IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 1, February 2024

A Literature Survey on Quadruped AI Assistant: Integrating Image Processing and Natural Language Processing for Emotional Intelligence

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Abstract: *At the nexus of artificial intelligence, robotics, image processing, and natural language processing (NLP), quadruped AI assistants provide a revolutionary method of interacting with machines. Intending to give quadruped AI assistants emotional intelligence, this literature review methodically looks over and compiles the body of research, concentrating on how to use natural language processing and image processing together. The review seeks to offer a comprehensive grasp of the developments, challenges, and possible uses in this diverse subject. The initial section of the survey provides an overview of quadruped robots and highlights how they are integrated with image processing technology to provide visual perception. It explores the various locomotion techniques, demonstrating how these robots use picture data to improve their capacity to navigate and adapt to different situations. The conversation also touches on sensor technologies, highlighting their function in obtaining and deciphering visual data for intelligent interaction. In addition, the research delves into how quadruped AI assistants include natural language processing and examines how these robots interpret and react to instructions in human language. One of the main topics of debate is how sentiment analysis and emotional recognition methods might help these assistants become more emotionally intelligent. Finally, this review of the literature offers a comprehensive viewpoint on how natural language processing and image processing are integrated in quadruped AI assistants, providing academics and practitioners with an outline for developing emotional intelligence in these robots. Compiling knowledge from robotics, artificial intelligence, image processing, and natural language processing is essential to creating emotionally competent quadruped AI assistants and ensuring their smooth incorporation into human-centered settings.This research also investigates the integration of Natural Language Processing and Image Processing for Emotional Intelligence in Quadruped AI Assistants and thoroughly assesses the gyroscope functioning on these robotic systems.*

Keywords: Quadruped AI Assistants, Digital Image Processing, Natural Language Processing, Artificial Emotional Intelligence (AEI).

I. INTRODUCTION

The field of robotics has experienced a significant transformation in the past few years, with the rise of Quadruped AI Assistants as a symbol of the new era. These amazing robotic assistants, distinguished by their four-legged form, signify a revolution in the way humans and robots interact. Their unique design, which draws inspiration from the quadrupeds' natural movement, not only improves their mobility and stability but also presents interesting opportunities for incorporating cutting-edge technologies. This review of the literature takes a fresh approach to this emerging field by investigating how Image Processing and Natural Language Processing combine to give Quadruped AI Assistants emotional intelligence that has the potential to completely change the dynamics of human-robot interactions.

The idea that the combination of Natural Language Processing and Image Processing can open the door to a new level of functionality for Quadruped Assistants is the driving force for this research. These robotic companions can recognize and understand the subtleties of human motions and expressions thanks to image processing, which analyzes and interprets visual data. Natural Language Processing gives them the ability to comprehend and react to textual

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information as well as human voice simultaneously. Combining several sensory systems enables a more thorough awareness of the user's emotional state as well as more nuanced and contextually appropriate interactions, which improves the emotional intelligence of the Quadruped Assistants.

The possible uses for emotionally intelligent Quadruped AIRobots become clearer as we continue thisresearch. These assistants have the potential to meet a variety of social needs, from offering help in educational settings to acting as sympathetic companions in healthcare situations. The survey will examine the present status of research, illuminating light on both the advancements and obstacles that stand in the way of the realization of emotionally intelligent Quadruped AI Assistants. Nevertheless, the journey is not without its problems.

II. LITERATURE SURVEY

2.1Development of an Autonomous Quadruped Robot for Robot Entertainment.

One novel application for autonomous robots in the entertainment sector is called "Robot Entertainment," according to the authors of the study "Development of an Autonomous Quadruped Robot for Robot Entertainment." They present MUTANT, a legged robot that resembles a pet and is outfitted with sensors and a behaviour generating system to engage in a variety of complicated interactions with people. The authors stress the necessity of interaction and control in Robot Entertainment, the possibility for a variety of entertainment applications employing cutting-edge technology, and the importance of building fully autonomous physical agents for entertainment. They also go through the design idea of MUTANT, emphasizing its extensibility as a stand-alone system or a remotely run system for applications like robot soccer, natural human-robot interaction, real-world comprehensive agent capabilities, sophisticated behaviour development, and reusable software.

The core concept of MUTANT's development is the conceptual idea of an entertainment robot similar to a pet, with an emphasis on genuine human connection and the capacity to display sophisticated behaviours. The robot has a behaviour-generating system that includes an instinct/emotion module, a high-level cognition module, and reactive behaviour subsystems. It also has sensors including a touch sensor, a stereo microphone, and a micro-camera. The authors stress the necessity of interaction and control in Robot Entertainment, the possibility for a variety of entertainment applications employing cutting-edge technology, and the importance of building fully autonomous physical agents for entertainment. They also go over MUTANT's design idea, emphasizing its natural human-robot interaction, real-world agent capabilities, production of complicated behaviour, software reusability, and extensibility as a stand-alone system.

