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Supervisor: Professor Henrik Schärfe

A REFLECTION OF OUR SOCIETY THROUGH THE EYES OF AN ANDROID ROBOT

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Summary

Our society is experiencing a transition from the information to the robotic era. Using the facial expressions of the Geminoid|DK android robot as stimuli, we triggered our society to reveal its' life-tasks. This work presents a blueprint of our society in this important period of time were new life-tasks are being formulated.

At first I justify the fact that we have already entered the robotic era and afterwards I introduce all the different technological landscapes the robotic era has generated. Hoping that the notion of robotics will be now a bit more comprehensible, I proceed to the analysis of one of these technological landscapes, the Android Reality.

The next chapter describes the method followed for collecting information about the life-tasks of our society. An online questionnaire was launched asking subjects to write in which way they could relate to the facial expressions of the android which were depicted in 15 embedded videos.

Combining all the above, an Entity-Relationship model is proposed aiming to express the relationships that exist between emotions, facial expressions and life-tasks.

The epilogue is dedicated to future work, including possible enhancements on the face of the Geminoid|DK for enabling it to reveal emotions in a more persuasive way and to engage actively to the world.

Keywords - Social Robots; Geminoid; Android Reality; Human-Robot Interaction; Emotions; Facial Expressions; Life-tasks;

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Chapter 1: Introduction

The key element of a society is the individual. In order to understand society it is vital to unlock the secrets hidden within the individual [1]. Of course, no one denies the fact that society has the power to produce individuals, but the truth is that one cannot study and comprehend the norms and values of a society, without first penetrating into the physical character and the inner reality of its' individuals.

Humanity is in the process of trying to "know thyself" since ever (this phrase has been carved into the temple of Apollo in Delphi almost 2.500 years ago [2]). Today, with the advance in robotic technologies, we stand in front of a great opportunity to approach closer towards the fulfillment of this pursuit. The branch of robotics that can play such a crucial role is called social robotics. Sociable robots intend to communicate with humans, interact and relate to society and are capable of understanding social terms [3]. Therefore, through the evolution of social robotics, we will make steps towards unlocking the mechanisms that steer human thought and action, we will and understand ourselves better and maybe even find our purpose in life. So far, the robots are those who learn from us, but in time the teacher might become the learner.

An android robot build for social interaction should embody emotional facial expressions in a respectful way towards the fundamental rules of human affect expression for achieving natural communication [4]. The ability of an android robot to reveal emotions through its facial expression determines the extent to which we have penetrated inside the depth of the individual.

One of the features emotions have is that they provide information on what is occurring inside the person (plans, memories, physiological changes), what most likely occurred before that expression (antecedents) and what is most likely to occur after (immediate consequences, regulatory attempts, coping) [5]. Using emotions as a portal, we wish to find the life tasks, the real-life actions, which relate our society to an android robot. Hence, with the gathered information we can reflect on the current state of our society and define routes of action that can allow a smooth transition to the robotic era [6] which has already started.

In the next chapters I will present and analyze the driving question behind this study, justify the fact that we are already living in a robotic age, introduce the different types of "intelligences" and "realities" that exist, describe how I managed to collect information about the life tasks of our society, propose a model for connecting emotions, facial expressions and life-tasks and conclude with a discussion about future work.

1.1 The Geminoid|DK

The Geminoid [20][81] is a new category of robot that works as a duplicate of an existing person. The term Geminoid was coined from the Latin word "geminus," meaning "twin" or "double," and the suffix "-oides," which indicates similarity or being a twin. The first Geminoid, HI-1, was created in 2005 by Professor Hiroshi Ishiguro of ATR and the Tokyo-based firm, Kokoro. Professor Ishiguro designed the original Geminoid as a tool to study the important notion of presence and to study the human nature. A Geminoid is an android, designed to look exactly like its master. It is remotely controlled by an operator through a computer system which uses a motion-capture system that tracks facial expressions and head movements of the operator, but also through manual controls. The next robot, Geminoid-F was a simpler, more affordable version of the original HI-1 and was modeled after a young female. In

2011, a new Geminoid was created. Geminoid|DK is the third in the Geminoid series, and the first to be modeled after a Caucasian face. It is the first of its kind outside of Japan and it is situated at Aalborg University in Northern Denmark [51].

