



An AI-Driven Visual Cue Application to Enhance Daily Task Independence in Individuals with Autism Spectrum Disorder: A Design-Based Research Study

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Abstract: People with autism spectrum disorder (ASD) frequently struggle to carry out everyday tasks on their own, which makes them more reliant on therapists, educators, and carers. Interventions based on visual cues have shown promise in helping people with ASD understand and complete tasks. In order to improve independence and task performance in people with ASD, this study describes the design, development, and assessment of an AI-driven visual cue application.

Through iterative real-world testing, a design-based research (DBR) technique was used, combining qualitative and quantitative methodologies. Sequential task scheduling, customisable visual cues, adjustable alarms and reminders, and positive reward for completing tasks are all made possible by the system. While system log analysis makes it easier to categorise users according to task engagement and completion patterns, an administrative dashboard lets educators and carers keep an eye on users' progress.

Semi-structured interviews, questionnaires, system logs, and organisational records involving kids with ASD, their parents, teachers, and therapists were used to gather data. Descriptive statistics and paired t-tests were used to assess quantitative data, and thematic analysis was used to look at qualitative input. Task completion behaviour was evaluated using log analysis based on Python. The beta implementation's results, which were created with Sandbox, Firebase, and B4A, show enhanced user engagement, more seamless transitions between tasks, and increased task completion efficiency. The suggested application shows promise in lowering carer stress, encouraging user autonomy, and improving cognitive engagement in people with ASD.

Keywords: Artificial Intelligence, Autism Spectrum Disorder, Visual Cue System, Inclusive Technology, Positive Reinforcement

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INTRODUCTION

Autism spectrum disorder (ASD) is a complicated neurological state of a person that influence dialogue, socializing and daily management. People experiencing this would encounter difficulties in following daily routines, changing over from one task to the other and performing tasks independently. This condition may upshot highly reliant on others for supplementary support, undermining self-esteem and less scope for independence. Consistently repeating the daily chores bolster individuals with autism, thus user-centred and bewitching daily task management tools are vital (Mukherjee, 2017).

Even though, the world has gone under swift transition from digital and industrialization development to AI driven era, still there lack ample of study to accommodate for ASD. Conventionally, visual cue cards are utilized to convey step by step visual support to ASD individuals. These tends to immensely assist the individuals in transiting between tasks and at the same time sustain their cognitive loads (AlSalehi & Alhifthy, 2020). These cue cards have proven to be effective; however, it tends to be less captivating for the ASD

individuals as they get easily distracted since cards are paper based and motionless. This gap limits the ASD individual progress as they require a more realistic and winsome tools to acquire their attention.

Many work sectors across worldwide are merging with AI to get a coherent result. This approach involves development of app to substitute the prompt cards as it tends to deliver captivating engagement, improved versatility and inclusiveness. Even so, there still lay gaps in present apps as most of them are structured on static illustration reminders and leak of functionalities. Along with this, they barely incorporate the AI features to accommodate for personalized scheduling for task, tracking the progress and grouping the ASD user based on the time span of the tasks.

This literature confronts this limitation by showcasing an AI driven Visual Cue Application for ASD individuals which integrates sequence task scheduling using real visuals and a capitative environment using reinforcement mechanism. The beta version visual cue application intends to guide the ASD user along with their daily task, play soft music, record

the time diverted towards each task and upon completion of a task module the user will be rewarded with a star and at the end of the days seclude, the user would be grouped accordance to the predefined data based on the total time taken to complete all the task (Zhang, & Wang, 2022).

As the world is advancing to a modern and a machine intelligence driven era, AI execute a vital play in enhancing preliminary screening, customized intervention and communicative support for people suffering for ASD. Over past years, research works have concentrated on how AI consisting of deep learning machine learning and merged system have tried to improve the identification accuracy and treatment. This review aims to collate and enlighten on the existing AI application for ASD users, analyse their progressive development and lastly discuss about their strengths and limitations (Jaliaawala & Khan, 2020).

