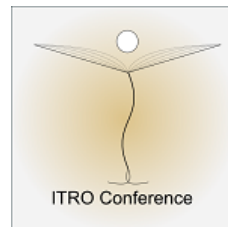




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# Design and Development of a Game for Recognizing and Expressing Emotions

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**Abstract - Autism Spectrum Disorders (ASDs), a neurodevelopmental disability in children, is one of the major health concern nowadays. In everyday situations, children with ASD encounter problems related with perceiving, understanding and using non-verbal cues as gestures, tone of voice or facial expression. Considering this facts, it is not surprising that the daily social interactions will be a problem for them. Conventional methods for treating children with ASD such as pharmacotherapy, special education and behavioral therapy, are not always successful and are usually expensive. There is a notable need to develop technology-based methods which will act as a supplement to the traditional ones, in order to make them more effective. *CatchMyEmotion* is an interactive game designed to measure the perceptual skills that are implicated in the recognition of facial emotions. It is designed and developed to promote emotional understanding, and to enhance facial and emotional recognition skills in children with ASD.**

## I. INTRODUCTION

Nowadays, it is hard to find a child who does not play and like computer games. They have been used for both learning and entertaining purposes at home and schools. Games are especially attractive for children with ASD, due to the visual nature of screen-based technology, the design and immediate feedback that they provide [1, 2, 3]. Playing games also helps them to practice flexible thinking, to become more comfortable after making mistakes and to recognize the importance of practice in order to improve skills.

Over the past years, great efforts have been made to teach children with ASD to improve their skills, especially recognizing and expressing emotions. Research shows that children with ASD have deficits in recognizing emotions and responding appropriately to non-verbal affective displays, which affects social development and reduce the probability of successful interactions [4, 5, 6, 7, 8]. Various interventions that aim to improve affective behavior and emotion expression of ASD children are recognized nowadays: developmental approach (relied on

interactive tools), behavioral approach (based on Applied Behavior Analysis (ABA) and affect training [9]. Apart from these traditional interventions, there is a new approach to use modern technology aimed to develop computer games which can be used to teach children with ASD various social and communicational skills.

The computer game *Let's Face It* [10] is an example of this new approach. It is designed to teach face processing skills to children with autism spectrum disorders and children with specialized learning needs. The game is organized in a theoretical hierarchy, in 3 Domains, which reinforce child's ability to attend to faces and understand facial structure, to recognize facial identity and facial expressions and to interpret the social meaning of these facial cues. Another similar application is *LifeIsGame* [11], designed to teach children with ASD to recognize facial emotions, using real-time automatic facial expression analysis and virtual character synthesis. The game uses avatars to recognize, create or mimic the emotion expression of a human. Another application that uses virtual humans (avatars), to teach emotion recognition to children, is *cMotion* [12]. By introducing avatars, *cMotion* hopes to increase users gaming motivation and thereby their ability to learn. *EMot-iCan* [13] is a game that tests the theory that atypical attention patterns are at the root of several of the features that characterize ASD. These features include impaired social and communicative skills, difficulty in adapting to changing environments, and academic underachievement. *SmileMaze* [14] is a training program developed with the aim to improve the expression production skills of children with ASD. The goal of the exercise is to successfully navigate a maze while collecting as many candies as possible. The player controls the character using the keyboard for navigation. Facial expressions, which are automatically detected using a standard web-cam video stream, are used to move the obstacles at various points within the maze. *Emotiplay* [15] is an interactive and intrinsically motivating online game, aiming to teach children to recognize emotions from facial

expressions, vocal intonation, body language, and their integration. This game was designed and evaluated as part of a large-scale European project (ASC-Inclusion), which explored technological ways to improve the inclusion of children with ASD. Mind-Reading [16], although not strictly a game, is an interactive program, designed to teach children with ASD about complex emotions. It is based on taxonomic system of 412 emotions and mental states, clustered in 24 emotion groups and 6 developmental levels from 4 years to old adulthood. Using this software over a period of 10-15 weeks improves the child's ability to recognize complex emotions and mental states from both faces and voice.

