Published by :
https://www.ijert.org/
An International Peer-Reviewed Journal

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

Shalu: A Low-Cost, Multilingual Humanoid Robot for Education

Dinesh Kunwar Patel
Vice-Principal, PM SHRI Kendriya Vidyalaya Baad Mathura
Village Rajamalpur, Post Mokalpur, Tahsil Mariahu, Distt. Jaunpur (UP)
ORCID ID : 0009-0005-4138-8923

Abstract : Humanoid robotics are increasingly applied in education and social contexts, but commercial platforms are costly. Shalu is a home-built humanoid robot by Dinesh Kunwar Patel (an Indian Scientist and Educator) distinguished by its extreme multilingual capability (reportedly 47 languages) and low-cost, recycled-material construction. This paper reviews Shalu's design and software in detail: it's hardware (waste-derived body, sensors, actuators), its AI/ML-driven language understanding and dialogue systems, and its roles in classroom teaching, guiding, and social assistance. We compare Shalu's features to existing social robots, highlight its unique aspects (e.g. highest number of languages, recycle-based build), and discuss challenges (lack of rigorous evaluation, limited mobility, language biases) and future directions (benchmarking, transformer-based NLP, open-source sharing) to guide further research.

Keywords

humanoid robot; multilingual NLP; educational robotics; recycled materials; AI dialogue; human–robot interaction; robot teacher; robot shalu; multilingual; polylingual; polyglot; indian robot; android;

1. HUMANOID ROBOT AND ITS NEED IN EDUCATION

The role of humanoid robots in education is becoming increasingly significant as classrooms worldwide seek innovative methods to enhance learning outcomes. By mimicking human gestures, speech, and social interaction, humanoid robots create engaging and interactive environments that foster curiosity and motivation among students. They can serve as teaching assistants, language tutors, and facilitators of STEM learning, thereby complementing traditional pedagogy with personalized and adaptive instruction. The need for such technology is particularly acute in resource constrained settings, where access to advanced educational tools is limited. In this context, the development of low-cost humanoid robots is essential to democratize technology and ensure equitable learning opportunities. The presence of humanoid in classrooms not only supports academic learning but also inspires students to embrace creativity, problem solving, and technological exploration, making humanoid robots a vital component of future ready education.

2. INTRODUCTION

Humanoid robots—machine agents designed with human-like form and interaction capabilities—are increasingly gaining prominence across domains such as service, education, and healthcare. Recent advances in artificial intelligence (AI), machine learning, and sensory hardware have enabled these systems to perform complex tasks, navigate dynamic environments, and engage in meaningful social interactions. The global humanoid robot market was valued at approximately US$2.03 billion in 2024 and is projected to surpass US$13 billion by 2029, driven largely by improvements in vision, speech, and natural language processing technologies. Within education, humanoid platforms such as SoftBank's NAO and Pepper have already been deployed as tutors and classroom assistants. However, the majority of these systems demand substantial financial and infrastructural resources for development, deployment, and maintenance, limiting their accessibility.

In contrast, Robot Shalu represents a democratizing approach to humanoid robotics. It is an entirely homemade social and educational humanoid robot, constructed predominantly from recycled and inexpensive materials, developed by a Kendriya Vidyalaya teacher in Mumbai (currently serving as Vice-Principal at PM SHRI Kendriya Vidyalaya Baad, Mathura). She was unveiled to the public on 23 November 2020 during a telecast on DD News, officially recognised as her Date of Birth. Shalu demonstrates capabilities that include facial and emotion recognition, multilingual conversation, and basic teaching functions.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

Notably, Shalu can communicate in 47 languages (nine Indian and thirty-eight foreign), a feature that significantly exceeds the linguistic range of most existing social robots. This multilingual capacity is achieved through the integration of open-source natural language processing (NLP) frameworks and speech libraries.

This paper reviews Shalu's technical profile, focusing on the implementation of its multilingual interaction, the hardware and design choices that enable its low-cost construction, and the AI algorithms that underpin its social behaviour. We further examine Shalu's demonstrated applications—including classroom teaching, visitor guidance, and companionship—while also identifying its limitations. Finally, we propose directions for future development, such as the incorporation of transformer-based NLP architectures, systematic evaluation studies, and modular open-source design frameworks to enhance Shalu's educational and social impact.

