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Review on Versatile Robotic Manipulation System

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ABSTRACT

The development of a robotic arm controlled by natural arm movements, coupled with voice commands and features like color recognition and facial recognition, holds great potential for aiding visually impaired individuals in object manipulation. This innovative technology not only enhances safety but also addresses accessibility concerns, showcasing a promising step toward inclusivity in various scenarios. The proposed concept involves creating a robotic arm that mimics human arm movements, allowing users to control it naturally. This robotic arm aims to perform repetitive tasks, such as moving objects, and is designed to assist individuals in situations where manual handling is challenging. The system utilizes voice commands processed by a custom MIT App Inventor app, enhancing usability for visually impaired users. Moreover, the robotic arm incorporates color recognition to assist individuals and facial recognition technology for identifying known individuals. The integrated speaker system alerts users to the presence o f unfamiliar faces, contributing to enhanced safety. This versatile technology not only facilitates object manipulation but also promotes accessibility and safety, particularly benefiting those with visual impairments. By focusing on enhancing safety and accessibility, this innovative technology not only assists visually impaired individuals in object manipulation but also contributes to a more inclusive and secure environment. The combination of robotic manipulation, voice control, color recognition, and facial recognition showcases a multi-functional and adaptable system designed to cater to diverse user needs.

INTRODUCTION

The Robotic arm aims to provide a versatile and inclusive solution for both blind and sighted individuals. Utilizing components such as ESP32, MIT INVENTOR mobile app, buzzer, motors, motor driver, servo motors, and a color detector, this project seeks to enhance accessibility and functionality. The robotic arm operates in two modes— automatic and manual, catering to the specific needs of users. This innovation particularly focuses on aiding visually impaired individuals, while also serving the broader community. The innovative use of a color detector in automatic mode adds a layer of sophistication. By recognizing and responding to different colors, the robotic arm showcases enhanced adaptability, making it an intelligent tool for a variety of applications.

LITERATURE REVIEW

S. Dwijayanti, M. Iqbal and B. Y. Suprapto. [1], The paper delves into the real time implementation of face recognition and emotion recognition within the context of a humanoid robot, employing Convolutional Neural Networks (CNNs) as the foundational technology. The core objective is to endow the humanoid robot with the ability to not only identify faces but also discern and respond to the emotional states of individuals through sophisticated neural network- based processing. The utilization of CNNs is a key highlight, representing a state-of-the-art approach in computer vision. These neural networks are designed to automatically and adaptively learn spatial hierarchies of features from input data, making them particularly effective for image- related tasks. In this case, the CNNs are trained to recognize intricate patterns and distinctive features in facial images, enabling the robot to accurately identify individuals in real-time scenarios. Ee Feng Zhan, Han Pang Huang. [2], Imitation system for a humanoid robot is a technology that allows the robot to mimic and replicate human actions and behaviours. This system typically involves sensors, cameras, and algorithms to observe and analyse human movements, and then enable the robot to perform similar actions.

This innovative approach empowers robots to not only observe but also learn and replicate intricate human movements and behaviors. The significance of this lies in the robot's newfound ability to adapt dynamically to there surroundings, breaking away from the rigidity of pre-programmed instructions. Imitation systems serve as a conduit for machines to acquire skills through observation and demonstration, fostering a more intuitive and context-aware interaction with their environment and human counterparts. Beyond the confines of traditional programming, these systems allow humanoid robots to learn new tasks in a manner akin to human learning, enhancing their versatility and adaptability. E. Morozova, G. Demidova and A. Rass Ikin. [3],This project aims to advance the field of wearable robotics through the development and simulation of a robotic glove prototype. Wearable robotic devices, particularly in the form of gloves, hold immense potential for augmenting human capabilities in various domains. The focus of this endeavor is on the design, creation, and virtual testing of a sophisticated robotic glove that integrates seamlessly with the human hand. By leveraging simulation techniques, the project endeavors to optimize functionality, enhance user experience, and explore potential applications in fields such as rehabilitation, industrial automation, and human-machine interaction. This innovative venture seeks to contribute to the evolution of wearable robotics, paving the way for more efficient and ergonomic human-robot collaborations.

