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A

Project Proposal

"VR Buddy - Virtual Reality for enhancing Learning in specially abled Children"

Budget - Rs. 3965250 (Thirty-Nine Lakhs Sixty-Five Thousand Two Hundred and Fifty only)

Investigators

SSN College of Engineering, Chennai	GUVI, Chennai	Shiv Nadar School, Noida
Dr.A.Kavitha Dr.S.Pravin Kumar Ms.B.Divya	Ms.Durga Mr.Praveen Mr. Muruganantham	Ms. Harleen Ahulwalia Ms. Manjima Chatterjee Mr. Mark Nelson

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Name and address of experts/ institution interested in the subject

1	Dr. Kavitha A. Professor & Head kavithaa@ssn.edu.in	Department of Biomedical Engineering, SSN College of Engineering, Chennai
2	Dr. Pravin Kumar S.Associate Professor, pravinkumars@ssn.edu.in	
3	Ms. Divya B, Assistant Professor, divyab@ssn.edu.in.	
4	Ms. Durga, durga@guvi.in	GUVI, Chennai
5	Mr. Praveen, praveen@guvi.in	
6	Mr. Muruganantham, muruganantham@guvi.in	
7	Ms. Harleen Ahulwalia, harleen@sns.edu.in	Shiv Nadar School, Noida
8	Ms. Manjima Chatterjee, manjima.chatterjee@sns.edu.in	
9	Mr. Mark Nelson, mark.nelson@sns.edu.in	
10	Mr. Balamurugan R. bmgn05@gmail.com	External Consultant
11	Mr. Vishnu T. U. vishnu@machenn.com	

Topic- "VIrtual REAlity for immersive Learning"

Title – Virtual Reality for Enhancing Learning in Specially Abled Children

1. Problem Statement

Persons grappling with learning disorders encounter significant challenges in traditional learning environments. Conventional teaching methods may not effectively address their unique needs, hindering academic progress. The absence of specialized tools exacerbates their struggle. Recognizing this, there is a pressing need to design Virtual Reality (VR) labs tailored specifically for individuals with Autism, Attention Deficit Hyperactivity Disorder (ADHD)and Specific Learning Disability[1].

In the realm of traditional education, a considerable number of students face unique challenges that conventional teaching methods struggle to address[2]. This is particularly evident among individuals managing Autism, ADHD and Specific Learning Disability[3], where the standard classroom setting often fails to align with their distinctive learning profiles. Traditional teaching falls short for diverse learners, urging a shift to tailored interventions like VR labs[4].

These labs should offer immersive, personalized educational experiences, leveraging VR technology to enhance engagement and accommodate diverse learning styles. By addressing the shortcomings of conventional approaches, the proposed VR labs aim to create an inclusive and supportive educational environment for individuals with Autism, ADHD and Specific Learning Disability.

2. Background Story

Autism Spectrum Disorder (ASD), a neurodevelopmental disorder is characterized by persistent difficulties in

- social interaction, communication, restrictive or repetitive patterns of behavior, interests, or activities[5].
- ADHD is marked by attention deficits and impulse control challenges.
- Specific Learning Disability impacts reading and writing,comprehension, executive functioning and organization skills.

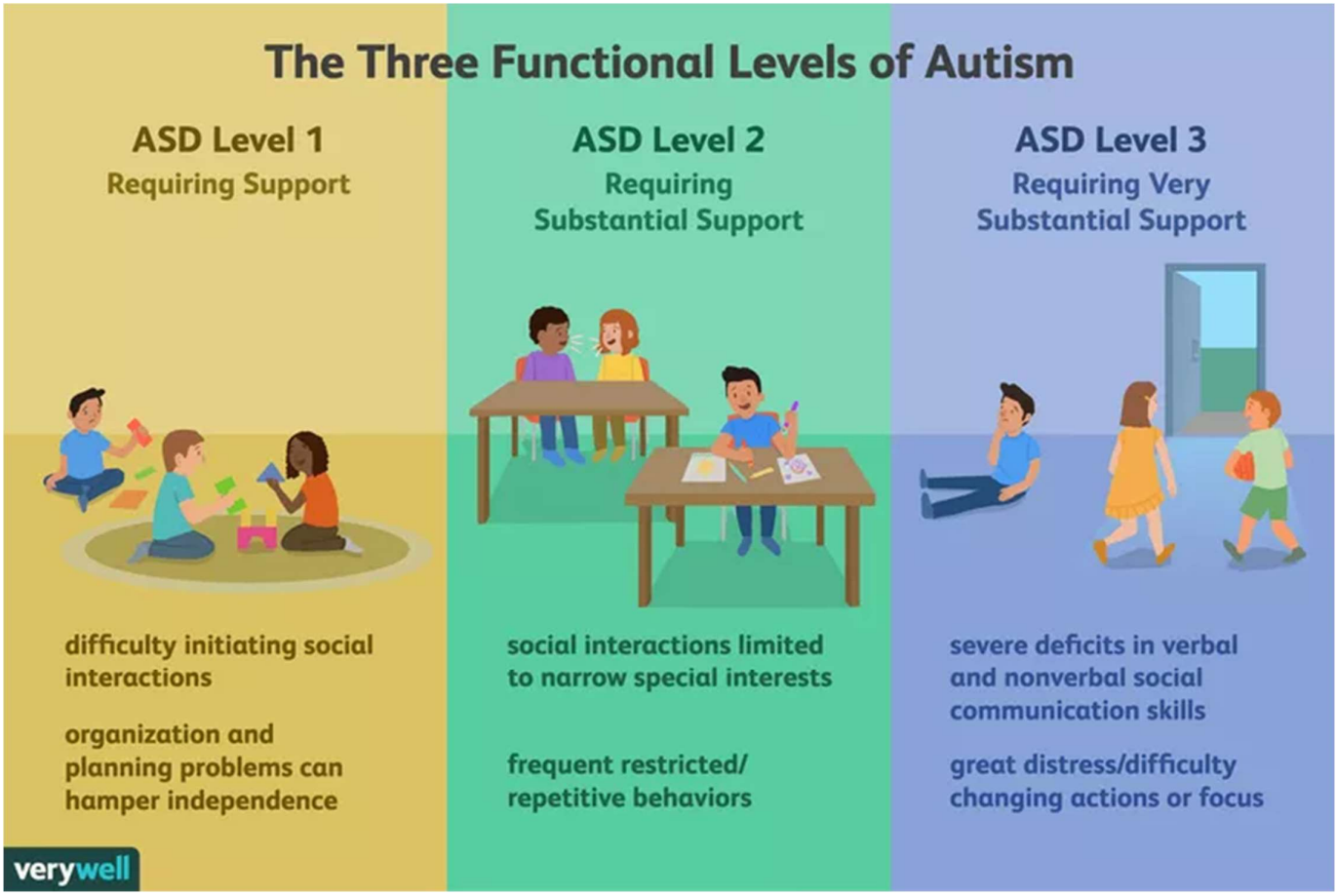
These conditions present intricate obstacles within the conventional educational framework[6]. The uniform pace of teaching and reliance on textual materials become stumbling blocks for optimal learning for these students. Recognizing these educational gaps, VR labs emerge as a forward-looking solution.