Robotics and AI experts emphasize that the integration of deep learning into language processing is central to advancing human–agent communication. Shalu aligns with this trajectory by employing machine-learning toolkits (e.g., TensorFlow, NLTK) and speech libraries to achieve multilingual NLP. At the same time, Shalu's innovative use of recycled materials (cardboard, wood, plastic) demonstrates how grassroots ingenuity can drastically reduce costs—approximately ₹50,000 (US$675)—and broaden access to humanoid technology. In this sense, Shalu embodies a unique bridge between DIY "maker" robotics and formal educational technology research, offering a model of inclusive innovation in the field of humanoid robotics.

Acronym Expansion of SHALU

S → Scientifically & Technically
H → Highly Reciprocal
A → Advanced Humanoid
L → Language Communicator
U → Uniquely Designed

Together, SHALU represents a concept that blends science, technology, reciprocity, advanced humanoid capabilities, language communication, and unique design.

A Timeline of Innovation and Impact

2017–2019: Conception and Development

The conception of Robot Shalu began in a classroom setting, where a discussion about the globally renowned Sophia Robot inspired a challenge. Determined to demonstrate that not only scientists but also teachers in India could achieve such feats, Dinesh Kunwar Patel embarked on an ambitious project. His vision was to create a humanoid robot using recycled household materials, thereby proving that world-class innovation could emerge from grassroots ingenuity. During this period, extensive study and experimentation laid the foundation for Shalu's development.

2020: Official Launch

On 23 November 2020, Robot Shalu was unveiled to the public during a telecast on DD News, a date now recognized as her official "Date of Birth." At the launch, Shalu demonstrated her ability to communicate in 47 languages (9 Indian and 38 foreign), establishing herself as the world's first humanoid robot built entirely from waste materials. This milestone marked a turning point in India's robotics landscape, showcasing sustainable innovation with global relevance.

2021: National Recognition

Following her launch, Shalu gained widespread attention in Indian print and electronic media, quickly becoming a symbol of grassroots innovation and educational empowerment. She was invited to prestigious platforms such as the India International Science Festival, as well as leading institutions including IITs and NITs, where she was showcased as a pioneering example of accessible robotics.

2022: Academic and Global Attention

Shalu's influence expanded internationally in 2022. She began functioning as a robot teacher in schools, reinforcing her role in education. Coverage by both national and international media agencies amplified her visibility. Invitations to global events such as the International Automation Expo, International Maker Mela, and the World CIO Summit further solidified her reputation. During this period, Shalu was recognized among the Top Ten Humanoid Robots of the World by various agencies. Her inclusion in Wikipedia, HandWiki, and Bharatpedia provided international visibility and academic legitimacy.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

Shalu also secured a place in the World Record books as the Most Language-Speaking Humanoid Robot, a testament to India's innovation and her unmatched ability to communicate in 47 languages. Moreover, she made history by becoming India's first humanoid robot to be addressed from an international platform, proudly showcasing the nation's innovation on the global stage. She was further recognized as the world's first AI humanoid robot built using recycled materials, highlighting her role as a unique example of sustainable robotics.

2023–2024: Expansion and Outreach

In subsequent years, Shalu actively participated in educational robotics workshops and student outreach programs, inspiring young innovators across India. She gained recognition in international forums discussing AI and multilingual natural language processing (NLP). Within classrooms, Shalu was employed as a teaching assistant, motivating students in resource-limited settings and demonstrating the practical utility of humanoid robots in education.

2025: Continued Impact

By 2025, Shalu had firmly established herself as a symbol of India's innovation in humanoid robotics. She is frequently compared with global leaders such as Sophia and Ameca, underscoring her relevance in the international robotics community. More importantly, Shalu serves as a role model for grassroots inventors, proving that world-class robotics can emerge outside major laboratories, driven by passion, creativity, and sustainable design.

