OPEN ACCESS
Journal of Computer Science Advancements
Vol. 3 No. 4. August 2025, pp. 195-204 DOI. 10.70177/jsca.v3i4.2348

Research Article

IMPLEMENTATION OF COMPUTER VISION AND NATURAL LANGUAGE PROCESSING IN SOCIAL ROBOTS FOR MORE NATURAL AND INTUITIVE HUMAN-ROBOT INTERACTION

Muchamad Sobri Sungkar[1], James Chirwa[2], and Giorgi Bagrationi[3]
[1] Politeknik Harapan Bersama, Indonesia
[2] University of Malawi, Malawi
[3] Tbilisi State University, Georgia

Corresponding Author:

Muchamad Sobri Sungkar,
Electronic Engineering Study Program, Hope Together Polytechnic.
44M5+766 eks-Poltek Harber, Jl. Mataram No.9, Pesurungan Lor, Kec. Margadana, Kota Tegal, Jawa Tengah 52147, Indonesia
Email: sobrisungkar@gmail.com

Article Info
Received: February 2, 2025
Revised: May 12, 2025
Accepted: July 19, 2025
Online Version: August 10, 2025

Abstract
The rapid advancement of artificial intelligence (AI) has driven significant developments in social robotics, particularly in enabling more natural and intuitive human-robot interaction (HRI). However, current social robots often struggle to interpret multimodal human input effectively, leading to limited contextual understanding and reduced interaction quality. This study addresses these challenges by integrating computer vision (CV) and natural language processing (NLP) to enhance robots' perceptual and communicative capabilities. The primary aim is to design and evaluate an interaction framework that allows social robots to recognize human emotions, gestures, and spoken language more accurately, thereby improving the fluency of HRI. A mixed-methods approach was employed, combining experimental implementation with qualitative user studies. The system architecture integrates real-time image recognition, gesture tracking, and speech understanding modules, which were tested through laboratory simulations involving 50 participants in controlled social scenarios. The results demonstrate that robots equipped with CV and NLP modules achieved a 30% improvement in gesture recognition accuracy, a 25% increase in contextual language understanding, and significantly higher user satisfaction scores compared to baseline models. Users reported that the robots exhibited more human-like responsiveness and adaptability in conversational settings. These findings suggest that combining computer vision and NLP substantially improves the naturalness and intuitiveness of human-robot interactions. This research highlights the importance of multimodal AI integration for the next generation of socially intelligent robots and paves the way for applications in healthcare, education, and service industries.

Keywords: Human-Robot Interaction, Computer Vision, Multimodal AI, Natural Language Processing, Social Robots

Journal Homepage	https://research.adra.ac.id/index.php/jcsa
How to cite:	Sungkar, M. S., Chirwa, J., & Bagrationi, G. (2025). Implementation Of Computer Vision And Natural Language Processing In Social Robots For More Natural And Intuitive Human-Robot Interaction. *Journal of Computer Science Advancements, 4*(4), 195-204. https://doi.org/10.70177/jsca.v3i4.2348
Published by:	Yayasan Adra Karima Hubbi

INTRODUCTION

Social robots have emerged as interactive systems designed to engage humans in various settings such as education, healthcare, and public services (Aguzzi et al., 2025). These robots rely on artificial intelligence technologies to interpret and respond to human behavior, aiming to create meaningful and efficient interactions. (Li et al., 2025) Human-Robot Interaction (HRI) has been a central focus of research, where communication between humans and robots is expected to be as natural and seamless as possible (Fu et al., 2025). Studies have shown that the quality of interaction depends on a robot's ability to perceive and process human cues accurately.

Advancements in computer vision have enabled robots to recognize visual patterns such as faces, gestures, and postures (Zhang et al., 2025). This visual perception equips robots with the ability to detect contextual signals that are critical for interpreting non-verbal communication (Brunello et al., 2025). Progress in natural language processing (NLP) has contributed to speech recognition and understanding, allowing robots to process spoken commands and respond appropriately (Blavette et al., 2025). Recent deep learning techniques have made NLP systems more robust and context-aware.

Integration of multimodal data, particularly visual and linguistic information, has been acknowledged as essential to improving HRI (Lefranc et al., 2025). A robot that can simultaneously understand what it sees and hears can potentially respond in a more human-like manner (Triana R et al., 2025). Several successful applications of social robots in classrooms, therapy, and elderly care demonstrate the promise of these technologies in enhancing learning experiences and social engagement (Sun et al., 2025). These applications have shown that robots can be valuable tools for supporting human needs in specific contexts.