## II. TECHNOLOGY BASED METHODS

According to Ekman [17] there are six basic emotions that are universally recognized from facial expressions by all human beings, regardless of their culture. These are: joy, anger, surprise, disgust, fear and sadness. The most often emotions used by researchers are: fear, happiness, anger, sadness and surprise [18–21], because they can be recognized with great accuracy. However, there are studies that used some additional emotions like: neutral and contempt [22, 23].

Different sensors are used to capture these facial expressions. The most often used is the camera that records the face of a person. Face expressions are recognized from two-dimensional (2D) or three-dimensional (3D) space [24, 25, 26]. Various methods are applied to recognize the basic expressions in 2D and 3D spaces. However, the landmarks localization processes are used both in 2D and 3D data.

In our work we used 3D data captured with a standard web camera. Since this is the first prototype of the game, we implemented only the following expressions: happiness, surprise and sadness. In a future versions, we plan to introduce the other basic emotions.

The game is developed in Unity3D [27], using the Affectiva SDK [28] for detecting emotions in real time. The Affectiva technology is designed to analyze spontaneous facial expressions that people show in their daily interactions. Computer vision algorithms identify key landmarks on the face such as: the corners of the eyebrows, the corners of the mouth, the tip of the nose etc. Then the machine learning algorithms are used to analyze the pixels in those regions and to classify facial expressions. Emotion classification is made using the Facial Action Coding System (FACS). FACS is a system to taxonomize human facial movements by their appearance on the face. It refers to a set of facial

muscle movements that correspond to a displayed emotion. Originally created by Carl-Herman Hjortsjö in 1970 [29], it was subsequently developed further by Paul Ekman, and Wallace Friesen [30]. Their version was first published in 1978, and later updated in 2002. Using FACS it is possible to code nearly any anatomically possible facial expression and deconstructing it into the specific Action Units (AU) that produced the expression.

## III. ARCHITECTURE

Standard computer games are created using a simple feedback loop, where the inputs are usually a mouse or/and a keyboard while the output is provided through a monitor and/or audio speakers (Fig. 1 (a)). The game, presented in this paper, has a slightly different feedback loop which provides additional interactivity (Fig. 1 (b)).

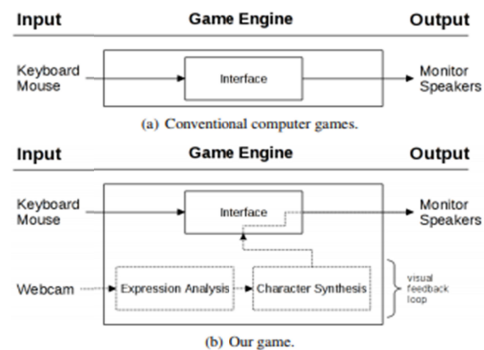


Figure 1. Comparison between conventional computer game loop and our

As it can be seen from the picture, the visual input from the player is continuously and automatically acquired by web camera. This additional input brings the interaction between human and computer to a level which is unattainable for the standard games. It also allows a design of advanced interactive games.

## IV. GAME DEVELOPMENT

The process of game development can be divided into several phases:

1. Development of the idea – this is the initial phase of game development in which the theme and the purpose of the game are selected.
2. Design of the game:
  - a. Object modeling – various models of objects are created in this phase.
  - b. Map modeling – the map and the environment in which the action takes place, is created.



3. Coding – this phase is specific for every type of game. In this phase the parameters of the physics for movement and control of objects are being set. All other necessary scripts are also created at this stage.
4. Testing – in this phase, user usability (especially in prototype development), playability and the efficacy in the learning process is evaluated.

#### A. The idea

In order to start the game development, it is necessary to develop an idea first. The games should attract the attention of the players, and force them to compete and improve. In particular, games designed for children with ASD should be fun and easy to use on the one hand, but also very motivating on the other hand, to keep their attention.

Having in mind the social interaction and communication problems that children with ASD face, we decided to develop a game in order to help them overcome these problems. CatchMyEmotion is an interactive game developed to help the emotional development of children with autism.