1.2 The 10th Semester Project

This project report was written in the spring of 2012 for the tenth semester obligatory module called "*The Master's Thesis*". The topic of the master dissertation must to fit in the framework of the master programme in Human Centered Informatics. This project is written in connection with the research placement of the Geminoid-DK, part of the Center for Computer-mediated Epistemology research environment. This module is organised within the boundaries of Human-Robot Interaction, emotional affordances in Human Robot Interaction, understanding how interaction with robots alters our perception of agency and communication, how people think and what the role of technology is. The interest of the project is focused on gaining theoretical, practical and methodical competencies so as to command the theory of science of the disciplinary area and the theories and methods of the discipline and their application in relation to a delimited problem. At the conclusion of the module, the objectives are to be able (a) independently and systematically to create an overview of existing knowledge in relation to the problem treated by the thesis and (b) independently and systematically to select, expound and argue for the chosen approach in relation to the problem treated by the thesis as regards its theory of science and its theories and methods.

Chapter 2: Problem Formulation and Problem Analysis

As Dr. Paul Ekman has stated; “emotions are viewed as having evolved through their adaptive value in dealing with fundamental life-tasks” [7]. Indeed, emotions are a product of our evolution. Recent research [8] revealed that even before birth, when we have the form of a fetus inside the womb, we learn to develop facial expressions which are associated to specific emotions. Therefore, the facial expression can be considered as an adaptive pattern that prepares our entrance to the society, formulates social attachments and bonds and even helps to negotiate hierarchies [12][16]. Another use of them is to maintain aspects of relationships between interaction partners [17]. Emotions allow our society to go beyond the information given and act as if certain things were true now, even if they might be not, just because they were true in the past [18]. They are the right tool to prepare our society for the transition from the information era to the robotic one [4]

Observing this issue from a point that combines the context of android robots with humans and their society, the question that occurs and can formulate the main problem of this project is:

> *“Which life-tasks of our society arise through the interaction with an android robot?”*

From a previous study [4], we have already taken two sets of photographs of the Geminoid|DK when depicting facial expression that correspond to the six basic universally accepted and firmly established emotions of surprise, fear, disgust, anger, happiness and sadness [10] and the neutral face. In total there are fourteen photographs separated in two equal sets. The first set of photographs is empirically driven and the Geminoid|DK is mimicking its master (the Original), while the second set of photographs is theoretically driven and the robot is programmed after the judgment based approach as described by Paul Ekman and Wallace V. Friesen in the book “Unmasking the Face” (2003). Since we already have these photos, we are going to use them also in this work.

Analyzing the problem even further, the photographs of the Geminoid|DK have to be judged by random people in order to gather information on how they perceive the selected facial expressions and how they connect with them. These connections can generate possible scenarios of interaction on the one hand and on the other, can provide information both for the robot programmer and the operator to assist them in selecting facial expressions for the androids’ face according to the topic of interaction. Certain facial expressions, create certain train of thoughts to peoples’ minds and for the sake of a natural flow of interaction, the android should be able to ground a visual communication, meet peoples’ expectations and respond with social appropriateness. Goetz [9] stated that people expect a robot to look and act appropriately for different tasks, so the Geminoid|DK should have a data base of suitable facial expressions to “wear” on every occasion.

The scope of this research is to discover the link between the observer and the Geminoid|DK and find the experiences of the individual that could be related to the android robot. We seek to find the relationships that exist between the facial expressions of the Geminoid|DK, the life-tasks of our society and the six basic emotions.

Using the facial expressions of robot as a stimulus, we trigger our society to reveal its' life tasks. The objective is to make the observer think of a situation that could cause him/her a similar facial expression and share it with us. A corpus of various descriptions can be build which reflects a range of life-tasks of our society. Since the study deals with the six basic universally accepted emotions, then the life-tasks that will be described can be characterized as fundamental.

