AR Communication Software for Children with Autism

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***Abstract*—Children that have autism spectrum disorder (ASD) often face various challenges in verbal communication, which makes it difficult for them to express their emotions and needs. This project explores the development of a software solution for an Augmented Reality (AR) platform that supports communication and self-expression for children with autism. The system aims to create an interactive and customizable environment in which the caregiver of the child can freely modify the content to tailor it to the unique needs of the child. The development follows an iterative prototyping approach to refine the application through feedback from professionals and users. This report details the rationale, objectives, and the development approach of the project.**

Keywords— Autism Spectrum Disorder, Augmented Reality, Assistive Technology, Communication, Human-Computer Interaction, Prototyping, ASD, AR.

I. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that affects the communication, social interaction, and behaviors [1] of adults and children. Many children with ASD struggle with conventional communication methods, which makes it difficult for them to express their needs and emotions effectively. Although various assistive technologies exist, they often lack flexibility, fail to sustain engagement, or are not tailored to the unique needs of autistic children. Augmented Reality (AR) presents a promising advancement in assistive communication tools, offering a more interactive and adaptable solution.

This project focuses on developing a software-based communication solution tailored for an AR system. Our goal is to provide an engaging, interactive, customizable software that can be tailored to the individual needs of the child. The use of AR allows for digital overlays in the user's physical environment, which in turn offers a multi-sensory experience that can promote understanding and interaction. By emphasizing visual support, contextual clues, and interactive elements, the system aims to supplement or enhance the communication pathways that children with ASD find most accessible.

II. Problem Statement

Children who face communication challenges – such as those on the autism spectrum – often encounter impairments in social interactions, and communication [2]. Which can hinder their participation in social and educational contexts. Existing tools are often limited in customization and sometimes fail to sustain user engagement due to lack of interactivity. This gap underscores the need for a more responsive and immersive communication tool.

An augmented reality-based software offers a promising solution by introducing dynamic visuals and auditory stimuli that enhance communication without overwhelming the user. The ability to adapt to individual preferences while encouraging interaction in a real-world context makes AR an ideal medium for this application. A flexible, user-friendly system tailored to individual learning profiles has the potential to improve expressive capabilities and social confidence.

III. Project Objectives

For this project our current objectives are:

- Develop a functional AR communication software.
- Allow for caregiver-driven customization of content and interface settings.
- Allow for emotion recognition.
- Design the user interface with accessibility and engagement as top priorities.
- Gather user feedback during development to ensure the system evolves to meet real-world needs.

IV. Project Methodology

Our project adopts a waterfall model with prototyping. This approach offers us a structured development process with built-in opportunities for iterative testing and refinement. Key stages include:

- **Requirement Gathering:** Consultation with specialists, therapists, end-users, to come up with a list of necessary requirements.
- **System Design:** Development of wireframes, and program design.
- **Prototype Creation:** Building early versions of the software for internal evaluation.
- **Evaluation:** User testing sessions with educators and therapy professionals.
- **Implementation:** Iterative enhancements leading to a stable, deployable prototype.

V. Structure Diagram

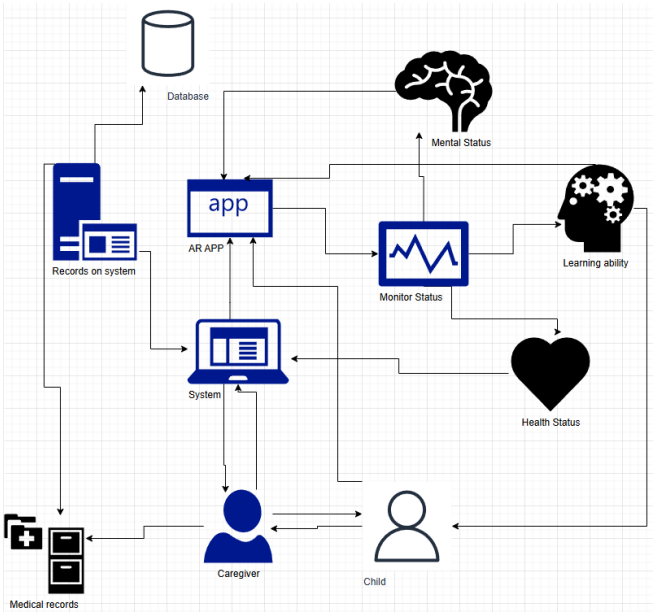

Figure 1: Structure Diagram of Our Project.

When designing our project, our vision is for pediatricians and healthcare professionals to systematically analyze and study the communication patterns and behavior in children with autism. The structure of this project uses an application as a tool for better understanding and appropriate communication. Certified medical practitioners utilize the application to track developmental progress across cognitive, emotional, and educational domains. The child using the app through the Augmented Reality (AR) headset will be able to immerse himself/herself in activities to help them understand and communicate in an efficient way. Every piece of information will be stored in the system with a database which only medical professionals will have access to.