ASD has been reported to be the most widely prevailing NDD and hence children with autism usually end up in special schools.

ASD has been classified in to major three categories

- Level 1 High functioning Autism,
- Level 2 Autism
- Level 3 Low functioning Autism.

In inclusive schools, class room teaching, use of flashcards, blackboards and role plays are merely successful as the children lack the ability to pay attention to a particular module for long hours. Even a meager change in the tone of their parents and tutors drastically affects the behavior of these children. To overcome these drawbacks in the conventional methods, focus can be given on developing customized VR environments to train and teach children with autism so that they can stay focused on a particular module for increased time sessions.



The establishment of VR labs is not a mere incorporation of technological innovation for its own sake; rather, it is a deliberate response to rectify a persistent educational void[7]. The immersive nature of VR facilitates an engaging educational experience, sidestepping the distractions and limitations posed by traditional classrooms. The adaptability of VR technology allows educators to individualize content delivery, accommodating the varied learning paces of students with ADHD[8].

Similarly, students grappling with Specific Learning Disability stand to benefit significantly within the VR lab model[9]. The transformation of written texts into Specific Learning Disability-friendly formats, complemented by audiovisual aids, addresses the fundamental challenge of decoding written information. The accessibility and customization afforded by VR labs mitigate the obstacles posed by conventional print-centric approaches, fostering a conducive learning atmosphere for students with Specific Learning Disability. The traditional narrative, characterized by instances of students grappling with conventional methodologies, underscores the urgency for change. VR labs, as a testament to inclusivity, strive to rectify a longstanding imbalance, ensuring that no student is left behind in the pursuit of knowledge[10].

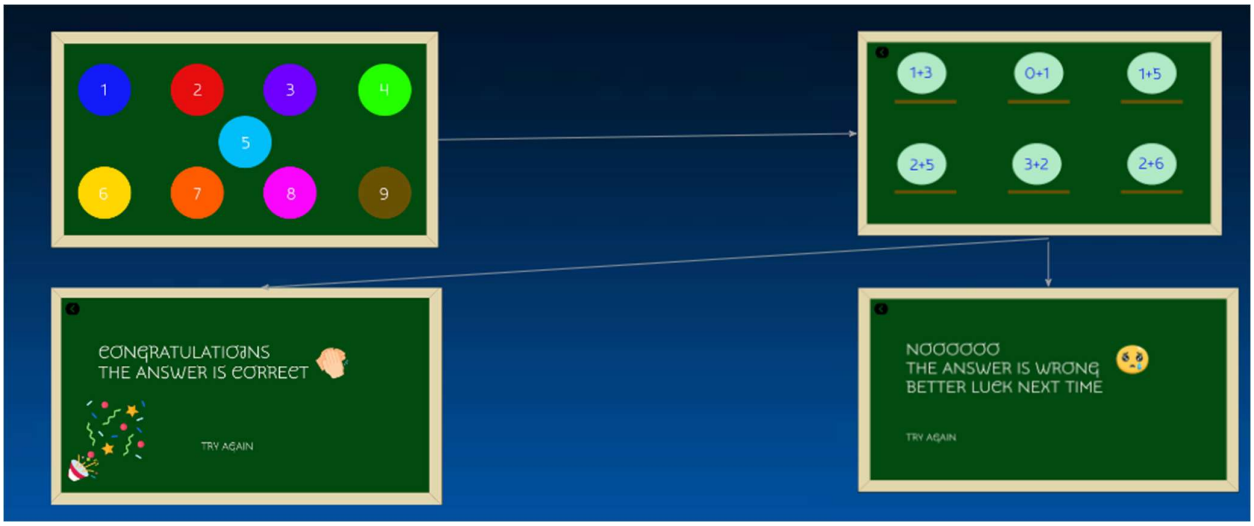
To sum up, the imperative for VR labs designed for individuals contending with ASD, ADHD and Specific Learning Disability stems from a broader commitment to equalizing educational opportunities[11]. The narrative unfolds within the context of systemic disparities that necessitate targeted interventions. VR labs represent a conscientious effort to align educational practices with the neurodiversity inherent in student populations. By seamlessly integrating VR technology, these labs embody a transformative approach that seeks to redefine educational norms, fostering an environment where every student, regardless of cognitive diversity, can thrive and achieve their academic potential.