M. Wairagkar et of. [4], This study presents the development and validation of an Internet of Things (IoT)-enabled social robot designed to convey emotions througha hybrid face. The robot features a humanoid hybrid face that combines a rigid faceplate with a digital display, effectively conveying complex facial movements and emotions. The research maps specific facial feature parameters to emotions and assesses the recognizability of archetypical facial expressions, incorporating pupil dilation as an additional dimension for emotion conveyance. Human interaction experiments reveal the robot's ability to effectively convey emotions, as demonstrated through neurophysiological electro encephalography (EEG) responses and qualitative interviews. Results indicate that humans can discriminate core hybrid-face robotic expressions with over 80% recognition, evoking face-sensitive neurophysiological event- related potentials in EEG. The concept has been implemented in the commercial IoT robotic platform "Miko," showing comparable EEG responses and recognition rates above 90%.

B. He, Q. Miao, Y. thou, Z. Wang, G. Li and S. Xu. [5], Visual tactile perception refers to the brain's ability to integrate visual and tactile information, allowing us to perceive and understand the world through both sight and touch. This integration occurs in the brain's sensory processing areas, where signals from the eyes and skin are combined to create a unified perception of objects and the environment. Research in this area helps us understand how the brain processes and integrates different sensory inputs, contributing to our overall perception of the world.

S. Gushi, Y. Shimabukuro and H. Higa. [6], The paper proposes a self-feeding assistive robotic arm designed to aid individuals with physical disabilities in their extremities. This innovative technology aims to enhance independence by facilitating the process of feeding. The robotic arm is likely equipped with sensors and adaptive mechanisms to cater to a variety of user needs, promoting accessibility and improving the overall quality of life for those with physical limitations.

S. A. Khan, T. 7. Anika, N. Sultana, F. Hossain and M. N. Uddin. [7], This paper represents the design and implementation of color sorting robotic arm which can detect the exact position of an object and can pick up the object to place it in designated place. This robotic arm is like human arm which can rotate according to its predefined angles. On the other hand, detecting an object on color basis is done by ultrasonic sensor & color sorting sensor. The heart of this project is microcontroller board ATMEGA328P which controls servo motors used in base, elbow, wrist and grip.

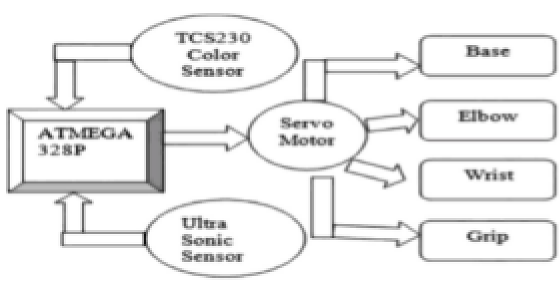
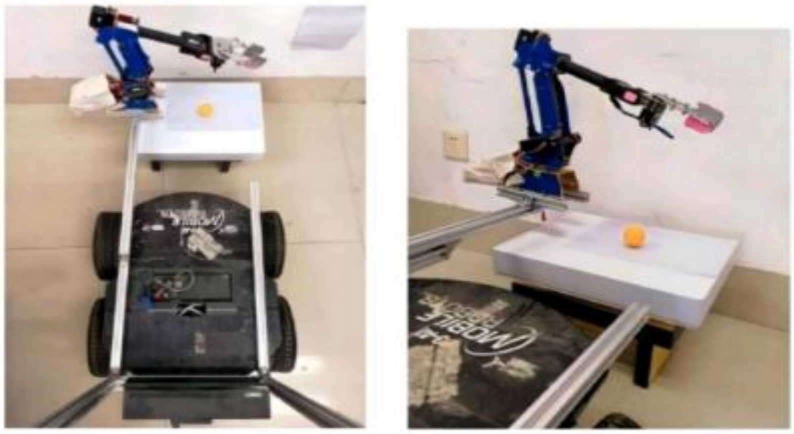


Fig. 1 Overview of the system

P. Wisanuvej, P. Giataganas, K. Leibrandt, J. Liu, M. Hughes and G. -Z. Yang. [8], This project introduces a novel approach to endomicroscopy using a threedimensional robotic-assisted system with a force adaptive robotic um. This technology likely integrates advanced imaging capabilities within an endoscopic device, enabling detailed examination of internal structures. The force adaptive robotic arm suggests a system designed to respond to varying tissue resistances, providing a more controlled and safer exploration. This innovation has the potential to enhance diagnostic procedures by improving the precision and adaptability of endomicroscopic examinations. The combination of 3D robotics and force adaptability signifies a significant step forward in achieving more effective and responsive medical interventions through endoscopic procedures.