Existing social robots still face challenges in interpreting multimodal human inputs when these inputs occur simultaneously in dynamic, real-world settings (Shah et al., 2025). The ability to fuse visual and linguistic data effectively remains limited, resulting in less intuitive communication (Chen & Adel, 2025). Current systems often fail to capture nuanced human emotions and gestures in real time, causing a gap between user expectations and the robot's capabilities (Takahashi et al., 2025). Many interactions become rigid, reducing the perceived naturalness of communication.

Research on adaptive algorithms that combine computer vision and NLP in a single integrated framework is still scarce (Takahashi et al., 2025). Most studies analyze these components separately rather than examining how their combination can enrich human-robot interaction (Wang & Ahmad, 2025). There is a lack of empirical evidence on how multimodal AI can influence user satisfaction, trust, and engagement in social contexts (Wang & Ahmad, 2025). This limitation makes it difficult to design robots that can perform effectively in education and other sensitive domains.

Bridging these gaps is essential because social robots are increasingly deployed in environments where human communication is rich, dynamic, and multimodal (Liu et al., 2025). A robot that can analyze facial expressions, gestures, and speech concurrently will be better equipped to engage users naturally (Merino-Fidalgo et al., 2025). Development of an integrated framework that combines computer vision and NLP holds the potential to transform HRI from rigid exchanges into fluid and intuitive conversations (Ghosh et al., 2025). Such advancements could benefit education, healthcare, and public services by improving user experience and effectiveness.

The purpose of this study is to design and evaluate a multimodal AI system for social robots that integrates computer vision and NLP to enhance recognition of emotions, gestures, and language (Y. Zhou et al., 2024). It is hypothesized that this integration will significantly improve the naturalness and intuitiveness of human-robot interactions.

RESEARCH METHOD

Research Design

This study employed a mixed-methods research design that combined experimental implementation with qualitative user evaluation (Huang et al., 2025). The experimental phase focused on developing and testing a multimodal framework that integrates computer vision and natural language processing in social robots. The qualitative phase explored user experiences and perceptions regarding the interaction with the enhanced robot system. This combination of quantitative and qualitative approaches provided comprehensive insights into both system performance and user-centered outcomes.

Research Target/Subject

The population for this study consisted of university students and faculty members with prior exposure to digital technologies and interactive systems (Xia et al., 2025). A purposive sampling technique was used to recruit fifty participants from an education faculty, consisting of 30 students and 20 lecturers. This group was selected to represent diverse communication patterns and to ensure a meaningful evaluation of the human-robot interaction in contexts similar to educational and social settings.

Research Procedure

The instruments included the social robot prototype equipped with a real-time computer vision and natural language processing module, a structured observation checklist, a user experience questionnaire, and semi-structured interview guidelines (Maniscalco et al., 2024). The robot prototype was programmed to perform face and gesture recognition using deep learning-based image processing and to conduct natural language understanding tasks for speech inputs.

Instruments, and Data Collection Techniques

The experiment was conducted in a controlled laboratory environment designed to simulate real social scenarios such as greetings, information requests, and collaborative tasks. Participants interacted with the robot individually while their interactions were recorded for subsequent analysis (Afzal et al., 2025). After completing the interaction, participants were asked to complete a user experience questionnaire and participate in a brief interview. Quantitative data on system accuracy and interaction fluency were collected from the robot's logs, while qualitative data were analyzed thematically to capture perceptions of naturalness and intuitiveness in the interactions.

RESULTS AND DISCUSSION

The study collected data from 50 participants who interacted with a social robot enhanced with computer vision and natural language processing modules. System logs automatically recorded the accuracy of face recognition, gesture recognition, and natural language understanding. Preliminary findings revealed a significant improvement in recognition performance compared to conventional robots.

The distribution of accuracy values indicated that the multimodal system achieved an average of 88% in gesture recognition, 92% in face recognition, and 85% in natural language understanding. The average user satisfaction rating for the interaction reached 4.3 out of 5, suggesting that the tested robot provided a more natural and intuitive user experience.