The mechanical setup and agent architecture of MUTANT is also addressed in the research, with a focus on the significance of intricate movements, gestures, and behaviours in raising the entertainment value of autonomous robots. The authors emphasize the value of representation and communication through gesture and motion, as well as the quadrupedal mechanical arrangement used for MUTANT. They also stress the significance of different behaviour and motion control subsystems, which can collaborate or compete to produce complex movements and actions in a natural way. The paper also explores the application of MUTANT, describing the design idea, the creation of a DC geared motor and a micro-camera unit, and the factors to be taken into account for a real-world agent architecture that includes complex behaviours, instinct/emotion modules, and coordinated reactive behaviours.

2.2 Quadruped Guidance Robot for the Visually Impaired: A Comfort-Based Approach

The paper describes a brand-new quadruped guiding robot system that is intended to help visually impaired people while keeping them comfortable and safe. The system has a comfort-based planning and control framework together with a configurable traction mechanism. It makes use of a Unitree Laikago quadruped robotic platform that is furnished with RGB-D and LiDAR sensors for mapping, localization, and measuring the location of humans. To plan suitable traction forces, the system uses a force-based human motion model, and to create orders for robot motion, it uses a robot motion planner. The purpose of the traction device, which consists of a force control mechanism and an elastic rope, is to keep the visually impaired person comfortable while providing guiding. Experiments conducted in the real-world show that, in comparison to conventional methods, the suggested solution greatly enhances the comfort of navigation for those who are visually impaired.

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In order to accomplish collision-free human guiding, the paper also highlights the contributions made by the suggested system, such as the creation of a force-based human motion model, a human motion planner, and a robot motion planner. The efficiency of the system in enhancing the comfort and safety of visually impaired persons during navigation is demonstrated by its implementation on the Unitree Laikago platform and its validation in real-world settings. Future work is outlined in the document as well, with an emphasis on more complicated applications such as safe sidewalk navigation with dynamic obstacles and cross-floor guidance tasks. In general, the paper highlights how crucial it is to build guide robot systems for people with visual impairments using a comfort-based methodology.

2.3 A review of quadruped robots and environment perception

The paper offers a thorough analysis of current advancements in the perception of the world by quadruped robots. It classifies mobile robots into three categories: tracked, wheeled, and legged. It emphasizes that because legged robots can walk on uneven surfaces and retain balance, they may be able to function in dangerous and unstructured situations. The capabilities, characteristics, and uses of the several quadruped robots created by diverse research groups are highlighted in this paper's detailed discussion. It also explores the design, functionality, and uses of particular quadruped robot systems, including MIT Cheetah, HyQ, StarlETH, ANYmal, and BigDog. The paper also examines important methods for quadruped robots to perceive their surroundings, such as sensors, feature extraction and identification, mapping, and simultaneous localization and mapping (SLAM). It discusses the challenges and potential avenues for further study in environment perception, highlighting the necessity of intelligent approaches and multi-sensor data fusion to improve robots' comprehension and adaptation of their surroundings.

The paper also highlights the benefits and drawbacks of the several mapping techniques for environment perception, including hybrid, topological, geometrical, and grid maps. Additionally, it examines SLAM (Simultaneous Localization and Mapping) techniques, such as EKF SLAM, FastSLAM, UKF SLAM, Graph SLAM, MonoSLAM, and CoSLAM, that are used for mapping and localization in unfamiliar situations. The paper highlights the significance of feature extraction for complex and extended perceptual tasks and talks about the difficulties in producing maps that are consistent over wide areas. In addition, it discusses the computational challenges posed by SLAM algorithms as map sizes grow, offering a thorough summary of the state of the art and potential future paths for the study of quadruped robotics and environment perception.

2.4 A Study on Locomotions of Quadruped Robot

The objective of the paper "A Study on Locomotions of Quadruped Robot" is to map out a quadruped robot's walking pattern on level ground. The study uses modelling and simulation with MSC ADAMS software to examine the robot's two-phase discontinuous gait for straight-line and turning navigation. The body is moved forward or backward while three legs keep balance on the ground as part of the gait's stability-promoting design. The study highlights how crucial it is to manage impact forces and responses from the ground up, and it recommends the use of force sensors, a compass, an image-processing camera system, and an accelerometer sensor to improve the robot's movement accuracy. The study also emphasizes how important it is to have a precise and trustworthy mechanical framework in order to maximize the robot's movements.

The outcomes of the simulation and experiment shed light on the trajectory and stability of the robot's movement and give a theoretical framework for the creation of motion control algorithms. The study highlights the need for more research to create a more comprehensive motion controller for the robot and recognizes the limits in the simulation conditions, such as the exclusion of the robot's movement on sloping surfaces. The publication highlights the larger context and potential for future developments in this topic by including references to relevant studies on the control and kinematics modeling of multi-legged robots.