With early intervention in AI driven ASD detection centralize in automated protection procedure via data centric utilities. Artificial intelligence Software as a medical device (SaMD) had evolved to equip health professionals in curing people suffering from ASD in age bracket of 18-72 months old employing short videos and questionnaires (Alvares & Ramasamy, 2023). Even though, this advancement gave much easier and faster accessibility to ASD diagnostic, but as some point lack data to present vivid results. As elaborated by Geo and Zhang (2022), eye tracking device integrated with machine learning just lack 2% accuracy in determining ASD traits that highlights how individuals see thing and concentrate despite any physical examination (Formisano et al., 2025).

Latest studies-initiated combination of variety information for instance; integrating words, letters, voices with actions to strengthen the ASD screening. For example, recent research threw light on a system utilizing questionnaires and voices which was accurate and effective determining individual with ASD risk (Choi et al. 2023). On the other hand, Lin and Park (2023), scanned brain and employed deep learning to ascertain autism patterns which achieved 90% correctness, thou the method is reflects gaps as test was conducted on small number of users.

With advancement in artificial intelligence, now it not just assists in curing conditions but also play an essential part in communication and therapy. As enlighten by Rahman and Das (2023), previous means just used picture cue cards to assist users in communication, but with development of mobile applications and devices, this system can communicate with them. Another work conveyed that, AI tools utilizing advanced models like VGG16 or ResNet50 can recognize the users' facial expressions and interact with them in a fun manner allowing them to express their feelings (Sultana & Khan, 2024). Furthermore, some system combines the audio and video like AV-ASD that

assist in recognize and detect the social and repetitive behaviours in users utilizing dynamic AI models like GPT-4o (Tran & Luo, 2023).

Most works studies portrayed that AI tools are advancing and gaining accuracy over 90% in detecting the ASD in users at initial phases. These AI powered apparatus is making detection faster, customized personal therapy and assists care givers in making informed and optimal decisions. Yet there prevail gaps in almost all the readings. As discussed by Wang and Li (2024), most of the works massively depends on the western data thus, limiting it to work with other people in other parts of the world. Also accessing data and cost incurred in maintaining the system leads to additional barriers for the system to be utilized at larger scale, as this makes the system erratic for countries with limited resources. Ultimately, matters like fairness, privacy and how the AI powered models are making the decision needs greater emphasize.

In a nutshell, AI powered systems have bought a revolution in how ASD are accepted and diagnosed. Instead on depending on human expertise, AI powered systems now assist in detecting and curing autism using the available data, not only, making faster but more accurate. With advancement of these tools, it has been made possible to diagnose the ASD individuals as well as provide customized and inclusive therapies. However, there still prevail challenges that needs to be addressed. Issues like limited access, data prejudice and slender test on real-life scenarios needs paramount attention. Further research should chiefly focus on development of AI powered system that is culturally adaptive, reasonable and ethically worthy so that users with autism can immensely benefit regardless of the socio and economical status.

As this study unfolds into elaboration on the AI driven visual cue application and its capability of positively reinforcing the users suffering from ASD and secondly a clear demonstration how utilizing the app in a proper manner reduces dependence on other people. With fusion of cue cards and AI driven approach for development of the application would contribute positively towards the ASD users and other relatively parties involved.

METHODOLOGY

Research Design

This research development project employed a Design-Based Research (DBR) methodology, systematically integrating qualitative and quantitative research techniques. The DBR process facilitates iterative development via practical deployment, ongoing testing, and refinement informed by user feedback and system performance. This method facilitates the incremental improvement of the application's usability, efficacy, and adaptation for the intended user demographic. A mixed-methods paradigm enhances

contextual relevance and practical applicability for technology-assisted therapies aimed at individuals with ASD, in accordance with previous research.

Participants and Data Collection

This study involved children diagnosed with Autism Spectrum Disorder (ASD), as well as their carers, educators, and therapists. Child participants were selected inclusively, without limitations according to cultural background, ethnicity, or socioeconomic condition. Carers, therapists, and educators provided evaluative comments on the AI-driven visual cue application based on their direct engagement and observation.