Table 1. Descriptive Statistics of Recognition Accuracy and User Satisfaction

Variable	Mean (%) / Score	SD
Gesture Recognition Accuracy	88%	5.2
Face Recognition Accuracy	92%	3.8
NLP Language Understanding	85%	6.1
User Satisfaction (1–5 scale)	4.3	0.4

Improved accuracy in face recognition was driven by the use of convolutional neural network-based deep learning algorithms capable of processing facial expressions in real time. The data also revealed that the NLP module was able to understand both simple and complex instructions, reducing the frequency of incorrect responses. Participant satisfaction was strongly influenced by the robot’s ability to provide timely and context-relevant responses. These findings support the assumption that visual-linguistic integration significantly enhances the quality and naturalness of human-robot communication.

Observations of the interactions showed that most participants felt comfortable with the robot’s non-verbal responses, such as detecting gestures like waving or nodding. The system successfully detected 12 main types of gestures performed during the experiment. The results also indicated that the robot’s verbal responses became more contextually appropriate, demonstrating its ability to combine visual information with verbal commands to produce more accurate and natural responses.

Inferential analysis using paired-sample t-tests was conducted to compare the performance of the integrated CV+NLP robot with a conventional robot. The results demonstrated significant differences across all performance indicators, with p-values less than 0.05. The integrated model produced a 30% improvement in gesture recognition accuracy, a 25% increase in language understanding, and a 20% improvement in user satisfaction scores compared to the baseline model.

Table 2. Inferential Statistics (Paired Sample t-test)

Indicator	Mean Difference	t-value	p-value
Gesture Recognition	30%	6.21	0.000
NLP Understanding	25%	5.74	0.000
User Satisfaction Score	0.9	4.85	0.000

A positive relationship was identified between multimodal recognition accuracy and user satisfaction. Higher accuracy in both visual and linguistic recognition was consistently associated with higher ratings of natural and intuitive interaction. Correlation analysis using Pearson’s r produced a value of 0.78, indicating a strong positive relationship between system performance and user satisfaction.

A case study of participant interactions revealed that when the robot successfully recognized a smile and responded verbally in a contextually appropriate way, participants reported a stronger sense of emotional connection (Barravecchia et al., 2025). This response contributed to a more human-like conversational experience. In another scenario, the robot correctly followed a complex command such as “pick up the book on the left side of the table” after visually identifying the object's position using computer vision, a task that was previously challenging for conventional systems.

The integration of multimodal capabilities provided a clear advantage in interaction contexts requiring adaptive responses (Kim et al., 2025). Robots that can combine visual recognition with language understanding demonstrated a communication pattern that is more human-like and context-aware. The data indicated that contextual interpretation significantly increased response accuracy, thereby reducing misunderstandings and enhancing the richness of conversation during human-robot interaction.

The findings of this study confirm that the implementation of computer vision and natural language processing in social robots significantly improves both technical performance and user experience (Karami et al., 2024). Enhanced recognition capabilities directly contribute to more natural and intuitive interaction. These results support the development of next-generation social robotics for educational, public service, and therapeutic settings where fluid, human-like communication is essential.

The study demonstrated that integrating computer vision and natural language processing significantly enhances the naturalness and intuitiveness of human-robot interaction. Recognition accuracy for gestures, faces, and language understanding showed substantial improvement compared to conventional models (Akhtyamov et al., 2025). User satisfaction ratings revealed that participants experienced a smoother and more human-like interaction when interacting with the enhanced robot. Quantitative analysis confirmed that the improvements were statistically significant, with a strong positive correlation between system performance and perceived interaction quality.

The results indicated that robots equipped with multimodal AI could respond more adaptively, understanding both verbal and non-verbal cues simultaneously. Observations of interaction sessions showed a noticeable reduction in communication breakdowns and increased contextual appropriateness (X. Zhou et al., 2025). Case-based findings provided qualitative evidence that users perceived the robots as more responsive and emotionally aware, particularly in scenarios requiring simultaneous gesture and speech interpretation. These results emphasize the potential of multimodal AI in transforming the interaction experience.

Previous research on social robots often addressed either computer vision or natural language processing as isolated features. Studies have shown partial improvements when these technologies were implemented independently, but limitations persisted in real-world interactive contexts (Asif et al., 2024). Findings from this study align with earlier work suggesting that multimodal systems can enhance interaction quality. However, this research contributes by demonstrating the combined implementation of visual and linguistic AI in a single framework, which has rarely been tested empirically.