2.5 Learning inverse kinematics

This research investigates how humanoid robots might learn inverse kinematics. Specifically, it focuses on resolved motion rate control (RMRC), which resolves kinematic redundancy by applying an optimization criterion. This article addresses the effective utilization of the statistical learning approach, Locally Weighted Projection Regression (LWPR), to acquire the inverse kinematic mappings for highly flexible humanoid robots. The work highlights the importance of

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understanding inverse kinematics in situations when analytical methods are hampered by computing complexity or when the kinematic model of a robot is not precisely accessible. It tackles the issues of non-uniqueness in inverse kinematics solutions for duplicate manipulators and suggests a learning technique that makes it possible for the system to learn a specific inverse and guarantee its validity. The report includes experimental assessments that show how well the suggested learning strategy works to help the robot trace a figure-eight route precisely, even in the presence of limited beginning data. Additionally, it compares the performance of the learned system with an analytical pseudo-inverse and addresses the consistency of the taught inverse kinematics.

The National Science Foundation, the ATR Human Information Processing Research Laboratories, and the Japanese Science and Technology Cooperation's ERATO Kawato Dynamic Brain Project are also acknowledged in the body of the paper. It shows a thorough comprehension of the body of knowledge on the subject of inverse kinematics for humanoid robots and includes references to relevant work in the robotics and learning algorithm domains. The work demonstrates how learning algorithms, like LWPR, may be used to handle difficult, high-dimensional motion planning tasks. This presents a viable solution to the problems caused by kinematic errors and redundancies in robot kinematic models.Overall, the research work offers insightful information about how learning algorithms can be applied to solve inverse kinematics issues in humanoid robotics, demonstrating the possibility of learning inverse kinematic mappings incrementally and accurately even in high-dimensional input spaces.

2.6 Inverse kinematics: a review of existing techniques and introduction of a new fast iterative solver.

The research that is being presented focuses on a new approach to inverse kinematics, known as FABRIK (Forward and Backward Reaching Inverse Kinematics). FABRIK is tested in the experimental setting against widely used IK techniques including CCD, Jacobian Transpose, Jacobian DLS, and Jacobian pseudo-inverse DLS. A 'Y-shape' model, a fully unconstrained hand model, a humanoid model, and unconstrained and restricted joint chains are among the kinematic models used in the study. The results show that, especially in scenarios with significant end effector motions, FABRIK performs better than other approaches in terms of speed, computing economy, and capacity to create realistic and smooth movements. Applications of FABRIK in real-time marker prediction, hand tracking, center of rotation estimation, and managing numerous end effectors are also investigated in this study.

Subsequently, FABRIK has been demonstrated to be a reliable and effective solution for IK challenges, outperforming conventional approaches in terms of time, cost, and animation quality. Applications such as hand tracking, center of rotation estimation, and marker prediction demonstrate its adaptability and validate its potential for real-time deployment in a range of contexts. The results indicate that FABRIK could contribute a substantial contribution to the advancement of IK techniques by providing workable solutions for scenarios involving many end effectors and complicated character models.

2.7 Evaluation of a solid-state gyroscope for robotics applications

Evaluating a Low-cost Solid-state Gyroscope for Robotics Applications is addressed in the paper "Evaluation of a Solid-state Gyroscope for Robotics Applications" which was published in IEEE Transactions on Instrumentation and Measurement in February 1994. In order to estimate the orientation of a moving robot vehicle, the research focuses on creating an error model for the sensor and incorporating it into a Kalman filter. It draws attention to the fact that in order to combat long-term drift in inertial systems, more data from absolute position-sensing methods is required. The history and prospects of inertial navigation systems in robotics and aerospace applications are also covered in the publication, with a focus on the growing availability of inexpensive solid-state inertial systems for robots. The study shows that, even though there is sometimes a requirement for realignment using landmark information, inertial sensors may give useful orientation information for mobile robot applications with careful error modelling.

The implementation of a solid-state gyroscope in an autonomous mobile robot system is further addressed in the document, along with the hardware setup and the need for the robot to self-localize about its surroundings. In order to create an error model for the gyroscope, the data must be recorded for lengthy periods of time. An iterative least-squares fit technique is then used to fit a nonlinear parametric model to the data. The paper lays the groundwork for improved orientation estimation in mobile robot guiding systems by advancing our understanding of the role of inertial

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sensors in robotics and highlighting the potential for increased performance through extensive error modelling and filtering approaches.

2.8 Dynamic locomotion and whole-body control for quadrupedal robots

With an emphasis on the ANYmal robot, the paper provides a thorough framework for quadrupedal robots to perform dynamic gaits. It presents an online motion planner based on Zero-Moment Points (ZMPs) that adjusts the reference motion trajectory in real time according to the robot's condition and contact schedule. This is combined with a hierarchical whole-body controller that solves a series of tasks in order of priority to optimize the whole-body motion and contact forces. The study demonstrates the successful execution of dynamic gaits such as a dynamic lateral walk, pacing gait, and smooth transitions between these gaits on the ANYmal robot, showcasing the framework's capability to adapt to changes in the contact schedule, reference footholds, and high-level operator velocity commands. Future work to enhance gait execution features, such as foothold evaluation and gait pattern adaptation to handle abrupt changes in the robot's state and gait pattern, is also discussed in the document. Additionally, the framework should be extended to include full flight phases for even more agile locomotion.