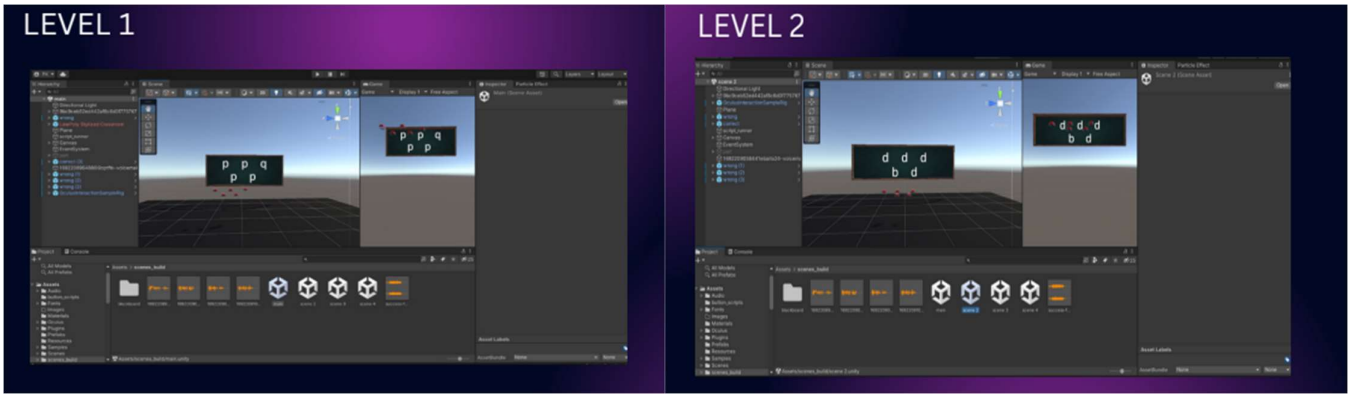
3. Approach and Methodology

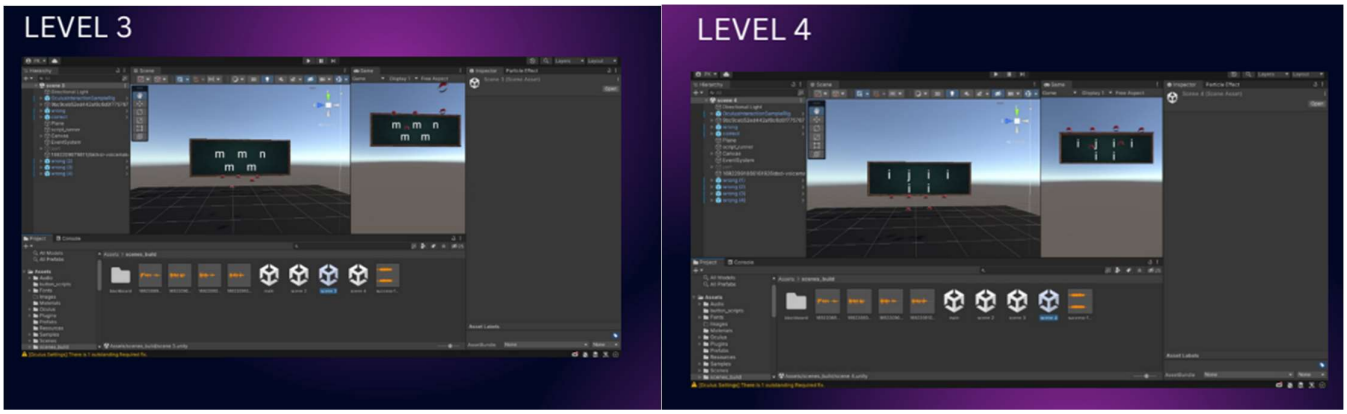
Objectives:

1. Tailor VR Labs for Learning Disorders[12]

Customizing VR labs to address learning disorders necessitates collaboration with experts in psychology and education. User testing involving children with Specific Learning Disability, ADHD and ASD will refine VR interventions, with continuous feedback loops from educators and parents contributing to ongoing improvements. Metrics will be established to assess the effectiveness of tailored VR interventions, ensuring that learning experiences are optimized for children with specific learning disorders.







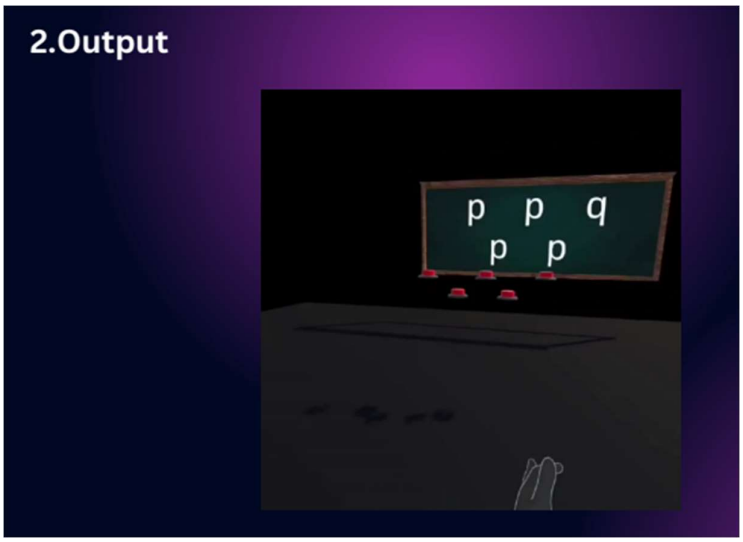


Figure 1: VR environments created for Specific Learning Disabilities

ASD has been reported to be the most widely prevailing NDD and hence children with autism usually end up in special schools where they receive