#### B. Game design

The design process determines the content of the game and the way in which the user feedback will be realized. During this process, individual elements of the game, the scene, the objects of interaction and the user interface are also created.

*CatchMyEmotion* consists of several levels in which the player needs to collect the emotional balls that are on the scene. The number of balls increases with each level. The first screen introduces the game, and explains how it is played. Each level of the game has a different scene that represents the environment of the playing field. During the game, the user's emotion is captured in real-time using a standard webcam. The goal of this game is to collect as many emotion balls as possible in one minute. If all the balls are collected by the user, the game goes to the next level. On each level a new emotion is presented, i.e. emotional ball with new emotion appears on the playing field. This motivates children and "force" them to learn new emotions so they can go to the next level. The feedback is delivered through audio, text and images. When a player collects a ball he/she receives a positive feedback through a sound. At the end of each level, the total number of collected balls is displayed on the screen.

#### C. Main character

Every game consists of objects. Whether they will be 2D or 3D object, depends of the designer's idea. In this game 3D objects that fit into the design of a game are used. The main object is a character presented on the following picture (Fig.2), which is taken from the standard asset of Unity. Through it, the player actually transfers his emotion in the game.

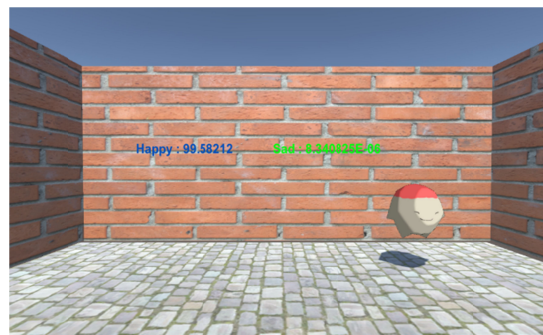


Figure 2. The main character in the game

The emotions of the player are detected through the web camera, and then processed by a computer program and displayed on the screen. The keyboard arrows (left, right, up and down) are used for navigation of the main character. To collect a ball, the player need to move the character to the desired ball and to express the emotion that is on the ball. For example, if the ball is with smile, then the player need to move the character to touch the ball and make a smile face. The emotion will be detected by the camera, and if it fits with that of the ball, then the ball is collected, and the player's score increases.

#### D. Emotion balls

Emotion balls are different kind of 3D objects which appear in the game (Fig. 3). They are used for showing different kind of emotions which the player should imitate. In this way the player learns to recognize different emotions and to express them.

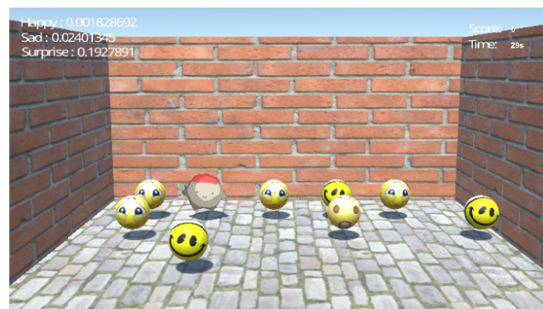


Figure 3. Level of the developed game

## V. CONCLUSION

Information and communication technologies (ICTs) offers new perspectives in therapy of ASD

children, who are facing various problems related to social interaction and communication. Children with ASD often find it hard to recognize facial expressions and the emotions behind them, as well as to copy and use emotional expressions. In this content, interactive games can be used as a tool to support traditional therapy for children with ASD, in order to improve their affective skills. The ability to accurately perceive, interpret and express emotions is fundamental to effective social communication.

In this study we have presented the design and development of an interactive game called *CatchMyEmotion* that teaches children with ASD to recognize and mimic emotions from facial expressions. The game employed various elements aimed to enhance users' motivation to play and to increase learning effectiveness.

*CatchMyEmotion* is primarily developed for home use by children with ASD and their families, but that does not mean that it cannot be used by others. However, in order to be used for therapeutic purposes, an evaluation should be carried out and results for the therapeutic relevance of this game should be provided.

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