses on future developments into even more powerful, responsive, and emotionally intelligent robotic companions. It is exciting to envision a new frontier based on this chatbot-powered interactive robot mascot: human-robot interaction that integrates conversational AI with physical robotics.

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