Summarized, the paper focuses on the ANYmal robot and provides a comprehensive motion planning and control framework for quadrupedal robots to perform dynamic gaits. The hierarchical whole-body controller and online ZMP-based motion planner are described, and their effective use in achieving dynamic gaits and seamless transitions is demonstrated. Further research is necessary to enhance gait execution aspects and expand the framework to incorporate all flight phases for even more agile locomotion, as the study makes apparent.

2.9 CARL: controllable agent with reinforcement learning for quadruped locomotion.

In response to environmental disturbances, the paper proposes a unique method for directing quadruped agents in dynamic environments. It focuses on combining high-level user controls with realistic movements and reactions. The three steps of the suggested method are imitation learning, which maps natural movements from reference motion clips to a physics-based controller; GAN Control Adapter, which maps high-level user controls to joint actions; and DRL fine-tuning, which allows the controller to recover and adapt to new situations. While the DRL fine-tuning enables the controller to respond meaningfully to external disturbances, the GAN Control Adapter is essential in approximating the natural action distribution that was acquired during the imitation learning step. Experiments verifying the controller's capacity to obey commands from the user, generate high-quality motion, and respond to outside disturbances confirm the technique and highlight its promise for a range of robotics and animation applications.

In managing dynamic surroundings and unidentified scenarios, the paper also addresses the drawbacks of conventional techniques like motion graphs and kinematic controllers. The difficulty of creating fresh quadruped animations from motion capture data and the inability of kinematic controllers to react organically to changing surroundings are brought to light. Utilizing deep reinforcement learning and generative adversarial networks, the suggested method overcomes these drawbacks by allowing the quadruped agent to respond to high-level user controls, learn natural movements from reference motion clips, and engage physically with dynamic environments. In order to achieve the ultimate objective of producing controllable and adaptive quadruped locomotion, the document offers comprehensive insights into the three training stages, highlighting the importance of each part.

2.10 The Study of Emotional Intelligence in Artificial Intelligence

This paper investigates the ways in which Artificial Intelligence (AI) and Emotional Intelligence (EI) can be combined, as well as the possible implications for different domains. It highlights how AI must advance emotional detection and understanding in order to humanize intelligent agents and enhance their ability to perceive, comprehend, and react to human emotions. The paper explores the possible uses of emotional intelligence (AI) in business, consulting, healthcare, and education, emphasizing how it might enhance society by offering more effective answers to challenging issues. It also discusses the potential negative effects of emotional AI, like privacy issues and AI manipulating human emotions, highlighting the necessity of using this technology sensibly and morally.

Furthermore, the document analyzes the emergence of Emotional AI in the form of virtual assistants, such as Siri and Google Assistant, and advanced humanoid robots like Sophia. Additionally, it looks at how AI hardware and chips may

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improve Emotional AI, especially in the automobile and medical diagnostics sectors. In order to avert potential detrimental effects on society, the document finishes by underlining the potential of Emotional AI to change how AI interacts with humans and handles societal concerns, while simultaneously emphasizing the necessity for responsible and ethical use of this technology.

2.11Emotion AI, Real-Time Emotion Detection using CNN

The creation of a real-time emotion recognition system with convolutional neural networks (CNNs) is discussed in the document. The MNIST dataset and the ImageNet Challenge were the original training grounds for the LeNet and AlexNet models, which the authors used and modified for emotion recognition. To meet the unique needs of their emotion recognition task, they changed the final softmax layer, retrained the first convolutional layer, and adjusted the input data layer. Additionally, the authors gathered labeled facial expression datasets from other sources, such as the Japanese Female Facial Expression dataset, the Extended Cohn-Kanade dataset, and unique photos. The images were then pre-processed using facial detection software, resampled, and enhanced. Using OpenCV and cloud computing, a real-time interface was created to process pictures using CNN and generate predictions.

The trials and findings demonstrated that the model's quantitative and qualitative performance was greatly enhanced by removing the disdain class, adding photos from the JAFFE dataset, and adding unique images. Using the CK+ dataset, the authors were able to attain over 90% train and test accuracy. By using the JAFFE dataset with custom-made images, they were able to further boost accuracy. Future research directions were also considered, including developing a user interface for iterative model training and using a continuous scale to predict emotion intensity. They also emphasized the necessity for improved datasets designed to comprehend "real" emotions in order to advance emotion identification technologies.

2.12 Emotion detection using natural language process.

The "Emotion Detection using Natural Language Process" publication delves into the creation of an Emotion Detection Model that leverages machine learning (ML) and natural language processing (NLP) ideas to identify emotions at the phrase level. The study highlights the significance of identifying emotions in written expressions, such as happiness, sadness, and rage, in order to improve interpersonal communication. It talks about the difficulties in determining human emotions when they are expressed in writing and the possible uses of emotion analysis, such as enhanced customer service, psychological understanding, and security services. The paper explores the application of Support Vector Machines (SVMs) in supervised machine learning for emotion detection, emphasizing how SVMs are used to build a linear discriminant model that can be used to categorize emotional patterns. The architecture of the suggested emotion detection methodology is also covered, with a focus on the usage of activity diagrams for flow control and the NLTK suite of tools for system testing and error correction. The study ends by discussing the importance of comprehending and identifying emotions from text for a variety of applications, and it includes references to previous research in the topic of emotion recognition.