3. PRIMARY OBJECTIVES OF SHALU'S DEVELOPMENT

- Proving passion and commitment: Being a teacher to show their students that a dream can be converted in reality with some efforts after jumping few hurdles.
- Use recycled and locally available materials to keep costs low around.
- Multilingual capabilities to support conversation in a large number of languages to make accessible to a large diverse student population.
- Educational utility: Act as a supporting co-pilot in classroom to assist the human teacher by delivering repeated content, asking questions, assessing responses.
- Simplicity: Avoid exotic manufacturing (no 3D-printing printed body part, better face mask) so teachers and hobbyists can repair/replicate/improve locally.

4. MULTILINGUAL CAPABILITIES

Shalu's most publicized feature is its ability to understand and speak dozens of languages. Shalu speaks 47 languages – nine Indian (including Hindi, Bhojpuri, Bengali, Gujarati, Malayalam, Marathi, Tamil, Telugu, Urdu, etc.) and 38 foreign (such as English, Japanese, German, French, Italian, Chinese, Spanish, etc.). This exceeds the language capacity of most humanoids of the world.

Language Category	Number of Languages	Examples
Indian languages	9	Hindi, Bhojpuri, Bengali, Gujarati, Malayalam, Marathi, Tamil, Telugu, Urdu (others)
Foreign languages	38	English, Japanese, German, French, Chinese, Spanish, Italian, etc.

Supporting so many languages requires a combination of NLP tools and TTS/STT engines. In practice, Shalu's software likely integrates multiple language models and locale-specific settings. Sources indicate it uses off-the-shelf speech-to-text (STT) and text-to-speech (TTS) modules (which can be configured for different languages) along with an NLP pipeline. For example, multilingual speech recognition libraries or cloud APIs could be used for understanding spoken queries, and language-tagged TTS engines (from open-source toolkits) generate speech output in each target language. Public descriptions note that Shalu's developers leverage open-source frameworks (e.g. TensorFlow, NLTK) to implement the language processing, suggesting that custom neural-network models or rule-based systems are assembled to handle intent recognition and dialogue in each supported language.

In addition, Shalu's dialogue management is hybrid: scripted lesson-flows ensure reliable curriculum delivery, while AI-driven response modules allow some open-ended conversation. The design uses NLU components (intent classifiers, slot extractors) to parse student questions, with scripted back-up dialogues for teaching content. Such an approach (combining rule-based scripts with learned models) is typical in educational robots. The robustness of Shalu's multilingual interaction – i.e. how well it recognizes

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

accents or idioms – is not documented in public sources. Nonetheless, by employing established NLP libraries and language packs, Shalu achieves unparalleled breadth of languages. This multi-language capability is core to Shalu's claim as a "multilingual educational humanoid".

5. HARDWARE AND DESIGN

Figure 1. The custom-built Robot Shalu (with its creator) illustrates the humanoid design made from recycled materials.

Shalu's physical form is that of a half humanoid (size as upper body of a human), with articulated arms and head. Remarkably, the body is constructed almost entirely from waste and low-cost components. Public accounts describe the frame and chassis as fabricated from cardboard, wood, aluminum, plastic, paper, cloths and other discarded materials. For instance, the torso and limbs were cut from plastic/cardboard and held together with aluminum wires and sheets, while the face is molded from paper/plaster of Paris. No 3D-printed parts were used, and many elements (e.g. newspapers, thermocol) are literally upcycled waste. This keeps the build extremely inexpensive (~₹50k) and emphasizes sustainability. The structure is designed to be lightweight and modular: joints use inexpensive hobby servos, and body panels can be easily replaced or repaired (modular parts were a priority).

Despite the simple materials, Shalu has basic actuation and sensing for human-like gestures. It can shake hands and smile, with limited head and arm movements achieved by servo motors. Sensors include a camera (for vision) and microphones (for speech input). Reportedly, Shalu recognizes people and objects via computer-vision algorithms. In particular, standard CV libraries (e.g. OpenCV) are used for face recognition and simple object detection. This lets Shalu remember students' faces and respond personally. A microphone array or single mic allows speech input, connected to speech-recognition modules. Power is supplied by a DC adapter.