VI. System Design

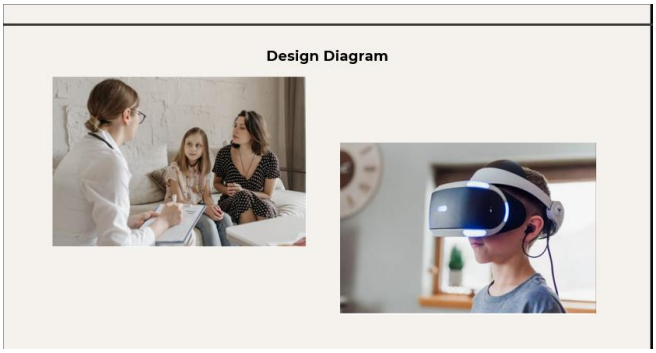

Figure 2: Design Diagram of Our Project.

The project employs a streamlined, user-centric design to ensure accessibility for its intended users (families and clinicians). We have the family visit their licensed medical doctor to have an evaluation of how the child interacts or communicates with other people. Following this evaluation, the next step is to gradually introduce the child to AR so that they can get accustomed to the platform. During this time, the doctor will be connected to a computer using the app to compile the data for analysis.

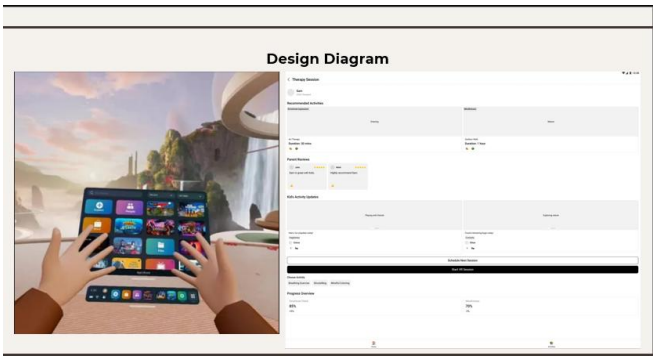

Figure 3: Wire Frames of Our Project.

The Augmented Reality headset incorporates a customizable menu of gamified activities, allowing the child to select various therapeutic modules aligned with their preferences. Each of the activities is designed to automatically transmit performance metrics (e.g., completion rates, response patterns) to the healthcare professionals' portal for behavioral assessment. The application, synchronized across AR hardware and clinical workstations, features role-specific profiles for medical practitioners. These profiles provide a centralized dashboard for progress tracking, adaptive goal setting, and session scheduling, enabling doctors to efficiently manage caseloads across multiple patients.

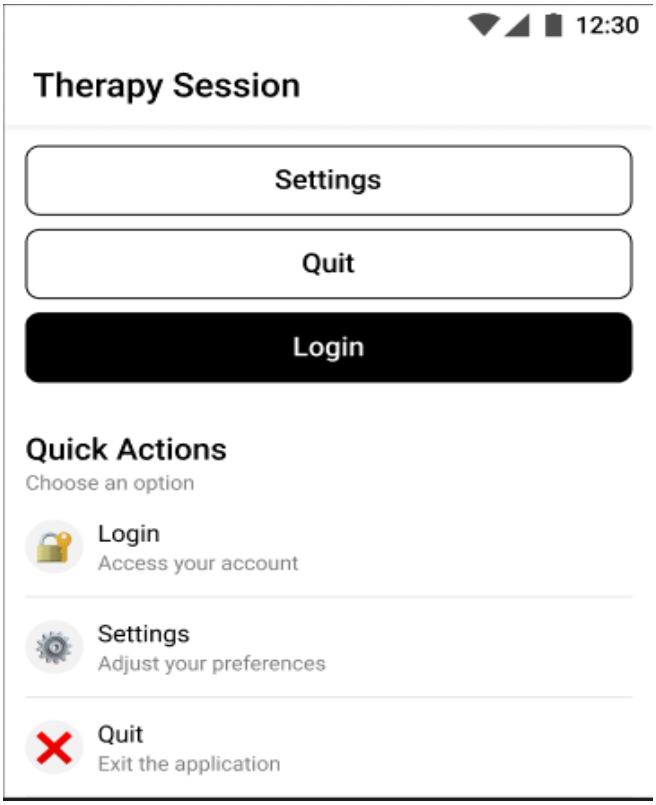

Figure 4: Login Screen for the Therapist.

A visualized concept for the project is to have a log in for the therapist/caregiver. In here, they can modify the activities for each session and have a clear progress of how the child

has been during the session. They can also start sessions with activities if the child has any trouble choosing an activity.