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The architecture of these relationships can be depicted in the following figure (Fig. 1). The facial expressions correspond to certain emotions; the emotions have evolved from dealing with fundamental life-tasks and each one of these life-tasks call for specific facial expressions.

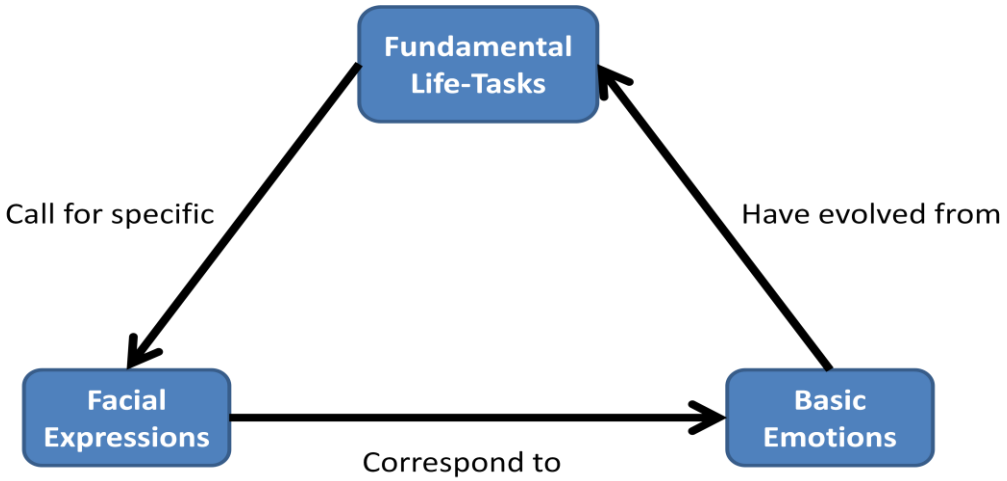

Fig.1 – *Relationships between emotions, expressions and life-tasks*.

2.1 Fundamental Life-Tasks

Before we proceed on with the rest of the study, it is crucial to clarify the term "fundamental life-tasks".

It is widely accepted that different people often have different emotions about the same situations, but most of the time, most people feel practically the same way about most things, meaning that there are physical, biological and social reasons which explain why we are more similar than dissimilar to each other [19].

If the case was not so, then within any society all the social processes would be unmanageable (communication, entertainment, eating, working etc). Without plenty of common life-tasks in a system, there would be plenty of chaos. Trying to give an explanation to this emotionally driven system activity, we tend to agree slightly more with the evolutionary theorists who give emphasis on the ancestral past history of the species, rather than the social constructionists who give emphasis only on the past history of the individual [5]. As always, the truth must be located somewhere in the middle, because when an emotion is mobilizing the organism to deal quickly with important interpersonal encounters, it is prepared to act like that according to types of activity that have been adaptive in the past of the species and the individual.

The organizing scheme for these social processes and activities of society is provided by the life tasks, which are embedded in the everyday life of the individuals. They provide an integrative unit of analysis for understanding the interaction between

a person and a situation and give meaning to his actions [13]. They are defined as the tasks which the person is working on and devoting energy to solving during a specified period in life. The social-intelligence view of personality does not propose that everyone at a particular age is engaged in the same sorts of life tasks. Periods of transition, are precisely those times where individual differences in life tasks become most apparent.

Life tasks are a passage by which individuals give personal meaning to their lives, organize personal effort and activities and reflect their personal history to the world. These tasks organize a wide range of behaviors in a particular life domain; and they may not always be done in conscious awareness by the individual as they often fall under the shadow of more general concerns about achievement, affiliation, power, or personal growth and identity [15].

Last but not least, according to [14] the fundamental life-tasks are “universal human predicaments, such as achievements, losses, frustrations, etc…[E]ach emotion thus prompts us in a direction which in the course of evolution has done better than other solutions on recurring circumstances that are relevant to goals”.