- Occupational therapy and Speech therapy, behavioral therapy training and functional academics through special educators

In inclusive schools, traditional classroom teachings are merely successful as the children lack the ability to pay attention to a particular module for long hours. To overcome these drawbacks in the conventional methods this study focuses on developing customized VR environments to train and teach children with autism.

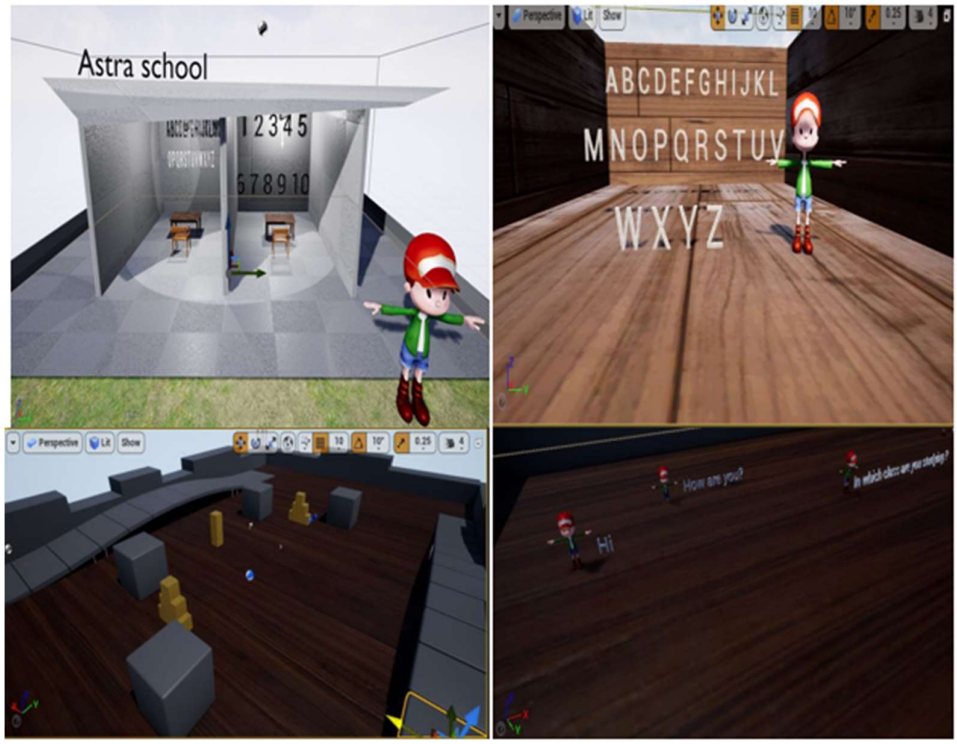


Figure 2:Classroom Environment developed for ASD

2. Enhance Learning Accessibility

Creating VR labs is a dedicated effort to foster inclusivity in education, especially for individuals managing ADHD, ASD and Specific Learning Disability[13]. By customizing immersive experiences to accommodate their distinct learning requirements through adaptive design, the initiative aims to overcome educational disparities. The utilization of VR technology is envisioned to offer an equal playing field, ensuring a supportive and accessible educational atmosphere that caters to the needs of individuals with ADHD, ASD and Specific Learning Disability. Figure 3 discusses the overall workflow of the project.