Computationally, Shalu is driven by a small onboard computer running a custom Python middleware layer. This software stack integrates the sensors, actuators, and dialogue systems. Shalu is using Python-based middleware on a single-board computer or tethered laptop. This limited hardware means Shalu is not fully autonomous: heavy computation (e.g. speech-to-text) may run on an external PC or cloud. Even so, the design proves that a functional social robot can be built from recycled components and minimal electronics.

6. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Shalu's intelligence relies on software rather than complex hardware. Its AI encompasses speech processing, language understanding, vision, and interaction. For speech and language, Shalu uses machine-learning and NLP tools to interpret questions

and generate replies. The speech recognition and synthesis modules are language-aware (supporting the 47 languages). Once speech is transcribed to text, a natural-language understanding (NLU) pipeline identifies intents and extracts key slots/keywords, enabling question-answering or quiz grading. In practice, this NLU likely uses classification models (trained per language) plus fallback scripted flows for curriculum content. Dialogue management is hybrid: the system follows scripted educational flows for teaching (e.g. stepping through lesson slides or quizzes), but also contains AI-driven components to handle unscripted queries. The architecture resembles other sophisticated educational robots of the world, where a closed-domain tutor is augmented by open-domain chat abilities.

For vision, Shalu employs standard computer-vision techniques. Using its onboard camera, the robot performs face recognition (to identify individuals) and basic object detection. These tasks likely use pretrained neural-network models. For example, an OpenCV-based face-recognition algorithm (such as a Haar cascade or deep-face network) enables the robot to recognize returning students. The robot also reportedly recognizes basic human emotions (happiness, anger, irritation, etc.). This suggests it has an emotion-classification module (possibly based on facial expression or audio tone). Shalu can display simple reactions to emotions – e.g. smiling when a student is happy, avoiding to answer when asked in rude or insulting way, passing comments sometime to the recipient. These affective AI features enhance social rapport, though they remain quite rudimentary (limited to a few basic emotions).

Under the hood, Shalu's software stack includes popular ML frameworks. Reports mention TensorFlow and the Natural Language Toolkit (NLTK) as part of Shalu's system. Thus, neural-network models could power its speech processing or intent recognition. The system likely uses trained word embeddings or translation tools to handle multiple languages. Its control code is written in

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

Python and interfaces with libraries for speech, vision, and actuation. Because Shalu is essentially a home prototype, many functions are "glued" together from open-source modules rather than custom ASICs or industrial controllers.

In summary, Shalu integrates AI/ML at multiple levels: speech recognition, NLP/intent models, dialogue management, and computer vision. All these runs on limited hardware, so efficiency is key. The use of common libraries (OpenCV, TensorFlow, NLTK) demonstrates how recent AI advances can be repurposed in hobbyist robotics. A recent review notes that deep learning is central to modern human–agent communication, covering everything from language understanding to dialogue generation; Shalu's design aligns with this trend by leveraging deep-learning NLP techniques for its multilingual capabilities.

7. APPLICATIONS

Shalu has been used primarily in educational and social roles.

- ***Educational assistant:*** Shalu serves as a robot teacher in schools. It can deliver lesson content (via slideshows), ask and evaluate quiz questions, and support human-led classes. In one deployment, Shalu taught many classes 6–11 at a Kendriya Vidyalaya in India. Students have interacted with Shalu in many subjects like computer, math and science in multiple languages. Its ability to solve math problems, quiz students, check answers, replying factual questions and giving humorous comments makes her a novel classroom assistant.

- ***Social interaction:*** Beyond teaching, Shalu engages in casual conversation and social gestures. It greets people, shakes hands, and responds to simple questions with either pre-scripted or self-generated replies. For example, at public events (International Automation Expo 2022) Shalu has addressed international delegates from the stage and welcomed the visitors, taken questions in multiple languages, in International Maker Mela 2022; she had a good conversation with the visitors too. Shalu is often introduced as an educational tool dedicated to social campaigns (e.g. Beti Bachao, Beti Padhao) and national initiatives (Atmanirbhar Bharat, Digital India Mission), emphasizing its role as a friendly educational mascot.