(a) (b)

Fig. 2 (a)Top view and (b)oblique view of the experimental environment

PAPER COMPARISON

PROJECT TITLE	AUTHORS	COMPARITIVE STUDY
Real-Time Implementation of Face Recognition and Emotion Recognition in a Humanoid Robot Using a Convolutional Neural Network	S. Dwijayanti, M. Iqbal and B. Y. Suprapto.	This project pioneers the integration of real-time facial and emotional recognition into humanoid robots using Convolutional Neural Networks (CNNs). The emphasis lies in advancing human-robot interaction capabilities, allowing the robot to dynamically respond to facial expressions and emotions. The novelty of this project lies in the application of CNNs for quick and accurate recognition, contributing to the evolving landscape of socially intelligent robots. It focuses on Real-time face and emotion recognition in humanoid robots.
Imitation System for Humanoid Robots.	Ze Feng Zhan,Han Pang Huang.	Behavioral approach — imitation systems for humanoid robots. This project explores the development and applications of an imitation system for humanoid robots. By mimicking human behaviors, it aims to enhance adaptability and learning capabilities. The reseach contributes to advancing humanoid robotics through a behavioral approach, potentially enabling robots to imitate and learn from human actions for various applications.

Robotic Glove Prototype: Development and Simulation	E. Morozova, G. Demidova and A. RassÖlkin.	Focused on hardware development, these projects involve creating prototypes — a robotic glove and a robotic arm. The simulation phase in the glove project signifies meticulous design, while the robotic arm project advances tangible robotic components. Both contribute to the field by pushing the boundaries of robotics hardware, with potential applications ranging from industry to healthcare.
Emotive Response to a Hybrid-Face Robot and Translation to Consumer Social Robots	M. Wairagkar et al.	Investigating emotive responses to a hybrid-face robot, this project aims to enhance emotional expressiveness in robots. The findings are translated for potential integration into consumer social robots, emphasizing practical applications in the consumer market. The research explores the nuances of human emotions and expressions, paving the way for emotionally intelligent robots in consumer-oriented settings.
Review of BioinspÉed Vision-Tactile Fusion Perception (VTFP): From Humans to Humanoids	B. He, Q. Miao, Y. Zhou, 2. Wang, G. Li and S. Xu.	Offering a comprehensive review, this project bridges insights from human sensory fusion to humanoid robots. The integration of bioinspired vision-tactile fusion perception con4ibutes to enhancing percepNal capabilities in robotic systems. By drawing paallels with human sensory fusion, the project explores novel avenues for improving

		humanoid interactions and understanding complex environments.
A Self-Feeding Assistive Robotic Arm for People with Physical Disabilities of the Extremities	S. Gushi, Y. Shimabukuro and H. Higa.	Addressing a crucial societal need, this project focuses on developing a self-feeding assistive robotic arm for individuals with physical disabilities. The humanitarian application aims to improve the quality of life for those facing challenges in feeding due to physical limitations. Considerations include user adaptation and safety measures for effective integration into the lives of individuals with disabilities.
Color Sorting Robotic Arm.	S.A. Khan, T.Z. Anika, N. Sultana, F. Hossain and M. N. Uddin.	The integration of sensors for object detection, a microcontroller for decision-mamng, and servo motors for precise movement enables the Color Sorting Robotic Arm to autonomously identify and manipulate objects based on their colors. This project showcases a practical application of robotics and automation in sorting and handling colored objects.

CONCLUSION

This project is not merely a technological marvel but a comprehensive solution that addresses the challenges faced by both blind and sighted individuals. It envisions a future where assistive technology seamlessly integrates into daily life, empowering users with autonomy security, and accessibility. The Voice-controlled Robotic Arm, with its multifaceted functionalities, embodies the spirit of technological innovation for the betterment of society, marking a significant stride towards a more inclusive and interconnected future.

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