The paper concludes by highlighting the significance of structuring emotional emotions in writing and the application of context-aware search algorithms to produce results that are specifically tailored. It also highlights the benefits of employing feature augmentation to amplify sentiments and the possibility of increasing the accuracy of emotional recognition. This research highlights the importance of emotion detection using natural language processing and its possible implications for customer service, security, human-computer interaction, and psychological insight. It does this by offering a thorough overview of the methods, problems, and findings in the field.

2.13 A review on emotion detection and classification using speech

An in-depth summary of the developments and difficulties in the field of speech emotion detection can be found in the publication "A Review on Emotion Detection and Classification using Speech". With applications in education, entertainment, medical diagnosis, and consumer comprehension, it highlights the growing significance of efficient human-machine communication. In order to classify emotions, the research examines a number of speech variables, including Mel Frequency Cepstral Coefficient (MFCC), Fundamental frequencies, and Linear Prediction Cepstral Coefficient (LPCC). It also emphasizes how important it is to automate systems that can identify emotions in speech in

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order to enhance customer comprehension and decision-making. The review article compares and contrasts various methods for detecting and classifying emotions, highlighting the significance of feature extraction, classification algorithms, and database selection for precise outcomes. The results and comments section describes the difficulties in detecting emotions, including words with various sentiment contrasts, noisy audio, and homophones, and discusses the role that machine learning algorithms play in overcoming these difficulties.

The report concludes by highlighting the necessity of fostering natural communication between humans and robots, given the anticipated rise in machine dependency in the years to come. Additionally, it emphasizes how crucial feature extraction, database selection, and classification algorithms are to getting precise emotion identification from voice signals. According to the analysis, MFCC is the most crucial method for extracting features from speech, yet the accuracy is mostly dependent on the database that is used. The study also addresses the difficulties in detecting emotions, including the use of machine learning methods to overcome problems with words that have many sentiment polarities, noisy audio, and homophones. All things considered, the paper offers a thorough review of the developments, difficulties, and potential paths in the field of speech emotion recognition, emphasizing the growing significance of efficient human-machine communication and the growing dependence on machines for a variety of purposes.

2.14 Recognizing Emotion Presence in Natural Language Sentences

A technique designed to automatically identify emotions in natural language sentences is demonstrated in the document "Recognizing Emotion Presence in Natural Language Sentences". Using lexical resources like WordNet Affect and Stanford parser to analyze sentence structure and Tree Tagger to identify emotional terms, the system employs a keyword-based method. The power of emotional words and how they interact with one another are then used to identify the emotional state of a phrase. The system's performance was assessed by an experimental investigation, and the results showed promise in terms of high recall, precision, and F-measure metrics for the classification of emotion presence. The system's capacity to describe the intensity of emotions was also evaluated by the study, and it showed good agreement with human annotators in this regard. Potential areas of improvement are highlighted in the body of the paper, including adding more lexical resources to the knowledge base and incorporating a neural network approach for emotion recognition.

The research paper concludes by giving a thorough overview of the constructed emotion recognition system, including information on its functionality, architecture, and performance assessment. It highlights how important it is to identify emotional content in textual material and how this recognition could be used to improve human-computer interaction. The methodology of the system, the outcomes of the experiments, and the future areas of research are all covered in detail, highlighting the system's encouraging performance and the possibility of future improvements to increase the system's accuracy and emotional detection range.

2.15 Analysis of Intelligent Machines using Deep learning and Natural Language Processing

The paper provides a thorough examination of intelligent machines with an emphasis on the contributions made by deep learning, natural language processing (NLP), and artificial intelligence. It highlights how crucial it is for intelligent machines to comprehend natural language and produce machine-level natural language. This study examines how natural language processing (NLP) functions, such as natural language generation (NLG) and natural language understanding (NLU), as well as how speech-to-text conversion and grammatical tenses understanding work. It also explores the importance of deep learning, namely the operation of deep neural networks and the use of models like Recurrent Neural Network (RNN) and Convolution Neural Network (CNN) for processing and image identification.

In conclusion, the paper offers a thorough explanation of how intelligent machines function, highlighting the role that natural language processing (NLP) and deep learning have played in this progress. It covers a wide range of topics, including the possibility of building extremely intelligent machines, sentiment analysis, problem-solving, and decision-making. The document provides a thorough review of the developments in this field and the possible uses of intelligent machines in a variety of domains, and it also includes references to pertinent publications and conferences.