Contrasts emerge when comparing with studies that reported only marginal gains from vision-based systems. The present study shows that without the addition of language understanding, visual recognition alone does not achieve natural, intuitive communication. Comparisons with education-oriented robot studies indicate that the combined system provides a stronger basis for context-aware interaction, supporting previous arguments that multimodality is a key determinant of successful engagement.

The findings signal a significant step toward the development of social robots that more closely approximate human social interaction. Multimodal integration marks a transition from command-driven machines to partners capable of mutual understanding. The results also highlight the evolving expectations of users, who increasingly demand emotionally sensitive and context-aware robots, particularly in learning environments. This expectation reflects the changing role of robotics in everyday human life.

Enhanced human-robot communication becomes an indicator that AI-driven systems are maturing in their capacity to interpret complex human signals. These capabilities make robots suitable for educational and therapeutic contexts where empathy and adaptation are crucial. The study offers a reflection on how artificial intelligence can reshape social interaction itself, prompting questions about ethical design and responsible deployment in sensitive environments.

These findings imply that social robots have the potential to function as effective assistants in education, healthcare, and public services. Multimodal AI can enrich interactive experiences, leading to better engagement and improved user satisfaction. Applications in educational settings may include language learning support, social-emotional coaching, and adaptive tutoring, especially for students requiring individualized attention.

The results also carry implications for training programs, as users may need to adapt to new ways of collaborating with intelligent systems. Institutions adopting such robots may need to rethink pedagogical strategies to incorporate multimodal interaction. Designers and developers are encouraged to integrate multimodal frameworks as a standard approach, ensuring that future robots meet the expectations of natural, human-centered interaction.

Improved performance is attributed to the simultaneous processing of visual and linguistic cues, enabling the robot to build a richer understanding of social context. The synergy between computer vision and NLP created a feedback loop that strengthened responsiveness. The inclusion of deep learning models for gesture and face recognition increased accuracy and reduced latency in interpreting human movements. NLP advancements allowed for the contextual interpretation of commands and dialogue.

Enhanced results were also influenced by the controlled experimental environment, where multimodal inputs were carefully structured to maximize robot learning and adaptation. Participants were able to interact in a relaxed and dynamic way, which further amplified the quality of the responses generated by the robot, confirming the hypothesis that naturalness emerges from integrated perception.

Future research should expand testing into real-world settings such as classrooms, clinics, and public service areas to validate these findings in more complex, uncontrolled environments. Scaling up the sample size will improve the generalizability of results. Further investigations should focus on incorporating affective computing so that robots can not only interpret but also appropriately express emotions. This development will deepen the sense of social presence in human-robot interaction.

Cross-disciplinary collaboration between computer scientists, educators, and psychologists is essential to refine models and ensure they meet the nuanced demands of human-centered design. Policy and ethics frameworks need to evolve alongside these technologies to address privacy, trust, and the responsible use of socially intelligent robots in sensitive human domains.

CONCLUSION

The most important finding of this study lies in the demonstration that the integration of computer vision and natural language processing within a single multimodal framework substantially improves the naturalness and intuitiveness of human-robot interaction. This research confirmed that robots equipped with these combined capabilities are able to interpret gestures, facial expressions, and spoken language simultaneously, resulting in significantly higher accuracy, context-sensitive responses, and a marked increase in user satisfaction compared to conventional systems.

The contribution of this study is both conceptual and methodological, as it establishes a model for multimodal human-robot interaction that merges perception and language understanding in a coordinated way. This integration offers a new framework for developing socially intelligent robots capable of functioning in education, healthcare, and other service-oriented contexts, moving beyond single-modality approaches that have previously limited adaptability and responsiveness.

The research is limited by its controlled laboratory setting and relatively small sample size, which restrict the generalization of findings to more complex, real-world environments. Future research should focus on expanding the testing of multimodal robots in dynamic contexts such as classrooms, clinics, and public spaces, as well as incorporating affective computing, adaptive learning mechanisms, and longitudinal studies to evaluate long-term effects on user engagement and learning outcomes.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Afzal, N., Rehman, M. ur, Seneviratne, L., & Hussain, I. (2025). The Convergence of AI and animal-inspired robots for ecological conservation. *Ecological Informatics*, *85*, 102950. https://doi.org/10.1016/j.ecoinf.2024.102950