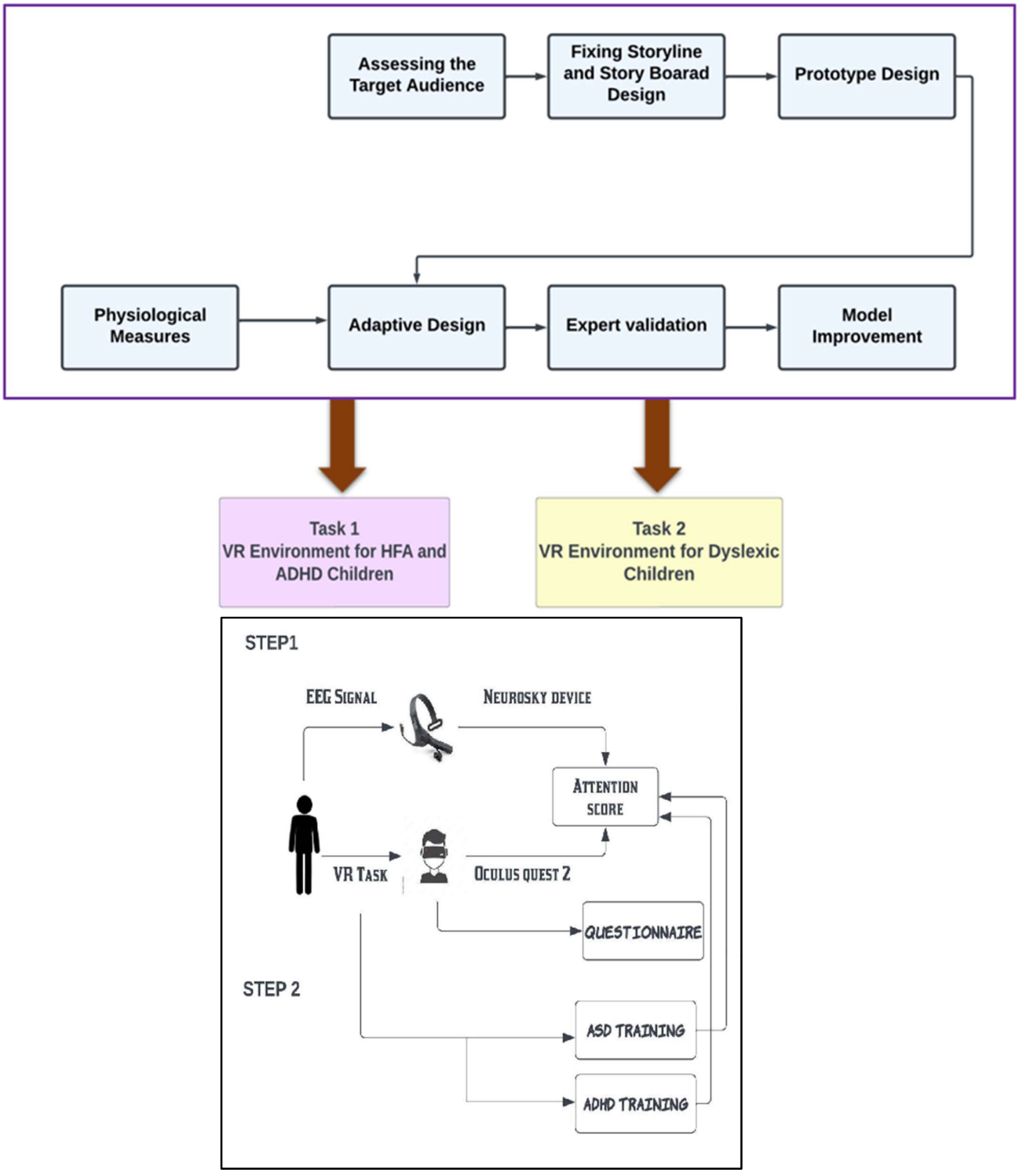


Figure 3 Proposed workflow

Thereby to fulfill above objectives, our approach will involve:

- **Collaboration with Experts:** Engage psychologists and education specialists to understand the nuances of learning disorders and gather insights for VR lab customization.
- **User Testing:** Conduct extensive user testing involving children with ASD, Specific Learning Disability and ADHD to refine and tailor VR interventions based on feedback.
- **Continuous Feedback Loops:** Establish ongoing feedback mechanisms with educators and parents to gather insights for iterative improvements to interventions.
- **Metrics Development:** Define measurable metrics to assess the effectiveness of tailored VR interventions in addressing the specific learning needs of children.
- **Optimization for Learning Disorders:** Utilize feedback and metrics to continually optimize VR experiences, ensuring they effectively address the unique challenges
- **Accessibility Focus:** Prioritize inclusivity in educational design, ensuring that VR labs are accessible and beneficial for individuals.
- **Technology Integration:** Leverage VR technology to create immersive and interactive learning experiences that go beyond traditional teaching methods.
- **Equal Opportunity Design:** Design VR labs with the objective of providing an equal educational playing field for individuals managing ASD, ADHD and Specific Learning Disability.
- **Collaborative Learning Environment:** Foster a collaborative learning environment within VR labs, encouraging engagement and participation among students with diverse learning needs.
- **Continuous Improvement:** Establish a culture of continuous improvement, where insights from ongoing collaboration, user testing, and feedback loops are consistently incorporated to enhance the effectiveness of VR interventions.

4. Expected Outcomes

- The tailored approach to VR labs for learning disorders anticipates several positive outcomes that collectively contribute to fostering a more inclusive and effective educational environment. First and foremost, the collaboration with experts in psychology and education is expected to yield a comprehensive understanding of the unique challenges posed by children with neurodevelopmental disorders[14]. By tapping into the expertise of professionals, the curriculum for learning can be devices and VR interventions can be finely tuned to address the specific cognitive needs of individuals managing these learning disorders.
- User testing involving children with ASD, Specific Learning Disability and ADHD is envisioned to be instrumental in refining VR interventions. The expected outcome is a more nuanced and targeted set of virtual experiences that resonate with the users, making the learning process engaging and tailored to their individual learning styles[15]. Through continuous feedback loops involving educators and parents, the aim is to create a dynamic cycle of improvement. This iterative process is anticipated to result in VR interventions that are not only effective but also adaptable to evolving educational needs.
- The development of measurable metrics to assess the effectiveness of tailored VR interventions is a crucial aspect of the approach. The expected outcome is a robust evaluation framework that gauges the impact of VR labs on the learning outcomes and experiences of children with NDD[16]. This data-driven approach allows for evidence-based decision-making and ensures that the interventions align with the overarching goal of overcoming educational disparities.
- In terms of optimizing VR experiences for learning disorders, the anticipated outcome is a set of interventions that prove to be particularly beneficial for individuals managing ASD, ADHD and Specific Learning Disability[17]. By tailoring immersive experiences to accommodate the distinct learning requirements of these students, the aim is to create an educational atmosphere that goes beyond mere accommodation, offering a supportive and enriching environment.
- The focus on accessibility and inclusivity is expected to result in VR labs that provide an equal playing field for individuals with NDD[18]. This implies not only overcoming physical barriers but also addressing

cognitive and learning barriers through innovative and tailored VR interventions. The envisioned outcome is a learning environment where every student, regardless of their cognitive profile, can thrive and actively participate in the educational process.

