

## A Pilot Study on Facial Expression Recognition Ability of Autistic Children Using Ryan, A Rear-Projected Humanoid Robot

Farzaneh Askari<sup>1</sup>, Haunghao Feng<sup>1</sup>, Timothy D. Sweeny<sup>2</sup>, Mohammad H. Mahoor<sup>1,3</sup>

**Abstract**—Rear-projected robots use computer graphics technology to create facial animations and project them on a mask to show the robot's facial cues and expressions. These types of robots are becoming commercially available, though more research is required to understand how they can be effectively used as a socially assistive robotic agent. This paper presents the results of a pilot study on comparing the facial expression recognition abilities of children with Autism Spectrum Disorder (ASD) with typically developing (TD) children using a rear-projected humanoid robot called Ryan. Six children with ASD and six TD children participated in this research, where Ryan showed them six basic expressions (i.e. anger, disgust, fear, happiness, sadness, and surprise) with different intensity levels. Participants were asked to identify the expressions portrayed by Ryan. The results of our study show that there is not any general impairment in expression recognition ability of the ASD group comparing to the TD control group; however, both groups showed deficiencies in identifying disgust and fear. Increasing the intensity of Ryan's facial expressions significantly improved the expression recognition accuracy. Both groups were successful to recognize the expressions demonstrated by Ryan with high average accuracy.

### I. INTRODUCTION

Children with Autism Spectrum Disorder (ASD) experience deficiency in verbal and non-verbal social skills. For most, ASD is a lifelong disorder, with long lasting symptoms from early childhood through adulthood [1]. Although, there is no known cure for ASD, research has demonstrated that those individuals who received behavior intervention during early ages exhibit improvements in communication and social skills in adulthood [2]. Therefore, it is of crucial importance to treat ASD in early ages.

The *Diagnostic and Statistical Manual of Mental Disorders* (5<sup>th</sup> edition; DSM-5; American Psychiatric Association, 2013) described ASD symptoms as deficits in social interaction, communication, and the presence of restricted, repetitive patterns of behavior, interests, or activities [3]. Although facial expression recognition and emotion perception are not main parts of the ASD definition, they are regarded as common shortfalls of individual with ASD [4], that prevent individual with ASD from perceiving other's mental state and regulating their behaviors

accordingly. In other words, emotion perception and expression recognition deficiencies can considerably limit social development in individuals with ASD.

Research has demonstrated that many children with ASD exhibit comfort and interest toward technology and robots [5]; as a result, the field of Socially Assistive Robots (SAR) has been widely studied [6]. Since children with ASD exhibit less anxiety and more comfort in more predictable (systematic) environments [7], robots can be used effectively to teach social skills to them because of their simplicity and predictability. There have been several socially assistive robots developed with emotionally expressive faces. Some of them such as KASPAR [8] and Tito [9] have more simplified faces to reduce sensory overload and anxiety [5]. In contrast, some other humanoid robots such as FACE [10] and Zeno [11] can demonstrate nearly realistic human facial expressions. Humanoid facially expressive robots are effective tools to target facial expression recognition and emotion perception in children with ASD. They are capable of expressing human like expressions and keeping children comfortable and engaged in a social environment. The idea that children with ASD suffer from emotion recognition deficiency is presumed [12-13]; however, there are studies [14,15] that cast doubt on the idea of a general emotion-recognition deficiency in children with ASD; instead, they suggest ASD children may perform worse, comparing to their Typically Developing (TD) peers, in recognizing some expressions out of six basic expressions outlined by P. Ekman [16]. Moreover, as [17] noted, children with ASD are not always impaired in recognizing expression with 100% intensity. Therefore, it is important to first study the deficiency, if one exists, in recognizing different expression intensities; and second, to use effective tools (e.g. SAR) to target and treat it.

There have been many studies in using SAR as a tool to teach social skills and emotion recognition to children with ASD. Keepon is a non-humanoid robot with snowman-like body made of silicon rub, which is able to express excitement, pleasure and fear emotions with body movement [18]. A study with a three-year-old autistic girl and a group of twenty-five TD children in the age range of 1-3 showed the success of Keepon to improve some of the social skills such as eye contact, joint attention, emotional expression, and turn-taking in both groups after several intervention sessions with Keepon [19].

An example of using humanoid robots to teach social skills to autistic children, is a study using KASPAR [8], which is a child-size male robot with active arms, hands, and head. KASPAR can open and close its mouth and eyes. In another study [20] KASPAR is used as a therapeutic tool for

<sup>1</sup> Farzaneh Askari, Haunghao Feng, and Dr. Mohammad H. Mahoor: Department of Electrical and Computer Engineering, University of Denver, Denver, CO 80208, farzaneh.askari@du.edu, howard.k.finn@gmail.com, mmahoor@du.edu <sup>2</sup> Dr. Timothy D. Sweeny: Department of Psychology, University of Denver, Denver, CO 80208 Timothy.Sweeny@du.edu <sup>3</sup> Dr. Mohammad H. Mahoor: DreamFace Technologies, LLC; <http://dreamfacetech.com/>