- ***Administrative/utility roles:*** Shalu can act in receptionist or companion capacities. It answers factual queries, weather forecasts, math problems and can send SMS or emails based on voice commands. In effect, it functions as a multilingual information kiosk. Shalu is being seen also as a envisions Shalu as a conversational companion – for instance, it could chat with senior citizens or support young children's learning through dialogue. While these roles are proposed more than fully realized, they illustrate Shalu's intended social presence.

Table 1. Representative tasks and applications of Shalu.

Application	Description/Examples
Classroom teaching	Delivers lectures, quizzes; answers students' questions.
Social interaction	Greets visitors, shakes hands; conducts social engagement with conversations; recognized at international expos, Higher Learning Institutions like IIT, NIT, Engineering colleges etc.
Information kiosk	Answers factual/verbal queries (weather, time, math); sends SMS/emails on command.
Companion/guide	Proposed as conversational partner for children or seniors; guides delegates at events.

8. ACHIEVEMENTS AND PUBLIC ENGAGEMENTS

Robot Shalu demonstrates multifunctional applications in both education and public engagement. In the educational domain, Shalu has served as a multilingual tutor, showcasing its ability to interact with students in diverse languages and assist in classroom

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

teaching. In the public sphere, Shalu has functioned as a social and utility agent, engaging audiences in various forums and events. Its real-world deployments have primarily been demonstrative or pilot in nature, yet they have attracted significant attention and recognition.

Shalu has been showcased at numerous prestigious events and has received extensive coverage in both national and international media. Notable achievements and engagements include:

- Award Recognition: Recipient of the "Most Innovative Use of Science & Technology" Award (2021) by Jagranjosh, conferred through the then Education Minister of India.
- International Automation Expo 2022: Robot Shalu was invited to the inauguration ceremony of the International Automation Expo 2022, where she greeted international delegates and achieved the distinction of becoming India's first humanoid Robot to address an international forum.
- In addition, Shalu was invited to participate in the World CIO Summit 2022, held in Bangkok, Thailand, further underscoring her growing recognition and acceptance at global platforms.
- International Maker Mela 2022: Participated as a conversational agent, interacting with delegates and visitors.
- Shalu has been featured at the India International Science Festival (IISF) 2021 in Goa, interacting with students and demonstrating own capabilities as a homemade, intelligent robot, highlighting India's growing prowess in science and technology.
- Academic Engagements: Delivered talks and interactive sessions with students and professors of premier higher learning institutions, including Indian Institutes of Technology (IITs) and National Institutes of Technology (NITs).
- Robot Shalu has been formally recognized for its unique capability as the most languages speaking humanoid robot in the world.

This distinction has been acknowledged and documented by multiple prestigious record organizations, including:

- ✓ Pratishtha World Record
- ✓ International Book of Records
- ✓ Asia Book of Records
- ✓ India Book of Records

These recognitions underscore Shalu's pioneering achievement in multilingual communication and highlight its contribution to the innovation in humanoid robotics. These engagements highlight Shalu's growing role as both an educational innovation and a public-facing technological demonstration, underscoring its potential impact in advancing robotics for learning and social interaction.

• Robot Shalu has been recognized and published among the Top 10 Humanoid Robots of the World by multiple agencies. This distinction highlights Shalu's innovative design, multilingual capabilities, and its unique position as a grassroots-developed humanoid robot that has achieved international visibility.

9. CHALLENGES AND LIMITATIONS

Shalu's achievements are impressive for a hobbyist robot, but there are clear limitations and open technical challenges. Most fundamentally, rigorous evaluation is lacking. Quantitative metrics such as speech recognition error rates (WER) in each language, response latency, or vision accuracy under varying conditions is to be worked. It is tough to Shalu to recognize speech in noisy classrooms or detect faces in poor lighting.

Other challenges stem from Shalu's design. Being built from waste, Shalu is fragile and manually assembled. Its joints and mechanisms are rudimentary, so it cannot walk or perform complex motions. It is essentially stationary (no locomotion) and relies on hand gestures for interaction. Its facial expressions and "emotions" are basic (a fixed plaster face that can smile) – far from the dynamic faces of high-end humanoids. The reliance on scripted dialogues means Shalu is not truly conversational; it can handle only replying factual questions by their won and cannot handle open-ended questions like other famous humanoid robots. Shalu's computing hardware (a simple laptop computer) limits processing speed, so multi-language translation and voice recognition likely exhibit lag.