Four data collecting instruments were utilised:

- Semi-Structured Interviews: Administered to carers, educators, and therapists to obtain comprehensive qualitative insights on usability, efficacy, and behavioural influence.
- Surveys: Conducted prior to and during application usage to assess alterations in accessibility, usability, and task engagement.
- System Logs: Gathered to assess job completion duration, frequency of carer engagement, and user interaction trends.
- Organisational Records: Preserved to chronicle program updates, enhancements, and design alterations based on user feedback and system performance.

Data Analysis

Data analysis was performed utilising three complementary methodologies:

- Quantitative Analysis: Descriptive statistics and paired t-tests were employed to evaluate performance indicators and ascertain statistically significant differences prior to and following application usage.
- Qualitative Analysis: Thematic analysis was utilised on interview data to identify principal themes concerning user experience, engagement, and system usability.
- Python-Based Log Analysis: System log data were analysed using Python to classify child users according to task engagement levels, completion consistency, and behavioural anomalies across designated activities.

The usability and performance of the AI-powered visual cue application were evaluated at seven-day intervals through direct observation, interviews, and pre- and post-surveys. Evaluation benchmarks were established based on mobile health (mHealth) standards, including:

- Data synchronization accuracy: $\geq 95\%$
- System uptime: $\geq 99\%$
- Response time: < 2 seconds
- AI classification accuracy: $\geq 85\%$

Ethical approval

Ethical approval for this study was secured from the relevant ethics review committee of the university before the initiation of the investigation. All research procedures adhered to the university's ethical principles and applicable national and international standards for research involving human participants. Informed agreement was secured from the carers or legal guardians of all participating children, and participation was wholly voluntary. The confidentiality and privacy of participants were rigorously upheld during the study, and all gathered data were securely archived and utilised exclusively for research reasons.

RESULT AND FINDINGS

The prototype of the developed visual cue application was assessed over two weeks in an inclusive institute in Lautoka. The participants involved random ASD students, teachers and caregivers. Mixed method analysis was employed that merges surveys, app logs and interview which tend to effectively contribute to understanding the user experience and the system impacts.

Activity completion rate of efficiency

Participants	Total time (Seconds)	Average Time Before use of App (Mins)	Total Time (Seconds)	Average Time After use of App (Mins)	Variance (%)
Students	46 915	39.1 mins	35 640	29.7	76%
Caregivers	45 325	38 mins	33 875	28.3	74%
Parents	38 785	32	31 487	26.4	82.5%

According to the above table it indicates that caregivers and parents have pointed out on the significant reductions in their dependence effort after employing AI-powered Visual cue.

Launch vs Accomplishment time

Launch time (Opening task): has enhanced from 38.5 seconds to 20.8 seconds, an improvement off approximately 4.12 seconds. (54 seconds)

Accomplish time (Completing tasks): has declined approximately from 46 915 Seconds to 35 640seconds approximately 29.7 seconds.

This result tends to convey the beneficial effect of using the AI Powered Visual cue.

Reduction in Caregivers Dependence

- The findings indicate a substantial improvement in both user independence and caregiver well-being. The average number of verbal instructions required per activity decreased significantly from approximately 4.5 instructions to 1.6 instructions, demonstrating that users were able to complete tasks

with much less prompting and external support. This reduction suggests improved clarity of instructions, better understanding of task requirements, and increased autonomy during activities.

- 80% of caregivers reported a noticeable reduction in stress and effort while supporting users. This improvement can be attributed to the system's structured guidance, reduced need for repeated

explanations, and the ability to monitor progress more efficiently. Together, these outcomes highlight the system's positive impact not only on user performance but also on caregiver workload and overall well-being.

This result conveys and supports Tran and Luo (2023), who stated that the involvement of AI-powered multimodal tends to reduce the supervision requirements.

Key Benefits of the System Implementation

Theme	Description
Stronger Engagement	Sound, visual cues and rewarding system tend to increase child's interest.
Greater Independence	Users tend to more tasks without being commanded.
Caregiver empowerment	With the summary dashboard it got easier for caregivers to keep track of progress report and at the same making it transparent.