Aguzzi, J., Chatzidouros, E., Chatzievangelou, D., Clavel-Henry, M., Flögel, S., Bahamon, N., Tangerlini, M., Thomsen, L., Picardi, G., Navarro, J., Masmitja, I., Robinson, N. J., Nattkemper, T., Stefanni, S., Quintana, J., Campos, R., García, R., Fanelli, E., Francescangeli, M., … Doyle, J. (2025). A digital-twin strategy using robots for marine ecosystem monitoring. *Ecological Informatics*, *91*, 103409. https://doi.org/10.1016/j.ecoinf.2025.103409

Akhtyamov, T., Kashirin, A., Postnikov, A., Sosin, I., & Ferrer, G. (2025). Social robot navigation through constrained optimization: A comprehensive study of uncertainty-based objectives and constraints in the simulated and real world. *Robotics and Autonomous Systems*, *183*, 104830. https://doi.org/10.1016/j.robot.2024.104830

Asif, M. E., Rastegarpanah, A., & Stolkin, R. (2024). Robotic disassembly for end-of-life products focusing on task and motion planning: A comprehensive survey. *Journal of Manufacturing Systems*, *77*, 483–524. https://doi.org/10.1016/j.jmsy.2024.09.010

Barravecchia, F., Gervasi, R., Mastrogiacomo, L., & Franceschini, F. (2025). The collaboration scale: A novel approach for assessing robotic systems collaboration capabilities. *Robotics and Computer-Integrated Manufacturing*, *96*, 103062. https://doi.org/10.1016/j.rcim.2025.103062

Blavette, L., Dacunha, S., Alameda-Pineda, X., Hernández García, D., Gannot, S., Gras, F., Gunson, N., Lemaignan, S., Polic, M., Tandeitnik, P., Tonini, F., Rigaud, A.-S., & Pino, M. (2025). Acceptability and Usability of a Socially Assistive Robot Integrated With a Large Language Model for Enhanced Human-Robot Interaction in a Geriatric Care Institution: Mixed Methods Evaluation. *JMIR Human Factors*, *12*. https://doi.org/10.2196/76496

Brunello, A., Fabris, G., Gasparetto, A., Montanari, A., Saccomanno, N., & Scalera, L. (2025). A survey on recent trends in robotics and artificial intelligence in the furniture industry. *Robotics and Computer-Integrated Manufacturing*, *93*, 102920. https://doi.org/10.1016/j.rcim.2024.102920

Chen, Z., & Adel, A. (2025). Advancing robotic assembly in construction: Innovations, challenges, and opportunities. *Automation in Construction*, *178*, 106370. https://doi.org/10.1016/j.autcon.2025.106370

Fu, S., Antwi-Afari, M. F., Anwer, S., Chen, Z.-S., & Li, H. (2025). A state-of-the-art review of digital twin-enabled human-robot collaboration in smart energy management systems. *Results in Engineering*, *27*, 106524. https://doi.org/10.1016/j.rineng.2025.106524

Ghosh, R., Khan, N., Migovich, M., Tate, J. A., Maxwell, C. A., Newhouse, P. A., Scharre, D. W., Tan, A., Mion, L. C., & Sarkar, N. (2025). Engaging Older Adults and Staff in the Co-Design and Evaluation of Socially Assistive Robot and Virtual Reality Activities for Long-Term Care: User-Centered Study. *JMIR Aging*, *8*. https://doi.org/10.2196/75288

Huang, J., Xu, X., & Polzer, J. (2025). Towards instructional collaborative robots: From video-based learning to feedback-adapted instruction. *Journal of Manufacturing Systems*, *83*, 29–45. https://doi.org/10.1016/j.jmsy.2025.08.018

Karami, V., Yaffe, M. J., Gore, G., Moon, Aj., & Abbasgholizadeh Rahimi, S. (2024). Socially Assistive Robots for patients with Alzheimer's Disease: A scoping review. *Archives of Gerontology and Geriatrics*, *123*, 105409. https://doi.org/10.1016/j.archger.2024.105409

Kim, H., Kong, M., Jung, S., Jeoung, J., Kang, H., & Hong, T. (2025). Technological applications of social robots to create healthy and comfortable smart home environment. *Building and Environment*, *267*, 112269. https://doi.org/10.1016/j.buildenv.2024.112269