- Lastly, the creation of a collaborative learning environment within VR labs anticipates positive social and educational outcomes. By fostering engagement and participation among students with diverse learning needs, the expected outcome is a sense of community and shared learning experiences[19]. This collaborative ethos contributes to a more inclusive educational culture, breaking down barriers and promoting a holistic approach to learning that accommodates the unique needs of every student.

Monitoring & Evaluation Framework

S.No.	Objective	Output to be achieved	Indicator	Indicator - How will it be measured	Reporting Timelines
1	To develop VR labs for children with learning disabilities like ASD, ADHD and Specific Learning Disability	Enhancing the cognitive functions of the children	Behavioral Scores/Quantitative EEG signatures	Behavioral scores from trainers Quantitative scores from EEG of participants	After training

Replicability plan for the project –

This pioneering initiative centers on developing Virtual Reality (VR) labs tailored for individuals managing ASD, ADHD and Specific Learning Disability[20]. Through collaboration with psychology and education experts, user testing, and continuous feedback loops, the objective is to create immersive and accessible learning environments. These VR interventions, enriched with measurable metrics and ongoing optimizations, aim to bridge educational gaps and establish an inclusive platform for diverse learners, ensuring equitable opportunities for academic success.

Replicating this project effectively requires strategic collaboration with educators, policymakers, and technology developers[21]. Curriculum design should prioritize content seamlessly integrating with interactive VR technologies, while ongoing professional development for educators is vital for adapting to and maximizing the potential of immersive learning tools. Anticipated outcomes include heightened student engagement, improved conceptual understanding, tailored learning experiences for diverse needs, and democratized educational accessibility.

To ensure replicability, key considerations involve technology integration, educator training, and a partnership model[22]. The scaling strategy entails initiating small-scale pilot programs in diverse regions, implementing continuous feedback mechanisms, and optimizing resources for cost-effectiveness without compromising quality. Evaluation metrics cover student engagement, learning outcomes, inclusivity, and accessibility. The sustainability plan emphasizes community involvement, government support, and open-source initiatives[23].

By documenting successful implementations, conducting workshops and conferences, and creating online resources, this replicability plan aims to serve as a comprehensive guide for global implementation, promoting inclusivity and transformative learning experiences in diverse educational settings.

5. Fund Utilization Plan (500 words)

Funds will be allocated as follows:

S.No.	TASK	DESCRIPTION	BUDGET
1	VR for high functioning autistic and ADHD children	● Assessing the children by investigating them during field trips (Hospitals, Special schools) ● Fixing the problem statement and creating storyboard & storyline depending on their needs. ● Designing Child friendly environments and creating Animations by designing properly rigged character models using 3D max, Mixamo or Daz studio to keep the learning module more realistic. ● Develop the fully working game model with gamification, simulation of the game to be done using Unity 3D game engine. ● Once the module has been created, with proper expert validation the improvements in the model can be done	- 2649500/-
2	VR for Dyslexic Children		1299500/-
	Grand Total		**3965250/-**

Institution Wise Budget Utilization (in rupees)

No	Head	SSN	GUVI	SNS	Total
1	Man power	720000	720000		**1440000**
2	Consumables	500000	250000		**750000**
3	Travel	50000	50000	25000	**125000**
4	Contingency	100000	100000	50000	**250000**
5	Minor Equipment	600000	400000	50000	**1050000**
6	Overhead	197000	152000	1250	**350250**
Total		**2167000**	**1672000**	**126250**	**3965250**

S.No	Head	Per month	I year	II year	Total
1. Man power	Junior Research Fellow	30000	360000	360000	720000
	Junior Research Fellow	30000	360000	360000	720000
2	Consumables		250000	250000	750000
3	Travel		25000	25000	125000
4	Contingency		50000	50000	250000
5	Minor Equipment		50000	50000	1050000
6	Overhead		175125	175125	350250
Total			2649500	1299500	3965250

- **Manpower:**
  Two NET/GATE qualified professional students are required to conduct the field trip, virtual reality design, implementation and other necessary experimental works. One candidate will work with SSN and the other one with GUVI. SSN and GUVI will work hand in hand for dealing with the technical side of the work. The position requested is a JRF with a pay as per SSN/SNU rules.
- **Consumables:**
  Components and other accessories needed for the work. One of the validation methods included for the study is by analysing EEG. Data Collection will be done by using wireless EEG system from gtec g nautilius and Emotiv Epoc which is available with P.I. Electrodes, Gel, Cotton, connecting wires, Batteries etc are required.
- **Travel:**
  Travel grant is required for regular visits to hospitals, schools and between institutes. In addition, travel grants will also be utilized for Shiv Nadar school students for any short-term training or lab visit towards knowledge transfer. In addition, the money can also be utilized for conferences.
- **Minor Equipments:**
  Majority of the equipment needed for the project are available with P.I under the center for healthcare technologies at SSN.
- **Contingency:**
  In executing the project, a budget for contingencies is required to buy small laboratory items, electric components, stationary items, postage, books and allied items etc. Miscellaneous instruments required for outsourcing, duty payment and PCB fabrication are included.
- **Overhead:**
  Overhead amount is required as a part of the project budget towards meeting the costs for overhead expenses including infrastructure facilities etc.

6. Collaborating Institution's Role

Sri Sivasubramaniya Nadar College of Engineering (SSN) will actively collaborate by providing technical expertise in virtual reality technology and infrastructure along with research support and guidance on the development of the virtual reality labs.