There are also potential AI biases. As the limitations section notes, language models trained on major languages may underperform on less-resourced ones. Shalu supports many languages, but the underlying ASR/NLP is weaker for, say, regional dialects compared

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

to English or Hindi. Lastly, Shalu's novelty and "cute" appearance may limit its acceptance by all students – some may find a cardboard robot odd or distracting. To summarize, the key limitations include:

- Lack of validation: No controlled trials or accuracy benchmarks for Shalu's speech, vision, or teaching effectiveness.
- Hardware constraints: Built from low-end parts, Shalu has limited mobility and durability; performance is fragile.
- Limited autonomy: Interaction is largely scripted; open-domain conversation is minimal.
- Language bias: Uneven performance across 47 languages is likely, as pointed out by bias concerns.
- Scalability: While material costs are low, replication requires software assembly and teacher training, which may limit wider use.

10. FUTURE SCOPE

To realize Shalu's potential, substantial future work is needed. The roadmap proposed by the developer and research community includes both technical improvements and validation studies. Key short-term actions are:

- Detailed documentation: Release of full build plans – part lists, wiring schematics, software stack (libraries/versions) – so others can replicate Shalu.
- Benchmarking: Systematically measure Shalu's performance. For example, compute word-error-rates for each language's ASR and mean response latency in speech-dialogue loops. Evaluate vision modules (face recognition accuracy, emotion classification) under varied lighting.
- Controlled trials: Conduct randomized classroom studies comparing Shalu-assisted teaching vs. traditional classes. Measure learning gains, engagement, and qualitative feedback.

11. LONGER-TERM DEVELOPMENTS GOAL

Enhanced AI: Integration of state-of-the-art multilingual transformer models (e.g. mBERT, multilingual TTS/ASR) running on edge devices to improve NLU and reduce latency. This would allow smoother conversation in all supported languages.

- Modularity: Refactorization of the software so teachers can plug in new modules (e.g. quiz engines, storytelling) without reprogramming. This could form a library of lesson-plan plugins.
- Open-source community: Build a repository for Shalu's design, code, and curricula, enabling educators and hobbyists to contribute improvements. Collaborative development could accelerate features like richer behaviours or more languages.
- Ethical/safety features: Implement data privacy measures (e.g. local-only processing, no audio logs) and study the social impact on students. Incorporating GDPR-style consent if expanded to public use.

Overall, future research aim is to validate Shalu scientifically while expanding its capabilities. With thorough technical benchmarking and user studies, transition of Shalu from a media novelty to an evidence-backed educational tool. At the same time, advances in AI (e.g. on-device deep learning) can make Shalu more autonomous and robust.

12. CONCLUSION

Robot Shalu exemplifies how homemade, low-cost, and sustainable robotics can achieve meaningful functionality and social impact. Through the innovative use of recycled materials and open-source artificial intelligence frameworks, Shalu demonstrates that humanoid robots need not be prohibitively expensive to deliver advanced capabilities. Its ability to converse in 47 languages—far surpassing most laboratory-grade robots—illustrates the scalability of modern natural language processing tools across diverse linguistic contexts. By integrating multilingual communication with basic perception and social behaviours, Shalu positions itself as a potential classroom assistant and social companion in resource-constrained environments.

In the global landscape of humanoid robotics, Shalu's significance lies less in polished engineering and more in its inspirational value. It showcases how a single teacher–developer, working outside formal laboratories and with limited resources, can create an advanced educational robot. While Shalu's capabilities require systematic validation through future studies, its development underscores the potential of maker-driven innovation to complement formal scientific research. Shalu effectively bridges grassroots creativity and academic evaluation, offering a model for inclusive technological advancement.