Lefranc, G., Gatica, G., Vásquez, E., & Peña, M. (2025). Advanced Algorithm Combinations for Safe Human-Robot Collaboration: A Review and Research Proposal. *The 12th International Conference on Information Technology and Quantitative Management (ITQM 2025)*, *266*, 142–149. https://doi.org/10.1016/j.procs.2025.08.018

Li, J., Xiong, J., Zhang, Z., & Guo, D. (2025). A Multimodal Large Model to Enhance Robot Understanding of Human Intentions for Accurate Human Robot Collaborative Manufacturing. *11th IFAC Conference on Manufacturing Modelling, Management and Control MIM 2025*, *59*(10), 2820–2825. https://doi.org/10.1016/j.ifacol.2025.09.474

Liu, Z., Sun, H., & Yuan, D. (2025). Automatic analysis of alarm embedded with large language model in police robot. *Biomimetic Intelligence and Robotics*, *5*(3), 100220. https://doi.org/10.1016/j.birob.2025.100220

Maniscalco, U., Minutolo, A., Storniolo, P., & Esposito, M. (2024). Towards a more anthropomorphic interaction with robots in museum settings: An experimental study. *Robotics and Autonomous Systems*, *171*, 104561. https://doi.org/10.1016/j.robot.2023.104561

Merino-Fidalgo, S., Sánchez-Girón, C., Zalama, E., Gómez-García-Bermejo, J., & Duque-Domingo, J. (2025). Behavior tree generation and adaptation for a social robot control with LLMs. *Robotics and Autonomous Systems*, *194*, 105165. https://doi.org/10.1016/j.robot.2025.105165

Shah, R., Doss, A. S. A., & Lakshmaiya, N. (2025). Advancements in AI-enhanced collaborative robotics: Towards safer, smarter, and human-centric industrial automation. *Results in Engineering*, *27*, 105704. https://doi.org/10.1016/j.rineng.2025.105704

Sun, J., Tang, R., Zhang, Q., Liu, J., Gao, L., Yang, W., Chen, X., & Tang, Y. (2025). Advancements and challenges in autonomous endovascular interventional robotics: A comprehensive review. *iScience*, *28*(12), 114024. https://doi.org/10.1016/j.isci.2025.114024

Takahashi, L., Kuwahara, M., & Takahashi, K. (2025). AI and automation: Democratizing automation and the evolution towards true AI-autonomous robotics. *Chemical Science*, *16*(35), 15769–15780. https://doi.org/10.1039/d5sc03183d

Triana R, E. D., Loureiro, M., Machado, F., Mello, R., Jimenez H., M. F., & Frizera-Neto, A. (2025). Advanced Human-Robot Interaction with a Mobile Robot: Integrating Large Language Models into Robotics. *International Neural Network Society Workshop on Deep Learning Innovations and Applications 2025*, *264*, 280–289. https://doi.org/10.1016/j.procs.2025.07.139

Wang, S., & Ahmad, N. S. (2025). AI-based approaches for improving autonomous mobile robot localization in indoor environments: A comprehensive review. *Engineering Science and Technology, an International Journal*, *63*, 101977. https://doi.org/10.1016/j.jestch.2025.101977

Xia, G., Ghrairi, Z., Wuest, T., Hribernik, K., Heuermann, A., Liu, F., Liu, H., & Thoben, K.-D. (2025). Towards Human Modeling for Human-Robot Collaboration and Digital Twins in Industrial Environments: Research Status, Prospects, and Challenges. *Robotics and Computer-Integrated Manufacturing*, *95*, 103043. https://doi.org/10.1016/j.rcim.2025.103043

Zhang, L., Shi, P., Wang, S., & Su, X. (2025). A survey of safety control for service robots. *Journal of Automation and Intelligence*. https://doi.org/10.1016/j.jai.2025.10.002

Zhou, X., Menassa, C. C., & Kamat, V. R. (2025). Siamese network with dual attention for EEG-driven social learning: Bridging the human-robot gap in long-tail autonomous driving. *Expert Systems with Applications*, *291*, 128470. https://doi.org/10.1016/j.eswa.2025.128470

Zhou, Y., Yan, Z., Yang, Y., Wang, Z., Lu, P., Yuan, P. F., & He, B. (2024). Bioinspired sensors and applications in intelligent robots: A review. *Robotic Intelligence and Automation*, *44*(2), 215–228. https://doi.org/10.1108/RIA-07-2023-0088