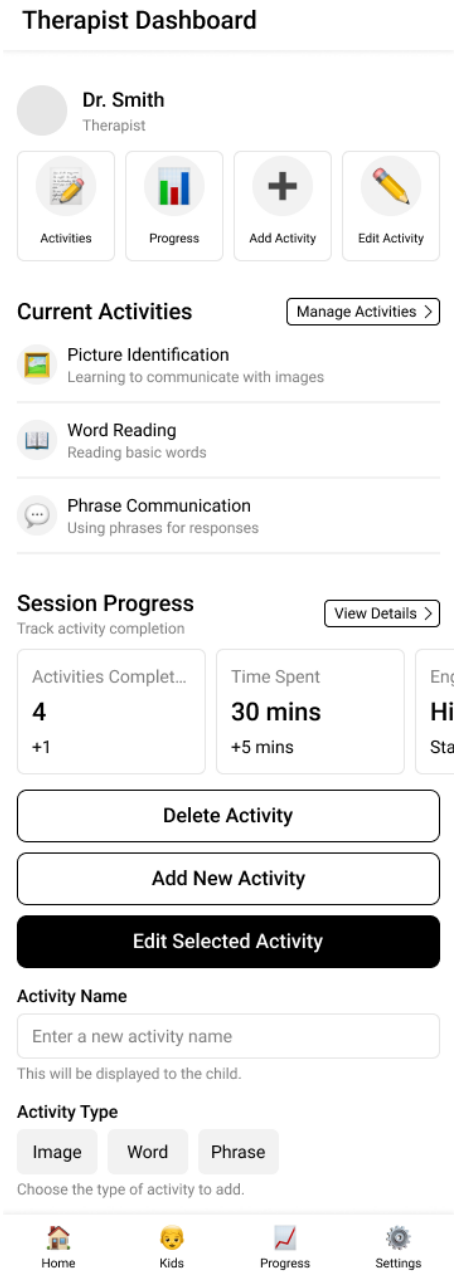

Figure 5: Menu Screen for the Therapist

This menu has access to all the content that can be personalized for the therapist/caregiver will use to have steady progress with the child. In here, we have information such as the doctor's name, the activities that will be implemented during the session and a progress to keep track of any communication that the child has learned.

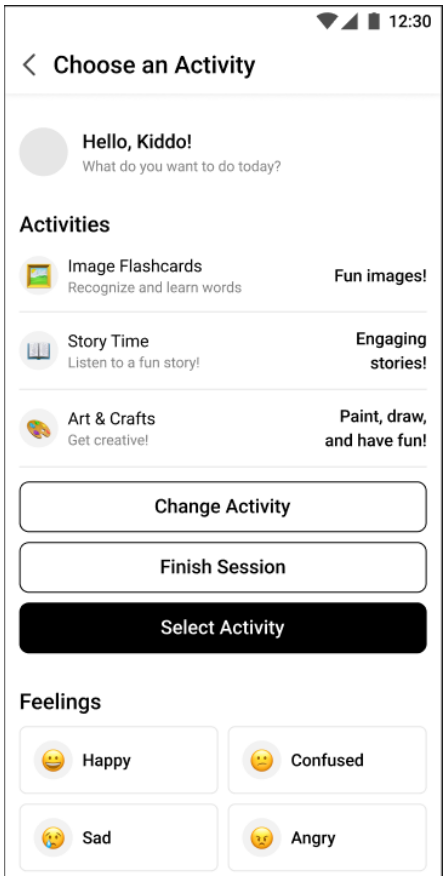

Figure 6: Menu Screen for Children.

This menu has more restrictions since it is for a child and to not overwhelm them with too much information. This simple menu has the child's name, the activity they want to partake in and a feelings option to express how they are currently during the session.

VII. Functional Requirements

Our current functional requirements for the project are as follows:

- AR (Augmented Reality) Overlay with Symbols:
  - These visual symbols will help the child who has difficulty trying to communicate.
- User Interface with AR Elements:
  - Since we do not know how the child will react to complete immersion, the layout and interface will be displayed in the real world.
- Customizable Content:
  - Dynamic library of games or activities for the child to participate in and interact with the doctor for better communication.
- Reward System:
  - Implementation of rewards for completing simple exercises.
- Motivational System:
  - Promote the child for good engagement.
- Basic Text-to-Speech System:
  - For better communication skills, we have a text-to-speech system so the child can also learn.
- Progress Tracking System:

- Useful for the licensed professional to maintain a curriculum with the child and keep steady progress.