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2.16 A survey of image processing and identification techniques

A comprehensive overview of the many image processing techniques and their uses can be found in the paper "A Survey of Image Processing and Identification Techniques". It highlights how important image segmentation is to making visual data easier to perceive and interpret by machines. This study explores the basic phases of image processing, emphasizing the importance of methods like Otsu's segmentation method, feature extraction, support vector machine (SVM), and artificial neural network (ANN) image classification. The paper also looks at the use of image-processing techniques in agricultural settings, including the automatic identification of rapeseed plant growth stages and the use of segmentation and genetic algorithms to detect plant diseases.

The use of image processing technology for scaffolding progress monitoring in LNG plant maintenance projects is also covered in the document, with a focus on how Building Information Modeling (BIM) and image processing technologies work together to provide precise progress tracking. The study highlights the value of automated systems in early disease identification and discusses the benefits and drawbacks of employing image processing techniques for the diagnosis of plant diseases. All things considered, the paper offers a thorough examination of numerous image processing methods, their uses, and their effects on a range of domains, making it an invaluable tool for scholars and professionals working in the fields of image processing and identification.

2.17 Toward Artificial Emotional Intelligence for Cooperative Social Human–Machine Interaction

The creation of an emotion-based assistive system through a multimodal approach for active human-robot interactions (HRI) is covered in the publication. It describes in detail the architecture of the proposed system, which analyzes and detects human emotions from voice and facial expressions using deep neural networks and emotion identification techniques. The study draws attention to the shortcomings of current emotion detection techniques, especially their assumption of a baseline emotional state that is neutral and their requirement for discretizing emotional state changes. In order to overcome these drawbacks, the suggested solution trains the network to recognize emotional shifts and modify the robot's actions accordingly. With the goal of enhancing the effectiveness and personalization of social robotics, the study also highlights how critical it is to comprehend and address human emotions in HRI scenarios.

The paper also includes talks on the suggested emotion-based assistance system and testing outcomes. It shows how the system can identify and anticipate human emotional states, which promotes a natural link between people and robots. The study also addresses the difficulties in applying emotion detection software to users with varying skin tones and provides first findings demonstrating the viability of the suggested strategy in resolving these issues. The study's conclusion highlights the suggested system's potential uses in the future, such as boosting computational efficiency and social intelligence for assistive robotic systems. The publication also highlights the significance of expanding the effort to encompass additional users and investigating user recognition and voice activation in the multimodality area.

2.18 Facial emotion recognition system through machine learning approach

The creation of an Automatic Facial Emotion Recognition (FER) system with a machine learning methodology is covered in the document. The goal of the project is to develop a system that can identify emotions from real-time webcam photos and prescribe music therapy to those who are anxious. A number of steps are included in the FER system: preprocessing, face identification, feature extraction, emotion categorization, and image acquisition. Six widely acknowledged emotions—happiness, sadness, surprise, fear, disgust, and anger—are the subject of the study. The user interface, emotion detection block, preprocessing stage, face detection stage, feature extraction stage, and emotion classification stage make up the system architecture. In addition, the authors present a review of the literature, highlighting the significance of spontaneous emotion databases in practical settings and going over different techniques and databases used for emotion identification systems. The paper also addresses several face expression databases that are employed in emotion identification research and stresses the necessity of real-time emotion detection.

The goal of the research is to meet the growing demand for computers to be able to understand and react to human speech as well as behavioural indicators of emotions and mental states. It highlights the significance of facial expressions, particularly those pertaining to affective and cognitive mental processes. By providing music therapy depending on the emotions of the patient, the proposed FER system offers intriguing possibilities for persons experiencing stress during working hours. It is designed to be independent of aspects like gender, age, ethnic group,

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beard, history, and birthmarks. The paper highlights the significance of incorporating real-world settings for trustworthy emotion identification systems and offers insights into various methodologies, datasets, and applications relevant to human emotion recognition.

In conclusion, the paper provides a thorough examination of the process of creating an Automatic Facial Emotion Recognition system using a Machine Learning methodology. It also describes the different phases of the system's architecture and discusses the system's potential to help people who are stressed out by providing music therapy. It also highlights the importance of identifying and reacting to human emotions and mental states in computer interfaces by giving an overview of the body of research, databases, and the necessity of real-time emotion detection in real-world scenarios.

2.19 Emotion Detection using Image Processing

The application of image processing for emotion detection is covered in the paper, with a focus on its importance in a number of domains, including education, healthcare, and security. The goal of the research is to apply deep learning methods to create an emotion detection model on a tagged image dataset. In order to improve performance, preprocessing and augmentation are used in conjunction with the MobileNet model for transfer learning. Early halting and model checkpointing strategies are used in the study, which leads to accurate real-time facial expression-based emotion identification. The article highlights the potential uses of emotion detection in security, healthcare, and education, highlighting how it might be used to identify suspects, detect depression, and measure student involvement.

Additionally, the examination of the literature indicates that Convolutional Neural Networks (CNNs) are widely used for emotion detection, and that researchers are investigating methods like Support Vector Machines (SVMs) and Deep Belief Networks (DBNs). Furthermore, the development of datasets such as CK+, AffectNet, and FER2013, in addition to picture preprocessing methods, are recognized as variables that enhance the accuracy of emotion identification. The assessment of emotion detection systems using several metrics is also covered in the study, with a focus on the importance of accuracy, precision, recall, and F1-score.