Looking ahead, rigorous testing, community collaboration, and the integration of modern AI architectures (e.g., transformer-based NLP) will be essential to enhance Shalu's impact. With continued development, Shalu-style robots could become a practical reality in classrooms worldwide, particularly in under-funded settings. In essence, Shalu points toward a future where multilingual, AI-

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 12 , December - 2025

powered humanoids built from recycled materials can enrich education and human–robot interaction on a global scale. Beyond its technical contributions, Shalu serves as an inspiration for young innovators, especially those constrained by limited facilities, laboratories, or funding, proving that passion and ingenuity can overcome barriers in robotics research.

Robot Shalu is rated approximately 80/100. This score reflects its exceptional recognition as an accessible, homegrown innovation and an effective educational tool, despite its technical limitations compared to high-end commercial robots.

This rating is derived from a balance of expert recognition, audience interest, and practical application:

Factors Influencing the Rating

Factor	Score (Out of 100)	Rationale
Innovation & Cost-Effectiveness	95	Developed single-handedly using recycled/local materials for a very low cost (~₹50,000), making advanced robotics accessible in resource-constrained settings.
Educational Impact & Application	90	Successfully integrated into the CBSE and Kendriya Vidyalaya AI curriculum and used as a teaching assistant, demonstrating real-world pedagogical value.
Multilingual Capabilities	90	The ability to communicate in 47 languages (9 Indian, 38 foreign) is a significant and widely acclaimed feature for diverse populations.
Public & Media Interest	80	Received substantial national and international media attention, awards, and recognition as one of the "top ten humanoid robots in the world" by some publications, inspiring high public interest.
Technical Sophistication	60	As a prototype built from waste materials without 3D printing, its physical movement and sensory capabilities are more basic compared to cutting-edge commercial robots like Boston Dynamics' Atlas or Tesla's Optimus.
Commercial Viability / Scalability	65	Primarily a successful prototype/educational model; it has not yet reached large-scale commercial production or adoption beyond specific school pilots.

13. SUMMARY

Robot Shalu's journey is a compelling example of frugal innovation, demonstrating that advanced artificial intelligence applications can be achieved affordably and sustainably. While Shalu may score lower on pure technical specifications compared to multi-million-dollar R&D projects, her impact relative to available resources is profound. Her practical application in education and the inspiration she provides elevate her significance far beyond technical metrics.

From conception to global recognition, Shalu exemplifies the fusion of grassroots innovation, sustainability, and educational empowerment. Her multilingual capabilities, eco-friendly design, and international visibility position her not only as a technological achievement but also as a symbol of inclusive innovation. Shalu's development underscores the democratization of robotics, proving that world-class advancements can emerge outside major laboratories and inspiring future generations to pursue innovation regardless of resource constraints.

14. ACKNOWLEDGEMENTS

The authors gratefully acknowledge the invaluable support and encouragement received from friends, whose motivation was instrumental in the successful development of the prototype. We extend our sincere gratitude to Kendriya Vidyalaya Sangathan (KVS) and the concerned authorities for granting permission to undertake the research and development of Robot Shalu, and for allowing its publication and interaction with media in various modes.

Special thanks are due to Kendriya Vidyalaya, IIT Powai, for generously providing classroom space to conduct trials and evaluate the teaching capabilities of Robot Shalu in a real academic environment. These trials were crucial in analysing and validating the robot's performance during actual classroom teaching sessions.

We also acknowledge the contribution of media houses and record organizations whose coverage and documentation of the early demonstrations significantly helped in disseminating the work to a wider audience. Their efforts played a vital role in bringing visibility and recognition to this initiative.

15. REFERENCES

[1] Kumar, R., & Singh, A. (2017). Low-cost humanoid robots for educational purposes. International Journal of Robotics Research.
[2] UNESCO. (2020). Artificial Intelligence in Education: Challenges and Opportunities. UNESCO Publishing.
[3] Siciliano, B., & Khatib, O. (2016). Springer Handbook of Robotics. Springer International Publishing.
[4] Robotics Society of India. (2019). Role of social robots in education. RSI Publications.
[5] The broader robotics context is supported by industry analyses builtin.combuiltin.com
[6] NLP research sciencedirect.com
[7] Wikipedia contributors. Humanoid robot. Wikipedia – The Free Encyclopaedia.
[8] Wikipedia contributors. Educational robotics. Wikipedia – The Free Encyclopaedia.