GUVI will play a critical role in providing expertise and technical support in the VR environment, gamification, animation development and content creation.

Shiv Nadar School (SNS) can be expected to play a crucial role in identifying the key learning modules for immersive experience, providing access to educational resources and expertise in pedagogy. Piloting the virtual reality labs in their school and providing feedback on the effectiveness of the learning modules.

Please find the contact details of the team that would be working on the project-

Sri Sivasubramaniya Nadar College of Engineering, Chennai

S.No.	Name	Email ID	Phone No.	Role
1	Dr. Kavitha A.	kavithaa@ssn.edu.in	8939223077	Principal Investigator
2	Dr. Pravin Kumar S.	pravinkumars@ssn.edu.in	9994246503	Member
3	Ms. Divya B.	divyab@ssn.edu.in	9952068826	Member
4	Mr. Balamurugan R.	bmgn05@gmail.com		External Consultant
5	Mr. Vishnu T. U.	vishnu@machenn.com		External Consultant

GUVI

S.No.	Name	Email ID	Phone No.	Role
1	Ms. Durga	durga@guvi.in		Principal Investigator
2	Mr. Praveen	praveen@guvi.in	9159996259	Member
3	Mr. Muruganantham	muruganantham@guvi.in	9944927917	Member

Shiv Nadar School, Noida

S.No.	Name	Email ID	Phone No.	Role
1	Ms. Harleen Ahulwalia	harleen@sns.edu.in	9811047745	Principal Investigator
2	Ms. Manjima Chatterjee	manjima.chatterjee@sns.edu.in	9818342455	Member
3	Mr. Mark Nelson	mark.nelson@sns.edu.in		Member

First year: VR environment creation and Validation for High Functioning autistic and ADHD children

Phase	Activity Description	Deliverables for the activity	Timeline	Owner
1. VR Environment creation for High Functioning autistic and ADHD children	Assessment of specific needs of autistic children Identification of behavioral and cognitive skills for improvement	**Field visit** **Sensory regulation Skills:**managing sensory overload, tolerating crowded spaces, coping with bright lights, and handling auditory stimuli **Social Communication Skills:** **Emotional Regulation Skills:** **Life skills:** reading product labels, making appropriate choices, understanding pricing and currency, handling money, and using technology for payment methods	3 Months	SSN-GUVI-SNS

	Storyboard design	● Literature review ● Template creation ● Scene descriptions ● Visual assets identification (2D/3D) ● Narration - Dialogue and texts ● Review and feedback Finalization of the storyboard	3 Months	SSN-GUVI
	Prototype design:	● Game engine ● Tool identification and application for 3D design and animation ● Plug-ins	2 Months	SSN-GUVI
	Customised design: Interaction design: finding and selecting products, payment	● Child friendly design with easy interaction using VR hand held controllers. ● Training the kids to navigate using the controllers. ● Providing instructions through captions and voice notes in order to help the children to play the game	2 Months	SSN-GUVI
	Gamification for rewarding	●After training the children by providing instructions, testing them by giving the product list and asking them to pick and do the billing on their own. ●After they finish the game rewards like stars, claps and points will be added at the end	One Month	SSN-GUVI

	Expert assessment - validation & Model improvement	● Assessing the product with experts working in the field of neuroscience. ● Validate the game using performance metrics analyzed while playing the game by children. ●Considering the difficulties faced by the children while playing the game and addressing them by improving and customizing the game	One Month	SSN-GUVI-SNS

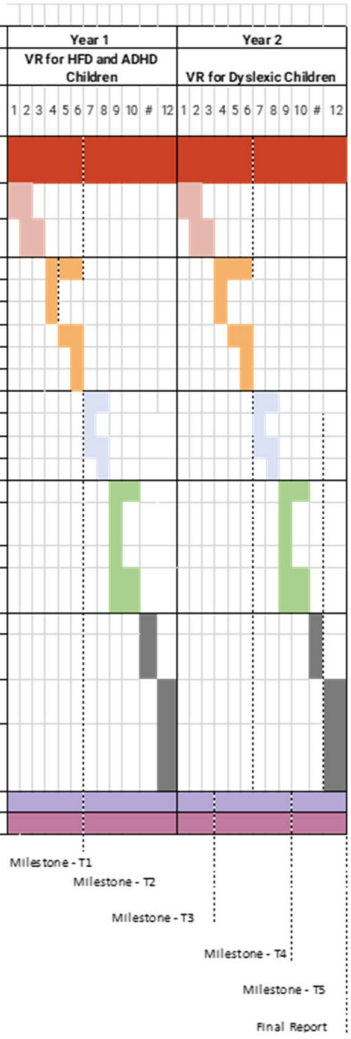
Second year: VR environment creation and Validation for dyslexic children

Phase	Activity Description	Deliverables for the activity	Timeline	Owner
2. VR Environment creation for Dyslexic children	Assessment of specific needs of dyslexic children Identification of behavioral and cognitive skills for improvement	**Field visit** 1.Enhanced Learning Environment 2.Improved Reading Skills 3.Engagement and Motivation 4.Personalized Learning	3 Months	SSN-GUVI-SNS
	Storyboard design	● Literature review ● Template creation ● Scene descriptions ● Visual assets identification (2D/3D) ● Narration - Dialogue and texts ● Review and feedback Finalization of the storyboard	3 Months	SSN-GUVI
	Prototype design:	● Game engine ● Tool identification and application for 3D design and animation ● Plug-ins	2 Months	SSN-GUVI