During transitions, when people feel that Kairos is near, they tend to be intensely aware of themselves and of their place in the world. Times like this, call for new age-graded life tasks.

Chapter 3: The Robotic Era

Society is not any more on the verge of a robotic era [6]. The truth is that the robotic era has already begun and some of its' concepts are already being applied to our society. For those still in doubt, just raise your head and take a look around. The probability of having at least one robot in your surrounding environment is extremely high. In order to have the ability to notice a robot, one should know what a robot is.

3.1 Introducing Robots

Talos, considered by many as the first android robot, was a bronze giant from the island of Crete in the remote past of Greek mythology [30], on a mission to protect Europa by circling the island's shores three times daily and throwing rocks to the invaders. Since ancient times, humanity displayed the tendency to anthropomorphize its' surroundings and the natural phenomena, but the word robot was crafted only recently. It comes from the Czech word "robota" which means forced labor or servitude and firstly appeared in the play R.U.R. (Rossum's Universal Robots) by the author Karel Čapek in 1921 [25]. In addition, the word "robotics" was first coined in the story "Runaround" (1942) from the "I,Robot" collection by Isaac Asimov.

One of the earliest formal attempts to define robots was made by the Robotics Institute of America back in 1979, stating that: "*A robot is a reprogrammable multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks"* [31]. Almost twenty years afterwards, a second definition of what a robot is was given by Kumar, saying that: "*The robot is a computer-controlled device that combines the technology of digital computers with the technology of servo-control of articulated chains. It should be easily reprogrammed to perform a variety of tasks, and must have sensors that enable it to react and adapt to changing condition".* Today, the field of robotics is still expanding and the best way to describe its' notion is to look into the different types of robots that exist.

3.2 Types of Robots

Many types of robots exist and most of the times the labels of their names are self-explanatory. A list with the most representative types of robots follows, aiming to shed some light on the various applications and fields of practice that a robot can be engaged in. Being aware of the properties that such a powerful tool like the robot holds will clear any foggy landscape of doubt and make more visible the fact that our society is already into the robotic era. The basic components of a robot system are the mechanical parts and joints, the actuators (linear/rotary and either electric, pneumatic or hydraulic), the sensors, the controllers (the intelligence of the robot), the user interface and a power conversion unit (takes the commands by the controller and converts them in order to move the actuators).

According to the characteristics it possesses, a robot can fall under three main categories, without being restricted by them. However, it is very likely to find a robot that combines elements of all the categories.

1. **Locomotion and Intelligence** [21-28].
   i) *Control:*
      - *Teleoperated Robot is* a robot that is remotely controlled and guided by a human operator who views and senses the environment through the robot sensors.

- *Telepresence Robot* provides a two way audio and video communication for embodied video conferencing using wireless connections.

ii) *Autonomy:*

- *Autonomous Robot* is able to fulfill the given tasks by obtaining information solely from its' surrounding environment without human intervention.

- *Semi-autonomous Robot* acts as an autonomous robot except for the occasions that a human interrupts the robots routine and is involved so as to handle an event or add perceptual input/ feedback.

- *Epigenetic Robot* or *Developmental Robot* uses metaphors from neural development and developmental psychology to develop the mind for autonomous robots. It's a type of robot inspired by the fact that most complex and intelligent biological organisms (as opposed to artificial ones) undergo an extended period of development before reaching their adult form and adult abilities [32].

iii) *Mobility*

- *Static Robot,* which usually performs with precision dangerous difficult or dull repetitive tasks like lifting objects, picking and placing, handling chemicals or performing assembly work. The term static is interwoven with heavy industrious work, but today exist static robots that perform completely different (socially related) tasks. We firmly believe that the term has to be redefined.

- *Mobile Robot,* which can move and navigate in the real world and can be completely autonomous or completely controlled or semi-autonomous. The type of the mobile robot movement varies from floating, swimming and flying to rolling or walking. For instance, on figure 2 is displayed an autonomous wheel mobile robot that avoids obstacles by exploiting one ultrasonic sensor and a set of proximity switches [29].