The study's future scope is outlined, outlining possible research directions including the creation of more complex deep learning architectures, sophisticated pre-processing feature extraction, and the incorporation of image recognition models into a range of industries and applications. In order to guarantee responsible usage, the text also emphasizes the necessity of ongoing study into the moral implications of picture recognition and classification models, as well as the need for legislative and policy frameworks. In summary, the efficacy of image processing-based emotion detection is emphasized, along with its prospective applications in the domains of psychology, marketing, and healthcare. Its role in enhancing mental health treatments, human-robot interactions, and user experiences is highlighted. Overall, the study shows image processing for emotion detection as a promising topic with a wide range of possible applications, particularly as technology develops and more data becomes accessible.

2.20 Facial Emotion Detection Using Deep Learning

In the document, the design and assessment of a convolutional neural network (CNN) architecture are the main topics of discussion about the creation of an artificial intelligence (AI) system for deep learning-based face emotion recognition. The importance of human emotion recognition from photos and the difficulties it presents for social communication are emphasized in the paper. It draws attention to the three primary processes in emotion detection: feature extraction, emotion categorization, and face detection. The Japanese Female Facial Emotion (JAFFE) dataset and the Facial Emotion Recognition Challenge (FERC-2013) dataset were used by the authors to assess the performance of a CNN-based deep learning architecture that they had suggested. For the FERC-2013 and JAFFE datasets, the suggested model yielded accuracy rates of 70.14% and 98.65%, respectively. The paper also explores adjacent fields such as deep learning for emotion recognition, image classification methods, and human facial expressions.

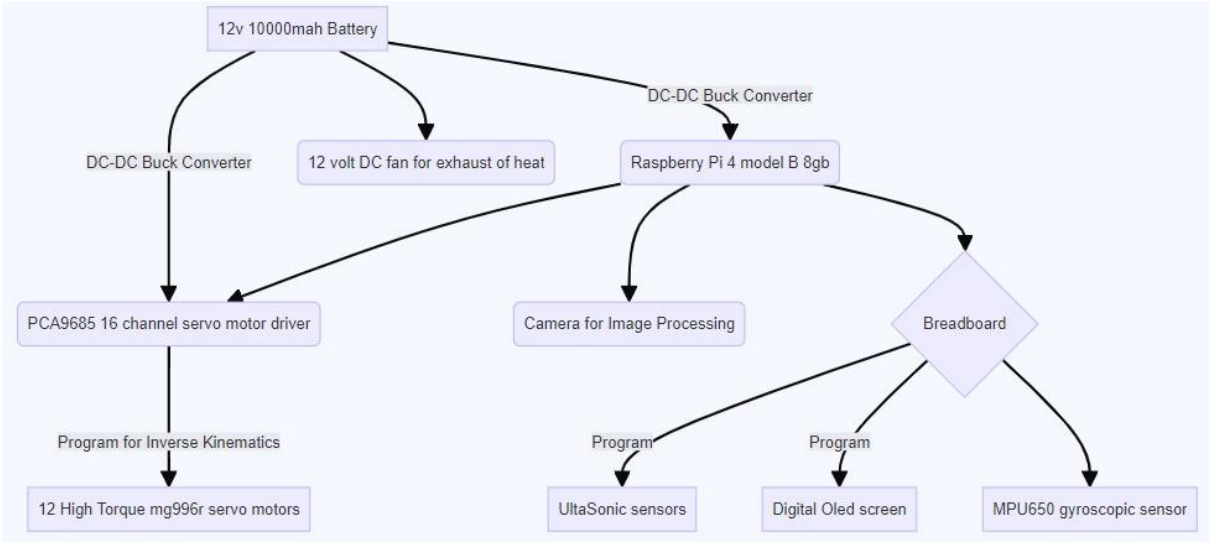
The paper also offers a thorough analysis of the CNN architecture employed in the suggested model, going over how input images are extracted, how feature extraction sub-models are concatenated, and how particular layers like convolutional layers, local contrast normalization, maxpooling, and softmax are used to classify emotions. The comprehensive presentation includes the training specifics, outcomes, and performance assessment of the suggested

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 1, February 2024

approach. The suggested model outperforms the prior model (Model B) in terms of validation accuracy, loss, and computational time per step, according to a comparative analysis. A qualitative evaluation of the suggested model for emotion detection is also included in the publication, showcasing its superior performance over the prior model and its efficacy.

The paper concludes by highlighting the improvements made possible by the suggested model and presenting it as a cutting-edge method for identifying face emotions in photos. It draws attention to the importance of the study and its possible effects on a range of applications, including emotional computing, human-computer interaction, leisure, commerce, physical and mental health, and applications connected to education. The study approach, experimental specifics, and the significance of the suggested model's performance in the area of deep learning and CNN architecture-based emotion recognition are all covered in detail in this work.