	Customised design: Interaction design: finding and selecting products, payment	● Child friendly design with easy interaction using VR hand held controllers. ● Training the kids to navigate using the controllers. ● Providing instructions through captions and voice notes in order to help the children to play the game	2 Months	SSN-GUVI
	Gamification for rewarding	●After training the children by providing instructions, testing them by giving the product list and asking them to pick and do the billing on their own. ●After they finish the game rewards like stars, claps and points will be added at the end	One Month	SSN-GUVI
	Expert assessment - validation & Model improvement	● Assessing the product with experts working in the field of neuroscience. ● Validate the game using performance metrics analyzed while playing the game by children. ●Considering the difficulties faced by the children while playing the game and addressing them by improving and customizing the game	One Month	SSN-GUVI-SNS

7. Timelines (200 words)

	Task Denomination	Responsibility	Partners involved in task
	VR Environment Creation and Validation	SSN	SSN-GUVI-SNS
1	Assessment of specific needs of autistic children		SSN-GUVI-SNS
2	Identification of behavioral and cognitive skills for improvement		SSN-GUVI-SNS
	Storyboard Design	SSN	SSN-GUVI-SNS
1	Literature review		SSN-GUVI
2	Template Creation Scene Descriptions		SSN-GUVI
3	Visual assets identification (2D/3D)		SSN-GUVI
4	Narration-Dialogue and texts		SSN-GUVI
5	Review and feedback-Finalization of the storyboard		SSN-GUVI-SNS
	Prototype design:	SSN	
1	Game engine		SSN-GUVI
2	Tool identification and application for 3D design and animation		SSN-GUVI
3	Plug-ins		SSN-GUVI
	Customised design:	SSN	
1	Child friendly design with easy interaction using VR hand held controllers.		SSN-GUVI
2	Training the kids to navigate using the controllers.		SSN-GUVI
3	Providing instructions through captions and voice notes in order to help the children to play the game		SSN-GUVI
	Expert assessment validation & model improvement:	SSN	
1	Assessing the product with experts working in the field of neuroscience.		SSN-GUVI-SNS
2	Validate the game using performance metrics analyzed while playing the game by children.		SSN-GUVI-SNS
3	Considering the difficulties faced by the children while playing the game and addressing them by improving and customizing the game		SSN-GUVI-SNS
	Dissemination and communication	SSN	
	Project Management		



Milestones T1: Literature review, Storyboard design, Prototype design for task 1
Milestone T2: Creation of VR environment for high functioning autistic and ADHD children
Milestone T3: Literature review, Storyboard design, Prototype design for task 2
Milestone T4: Creation of VR environment for dyslexic children
Milestone T5: Completion of objectives and validation
Final report preparation

The project is planned for a span 24 months:

In conclusion, this grant proposal seeks support for an innovative approach to use virtual reality (VR) technology as a therapeutic tool for helping ADHD, high functioning autistic and dyslexic children to be more comfortable with their learning and to perform better in their day to day life. Numerous studies have demonstrated the potential of VR interventions to improve attention, focus, social skills, and sensory integration in individuals with these conditions. The immersive and interactive nature of VR provides a controlled and customizable environment for targeted interventions, making it an appealing alternative or complementary approach to traditional therapies. While the use of virtual reality for treating ADHD, autism and dyslexia holds promise, there is still much potential for future research and development. Here are some areas that warrant further exploration:

- **Long-term efficacy:** Continued research is needed to assess the long-term benefits of VR interventions for individuals.
- **Personalization and customization:** As VR technology advances, efforts should be made to tailor interventions to the specific needs and preferences of individuals with ADHD and autism. Customizable features, adaptive algorithms, and individualized treatment plans can enhance the effectiveness of VR-

based therapies.

- **Generalizability:**While VR interventions have shown promising results within controlled environments, it is essential to assess their effectiveness in real-world settings. Studies should investigate the generalizability of VR-based interventions and their impact on daily functioning, school performance, and social interactions outside of the virtual environment.
- **Accessibility and affordability: I**mproving the accessibility and affordability of VR technology is crucial for its widespread adoption. Continued advancements in hardware, software, and cost reduction will ensure that VR interventions become more accessible to individuals with ADHD, autism and dyslexia, regardless of their socioeconomic background.
- With all the prerequisites taken into consideration, the project's successful completion could have far-reaching effects by improving the involvement in learning by development of virtual reality environments for children with high functioning autism, ADHD, and dyslexia.

Major Equipment available with the PI at Extended reality (XR) Lab at SSNCE, Chennai

VR/AR Equipment List	XR LAB VR Equipment List
Equipment Name (Available)	**Equipment Name (Under procurement)**
Oculus Quest 2/ VR Headset -256GB	Meta Quest 3, Head strap Mount Adjustable
Alienware Core i7 - 8th Gen System	Meta Quest Pro, Head strap Mount Adjustable
Microsoft HoloLens 2 - 64GB	Meta Quest 2, Head strap Mount Adjustable
RealSense Depth CameraD435i	CB- Controller (PC/VR Compatible) Wireless
T L Spine Model with R/O Sawbone	15" Display Hologram. SD Card Support
Optitrack Duo- V120 optical tracking camera	3 DOF touch haptic arm
FLIR- E86 24 Thermal Camera	360 Camera (Insta pro 2)
	Production Hardware PC RTX3080-()
	All in one interactive panel. 3D touch screen,5G
	Creality 3D Scanner
	Samsung Galaxy Table4t S9,8 GB RAM,, 128gb
	Designer's Board and Stylus/ Windows Compatible
	Consumables

8. References

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