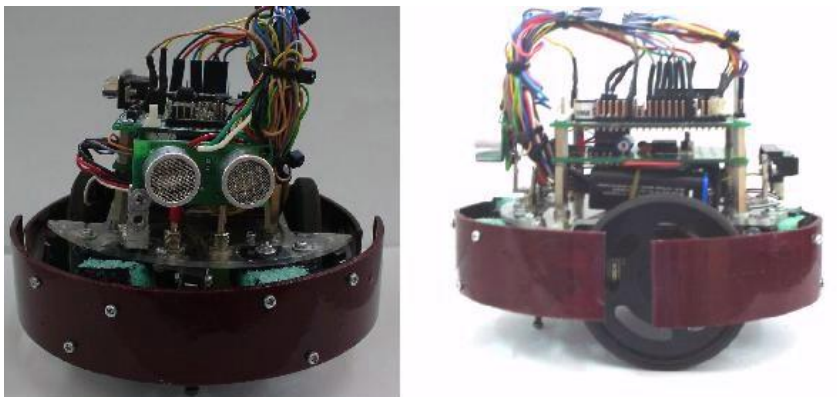

Fig. 2 – *Autonomous wheel mobile robot for obstacle avoidance following a low computational algorithm*.

2. Appearance

Maybe the interface is the most important component of a robot because it uncovers immediately the purpose that it serves and sets the interaction rules. Robot appearance is a factor that requires further categorization.

i) Mechanoid Robot is a robot with a machine-like appearance which has no overtly human like features and bears no resemblance to a living creature [33].

ii) Zoomorphic Robot is a robot *build* to imitate living creatures. For these robots, a zoomorphic embodiment is important for establishing human–creature relationships. Usually their objective is to create robotic "companions" [26].

Under the rubric of Zoomorphism there exist several sub-categories [33][34].

- *Anthropomorphic Robot (anthrobots)* Anthropomorphism, a term coming from the Greek "anthropos" for man and "morphe" for form, is attributing human characteristics to objects aiming to rationalize their actions.
    - *Humanoid* Robot is a robot which is not realistically human-like in appearance, but possesses some human-like features, which are usually stylised, simplified or cartoon-like versions of the human equivalents, including some or all of the following: a head, facial features, eyes, ears, eyebrows, arms, hands, legs.
        - *Android Robot, which is* build to mimic humans both in appearance and behavior. Androids have a broad range of applications and can sometimes combine the features of various types of robots.

3. Scope

i) Industrial Robots, which according to the ISO 8373 definition are "…automatically controlled, reprogrammable, multipurpose, manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications".

ii) Social Interactive Robots which are embodied agents, part of a heterogeneous group (including humans and other robots) and are able to recognize the members of its group, engage in social interaction, communicate within the social and cultural structure and also learn. Embodiment means establishing a basis for structural coupling by creating the potential for mutual perturbation between system and environment [35]. Social robots are describes as relational artifacts that present themselves as having 'states of mind' [36].

The design requirements [37] for them should be to have abilities to:

1. Recognize the presence of a human through its senses such as vision, touch and sound.
2. Engage in physical acknowledgment such as holding or touching.
3. Use physical motions and gestures.
4. Express and/or perceive emotions.
5. Engage in a conversation.

> There are two classes of social robots: the *utilitarian* humanoid social robot and the *affective* humanoid social robot [38]. Utilitarian social robots or domestic robots are designed to interact with humans mainly for instrumental or functional purposes. It typically regards robots as "very sophisticated appliances that people use to perform tasks". Affective humanoid social robots on the other hand, are robots that are designed to interact with humans on an emotional level through play, sometimes therapeutic play, and perhaps even companionship.

Last but not least, there are the *Virtual Robots, which* acts like virtual simulators in order to test the software of a robot while the real robot is in still at the stage of development. It predicts the result of a command before the command is send to the remote robot. This is stand-alone category that can be applied to all the above.