- Emotion Recognition Assistant:
  - To maintain the safety of the child and have a safe environment and to keep the child at ease.
- Visual Setting Customization:
  - Adjust brightness, sounds and animations to accommodate the child wearing the headset.
- Voice Recognition and Commands:
  - Implement for an interaction through voice commands.
- Multi-language Support:
  - Create new ways of learning using different languages.
- Alert System:
  - Allow professionals to act if the child is under any kind of stress.
- Offline Functionality:
  - To maintain integrity and confidentiality, we will develop some parts with offline capabilities to keep information of patients secure.

VIII. Non-Functional Requirements

Our current non-functional requirements for the project are as follows:

- System Usability:
  - Make the system easy for both the medical professional and the child to use.
- Performance:
  - The system should always run smoothly and not cause any disturbance during the therapy session.
- Portability:
  - For cases where the child needs to be attended to in a different setting, have a way to keep data and take it to where the session will occur.
- Scalability:
  - Implement a database for keeping more patients.
- Availability:
  - The system should be ready at any time of the day.
- Security:
  - Access to confidential information should be given to medical professionals and the creators of the system.
- Maintainability:
  - Maintain updates for the software to prevent any intrusions and keep the software running without any problems.

IX. Cyclomatic Complexity

To evaluate the complexity of our system, we conducted a cyclomatic complexity analysis on the main functional modules of the software. Our system diagram includes major modules such as the AR activity interface, text-to-speech communication module and progress tracking system. After analyzing the complete module structure and their control paths, the total cyclomatic complexity was calculated to be twelve, this indicates a moderate level of complexity. The result reflects our design intention to maintain simplicity and usability, particularly considering our target users. The cyclomatic complexity evaluation was supported using GitHub Copilot, an AI-based assistant, which helped in structuring the control flow analysis and refining the module logic [9].

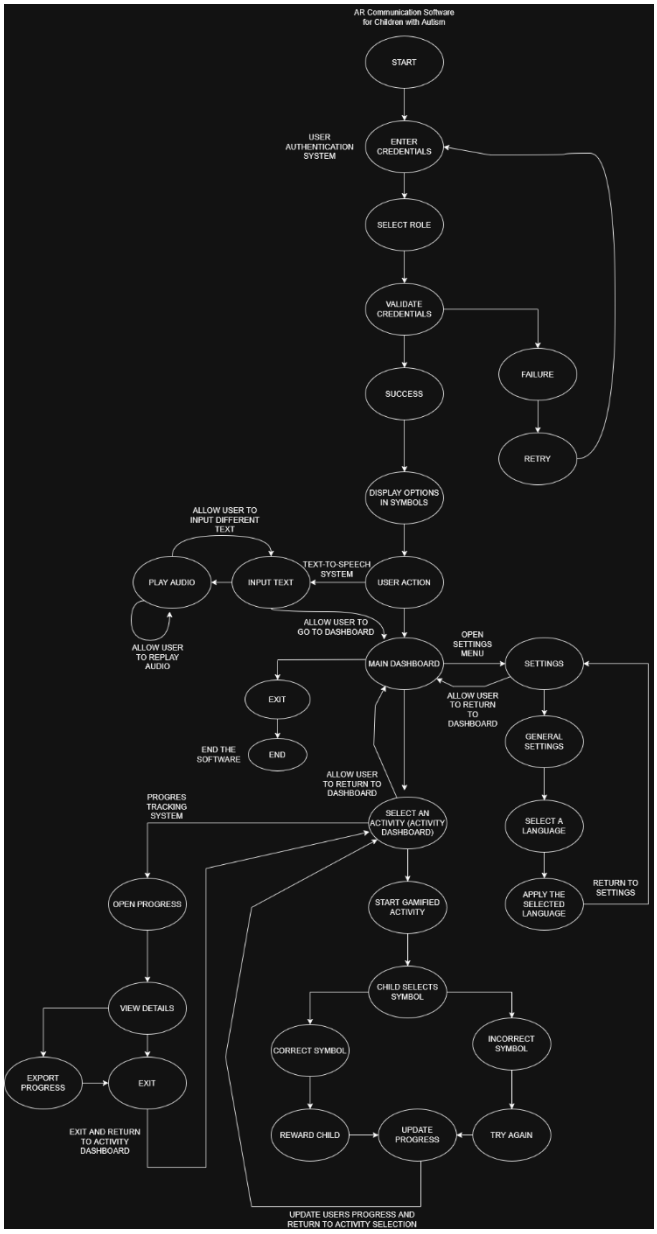

Figure 7: Cyclomatic Complexity Graph.

X. Conclusion

This project investigates the potential of augmented reality to enhance communication experiences for children with Autism Spectrum Disorder. By focusing on software development for an existing AR device, the solution seeks to complement real-world interactions with responsive digital support. As development progresses, emphasis will remain on usability, flexibility, and personalization – ensuring that the final product aligns with the unique needs of its users and contributes to more inclusive communication practices.

XI. References

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