The total development expense of the proposed system was comparatively minimal, given most platforms and technologies employed were free and open source. This cost-effectiveness enhanced the system's accessibility and scalability, especially in resource-limited environments. The deployment of the AI-driven visual cue application led to an estimated 40% reduction in carer monitoring time, signifying a significant alleviation of carer workload. Moreover, children utilising the system exhibited a significant enhancement in autonomy and a more reliable execution of daily tasks. The application demonstrated cultural adaptability and economic viability, rendering it a feasible and sustainable solution for Pacific Island nations and other areas with constrained technology and financial resources.

in technical terms having low response time and high uptime showing that it could operate flawlessly with low internet connection. With captivating interface along other features like instrumental sound and animated rewarding system made students more interested. As this was along side Sultana and Khan (2024), that motivation can be enhanced via simple gamification other than expensive robotics tools.

As elaborated by Tran and Luo (2023), that previous Augmentative and Alternative Communication therapy system was relied on specialized devices that controlled laboratory settings. Thus, this project gave a breakthrough by showing that similar behaviour improvement could be attained utilizing just a mobile phone. The applications cultural customization trait replies directly to the issues in the paper that discuss the western bias in ASD technology by (Wang & Li, 2024). The results also strengthen Rahman and Das (2023), who indicated that gamified and visual tools tend to improve communication and engagement but here the solution is usability in low resourced pacific island countries.

DISCUSSION

The result portrayed that with the use of AI powered visual cue application, children started and completed tasks more independently with less support provided by the caregivers. The tool also performed well

Practical Implications

Area	Implication
Policy	A cheap support tool is used facilitate the inclusive education goals in low resourced countries.
Home Routine	Parents and caregivers could utilize the similar prompts to enhance consistency.
Therapy	The data logs assist therapist in planning and amending the therapy treatment based on the data of daily activity performance.
Education	Educators could merge visual routines in the education plans to assist children in transition and focusing on classes.

This vividly indicates that the tool can assist both the individual children and system wide inclusion tactics.

Challenges vs Remedies

Challenges	Remedies
Cultural Mismatch	Bilingual support + Localized Visuals
Data Limitation	Local dataset building + Transfer Learning
Privacy	Consent safeguard + Masking of Identity
Connectivity	Offline design + sync later
Diverse abilities	Amendment in cues

With iterative development process, it allows these issues to be identified at an early phase and amended quickly.

The considered sample size was small, and the duration of the test conducted was of short span. While the results are out shining, it is essential to have longer tests conducted to study behavioural changes, classroom transfer impacts and endurance across various society.

This project development research project highlights that budget-friendly AI powered visual cue could significantly enhance daily task independence while remaining culturally adaptive and easy to deploy in less resource equipped countries. By fusing usability, customizability and ethical design, the project showcases a practical beta version for inclusive AI powered for ASD care across the pacific.

CONCLUSION AND RECOMMENDATIONS

The analysis highlights robust enhancement in activity completion, routine stability and self-reliant task initiation. Caregivers also expressed low stress because lesser verbal instructions were needed for support. The captivating interface, adaptive instructions, sound and rewarding system assisted children to stay connected and engaged.

Recommendation For Implementation

To flawlessly expand and implant the system in the real environment, the following steps are suggested:

- **Pilot Extension:** it is essential to deploy the AI powered visual cue application in more inclusive schools and test it with different ASD level and at the same time various age groups.
- **Training and Support:** it is vital to educate the administrative users on how to operate the system and at the same time provides hands on training how to customize routines and understand the dashboard.
- **Organizational Support:** to ensure the system is deployed and reach out to all the needed families it would be essential to involve ministry of education along with other NGO that deals with inclusive and disable children.
- **Viability Planning:** to ensure the system is utilized by all the needed families and stakeholders it is important a local maintenance and deployment team is created to handle and maintain the system in long run.

Future Scope

The AI powered visual cue application developed is currently at a small scale and there are a lot of possibilities of future developments such as:

Areas	Future Goals
Technology	- Emotion detection system can be embedded. - Customized voice support. - Other than grouping in ASD users, recommending the possible treatments
Sustainability	- Can integrate the customized and local icons. - Real time visual cues.
Pacific Scaling	- The application can be customized in accordance with other pacific island countries.

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