Beyond the Lab: Four Use-Inspired Applications of Intelligent Systems for Societal Challenges

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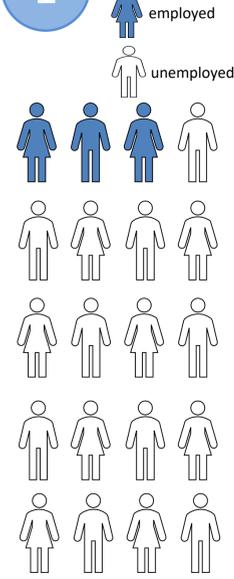**VANDERBILT** School of Engineering

ABSTRACT

The Robotics and Autonomous Systems Lab (RASL) focuses on the creation of intelligent systems to address societal needs. Presented here are projects that focus on addressing 3 main issues with various technologies:

1) **virtual reality** for soft skill training to address unemployment in autistic adults,

2) **wearable technologies and machine learning** for notifying caregivers of potential challenging behaviors in children with ASD,

3) the use of **augmented reality** to address loneliness in older adults residing in long-term care settings

Our technological solutions in each project have been developed with stakeholders and user input for deployment in real-world settings.

1 Background

THE FRIST CENTER FOR Autism AND INNOVATION

In collaboration with the Frist Center for Autism and Innovation, we aim to address two of the common barriers to employment for autistic adults: the interview process and collaboration in the workplace
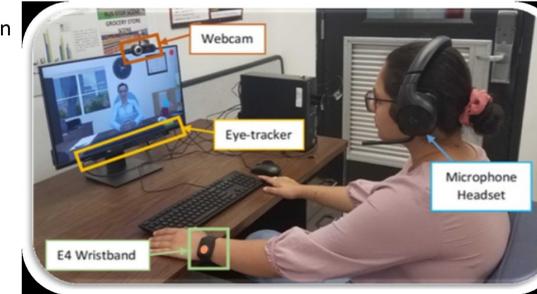
Of the 5,437,988 autistic adults in the United States, **85%** are under or unemployed

CIRVR — Career Interview Readiness In Virtual Reality
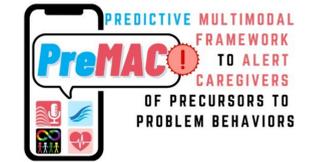
Project Objectives
- Provide an AI-adaptive, engaging, and individualized interview experience to practice interviewing skills
- Visualization of data to provide feedback to autistic individuals
- Data analysis to provide recommendations to employers on how to improve the interview process for autistic individuals

Project Components
- Conversation Module With Bidirectional Communication
- Emotion Detection Module Via Facial Expressions
- Eye Gaze Detection Module
- Physiology-based Stress Detection Module

Webcam, Eye-tracker, Microphone Headset, E4 Wristband

VIRCAS — Virtual Reality-based Collaborative Activities Simulator

Project Objectives
Create an interactive, engaging, and easy-to-access virtual-reality based simulator that can support teamwork skills training
Provide a quantitative measurement and evaluation of teamwork skills through the analysis of multimodal data

Project Components
- A Wide Range Of Collaboration Features
- A Video And Audio Streaming Service Embedded Within The Virtual Environment
- A Multimodal Data Capture Module
- A Network Communication Layer In The Virtual Environment

Fulfillment Center, Furniture Assembly, PC Assembly, Lego-based Task

2

PreMAC — PREDICTIVE MULTIMODAL FRAMEWORK TO ALERT CAREGIVERS OF PRECURSORS TO PROBLEM BEHAVIORS

Background

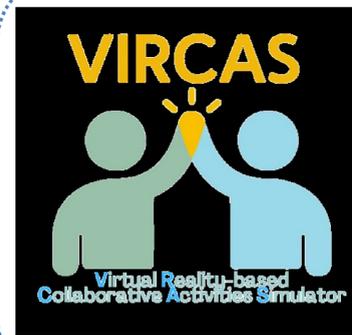Approximately 50% of children and adolescents with Intellectual and Development Disorders (IDD) exhibit challenging behaviors (self injurious behaviors, aggression toward others, elopement, etc.)

Project Objectives
- Develop an unobtrusive and well-tolerated wearable sensor network for sensing multimodal inputs (e.g., physiology, limb movement, vocal tone etc.) and create a real-time machine learning model grounded in state-of-the-art clinical intervention for predicting precursors to challenging behaviors in children and young adults with IDD
- Apply, test, and validate the new precursor detection framework in real-world intervention studies in several clinics in and around Nashville

Project Components
- Customized Hardware To Capture Motion, Electrodermal Activity, and Heart Rate
- Audio Is Collected and Mel Frequency Is Extracted
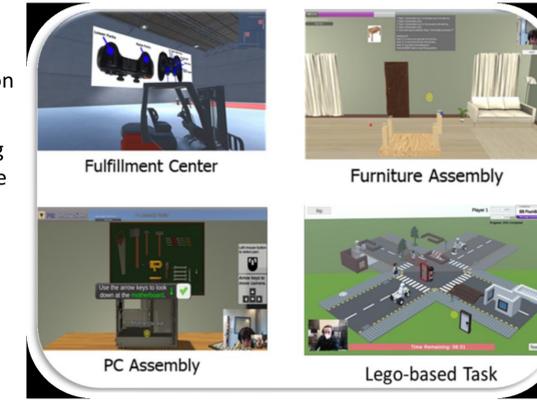- Multimodal Data Is Used To Train A Realtime Predictive Model

3 AUGMENTED REALITY COLLABORATION — ARC

Background

75% of older adults living in long-term care facilities report experiencing loneliness. Loneliness has been linked to increases in heart disease, depression, and reduced quality of life.

Project Objectives
- Develop a novel Collaborative Augmented Reality (CAR) framework to increase *social presence* in interactive communication technology where photorealistic 3-D avatars of an older adult's family members will be transported to their room in LTC for real-time joint activities with appropriate verbal and nonverbal communication
- Apply the above developed framework to develop CAR activities to mitigate loneliness among older adults in long-term care (LTC) settings, study its implementation, challenges, and impact

Project Components
- Bidirectional Networking Between Multiple AR Head Mounted Displays
- Facial And Body Gesture Mapping Between Local User and Their Remote Avatar
- Dynamically Weighted Body Pose Optimization During Avatar-object Interaction
- Spatiotemporal Rectified Mapping Of Locomotion Between User and Avatar Environments

Acknowledgements