III. PROPOSED ARCHITECTURE



- **12v 10000mah Battery:** A 12V 10000mAh battery serves as the main power source for the Quadruped AI Assistant, specifically powering the Raspberry Pi 4, the robot's central computer, ensuring uninterrupted and portable energy for optimal performance.
- **PCA9685 16 channel servo motor driver:** PCA9685 is a 16-channel servo driver commonly used in robotics and automation; it allows precise control of servo motors by generating PWM signals, making it ideal for smooth and accurate movement in various applications.
- **DC-DC Buck Converter:** A DC-DC buck converter efficiently steps down voltage, matching the voltage requirements of components like servo motors and Raspberry Pi 4, ensuring a stable and regulated power supply for optimal performance in robotics and electronic applications.
- **12V DC fan:** A 12V DC fan serves as a heat exhaust component in a Quadruped AI Assistant, effectively dissipating heat generated by the system to maintain optimal operating temperatures, enhancing overall performance and longevity.
- **Raspberry Pi 4 model B 8gb:** The Raspberry Pi 4 Model B 8GB acts as the main computer for a Quadruped AI Assistant, utilizing its 8GB RAM to implement emotional intelligence algorithms and drive servo motors through inverse kinematics, ensuring precise and sophisticated motion control in the robot.
- **Camera for Image Processing:** The 720p camera module integrated into the Quadruped AI Assistant facilitates image processing, enabling the robot to analyze visual data with clarity and precision for tasks such as object recognition, navigation, and human interaction.

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- **Breadboard:** The breadboard in the Quadruped AI Assistant serves as a versatile prototyping platform, allowing easy and temporary connection of electronic components for testing and refining circuits, supporting the development and integration of various functionalities in the robot.
- **Program for Inverse Kinematics:** The Inverse Kinematics program in the Quadruped AI Assistant calculates joint angles to achieve desired end-effector positions, enabling precise control and coordination of the robot's leg movements for optimal stability and motion planning.
- **High Torque mg996r servo motors:** The high torque MG996R servo motors in the Quadruped AI Assistant deliver robust rotational force, ensuring powerful and precise leg movements for enhanced stability and agility in various robotic tasks.
- **Ultrasonic sensors:** Ultrasonic sensors in the Quadruped AI Assistant use sound waves to measure distances, enabling the robot to perceive its surroundings and avoid obstacles, enhancing navigation and safety during autonomous movements.
- **Digital OLED Screen:** The digital OLED screen in the Quadruped AI Assistant functions as an expressive interface, displaying animated emotions and enhancing human-robot interaction by visually conveying the robot's feelings, contributing to a more engaging and communicative experience.
- **MPU650 gyroscopic sensors:** The MPU650 gyroscopic sensors in the Quadruped AI Assistant provide precise orientation data, enhancing stability and balance by continuously monitoring the robot's angular movements, crucial for coordinated and agile navigation.

IV. CONCLUSION

In conclusion, a fascinating new area in artificial intelligence research is the fusion of natural language processing with Image processing for enhanced emotional intelligence in Quadruped AI systems. This synthesis demonstrates the increasing interest in granting AI systems language and vision skills in order to enable a more compassionate and socially aware existence.

These AI systems become more successful at understanding and reacting to human emotions when they incorporate image processing, which gives them the capacity to recognize visual signals and facial expressions. This sense of sight enhances the verbal understanding made possible by natural language processing, enabling AI systems to perceive and interpret context-specific emotional subtleties and have meaningful conversations.

The many studies that are reviewed here demonstrate the potential benefits of this integration, including enhanced user engagement, personalized replies, and more complex comprehension of user emotions. Beyond these advantages, there is great potential for applications in healthcare, education, and other fields where human-robot interaction is essential when emotional intelligence is included in AI systems.

Even with these encouraging developments, issues including concerns about privacy, ethical dilemmas, and the need for reliable algorithms to recognize and react to emotions correctly still exist. Future studies should focus on resolving these issues, improving on current models, and exploring novel strategies to strengthen AI systems' emotional intelligence.

Essentially, the merging of natural language processing with Image processing in artificial intelligence systems sets the stage for a new age of emotionally aware computers that can navigate intricate social situations. As this subject develops, it becomes more and more possible that these intelligent systems will become a seamless part of our everyday lives, providing support and understanding in a variety of circumstances.

V. ACKNOWLEDGEMENT

We wish to express our profound gratitude to Dr. Kiran Y C, our mentor, for all his help and assistance during our literature review on the topic of integrating Natural Language Processing and Image processing for emotional intelligence in quadruped AI robots.

We also thank the writers and researchers whose work has been assessed and greatly aided in the development of this research. We appreciate the Global Academy of Technology for its resources and assistance.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
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Volume 4, Issue 1, February 2024

We appreciative to our friends and colleagues for their insightful critiques and lively debates that have influenced the direction this study has taken. Special thanks go out to our families for their steadfast support.
Without the combined efforts of these people and organizations, our work would not be feasible. We are pleased for your insightful advice and support.

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Impact Factor: 7.53
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