3.3 Geminoid Robots

The Geminoid|DK is an Android robot which combines features from almost all the types of robots. It is build for social interaction; it is mostly teleoperated and uses telepresence. According to the purpose of its' every time usage and the environment or the group of people that will interact with the Geminoid|DK, it offers the option to perform pre-programmed loops without the aid of an operator. Of course, the operator is free to intervene whenever necessary. This description reminds the characteristics of the semi-autonomous robot, but most of all, a Geminoid is a social robot that proactively engages people in a social manner, it has a social presence, behaves socially and is believable [39].

Chapter 4: The Android Reality

In the last decades, as technology was progressing following the Moore's Law exponential curve [40] and microprocessors were improving in speed and/or performance while decreasing in size, societies were struggling to adapt to these abrupt changes. One after-effect of that fierce technology explosion was the fact that humanity suddenly gained the power to receive and process on the same time, almost parallel to real time, more information than they could physically sense with the natural human sensors. Humanity had the power to build systems, programs and algorithms that could predict the effects of various changes in the environment, simulate these changes to virtual environments and be prepared to take action in reality. All these happened in the blink of an eye. Both the sensors and the results of this enhanced sensing -either of the environment or thyself- could be available on small, almost invisible to the eye, portable devises. A complex system that encapsulates the same or similar attributes with the one described above, formulates a different kind of reality and in addition is perceived as a different one. Henceforth, societies were introduced to a world cloud of terms like virtual reality, augmented reality, mixed reality, artificial intelligence, ambient intelligence, ubiquitous intelligence and disappearing computers.

These technologies change the computing landscape and therefore cause a change in the human-computer interaction and communion landscape. For better clarity, a brief and comprehensive reference to all the possible realities and intelligences follows:

- **About Reality**
  - *i)* *Objective Reality* [59] *is a reality* independent of our presence, where events and objects exists independently from our mind and depend on observation. Kant argued that we automatically apply *"a* priori" concepts to every observation and have no choice in this.

  - *ii)* *Visual Reality* [60] is a constructive process that evolution has shaped it to guide adaptive behavior, just like our perceptions are shaped by natural selection (for example you do not step over a cliff, you back away from a spider, you do not step in front of a moving car etc). Society's' perceptions of space, time, objects, colors, textures, motion, and shapes are useful but are not true, just as the icons of a computer desktop are useful and also not true, but serve as guides to useful behavior. If an incorrect perception is seen by most people when they view a specific stimulus, then visual reality is constructed.

  - *iii)* *Virtual Reality (VR)* is a computer system that lets the user immerse into a computer generated visual or audiovisual environment either created originally or based on a simulation of the real world in real time [48]. The user interacts with the world and can directly manipulate objects in the world.

  - *iv)* *Augmented reality* (AR), refers to a live view of physical real world environment whose elements are merged with a computer generated virtual environment creating a mixed reality. The augmentation is typically done in real time and in semantic context with environmental elements. By definition, the AR is a real-time direct or indirect view of a physical real-world environment that has been enhanced/*augmented* by adding virtual computer-generated information to it [43].

v) *Mixed reality (MR)* can be used to develop an almost magical world where the virtual environment, such as 3D computer graphics images and animations are fused in a spatially coherent manner with the real physical world as seamlessly as possible in real time [45], [46].

- **About Intelligence:**

i) *Artificial intelligence* (AI) started as a field whose goal was to replicate the human intelligence in a machine. The magnitude and difficulty of that goal was not considered thoroughly, therefore it was thought that the best way of action would be to partition the human intelligence into sub-categories [42].

ii) *Ambient Intelligence* (AmbI), is a digital environment that proactively but sensibly supports people in their daily lives. The basic idea behind AmbI is that by enriching an environment with technology (e.g., sensors and devices interconnected through a network), a system can be built to act as an “electronic butler", which senses features of the users and their environment, then reasons about the accumulated data, and selects actions to take that will benefit the users in the environment. These flexible and adaptive technologies weave themselves into the fabric of everyday life until they are indistinguishable from it [44].

iii) *Ubiquitous Intelligence and Computing* (UIC) or Pervasive Computing includes technologies of wireless communication, ambient intelligence and embedding technologies applied in everyday objects so as to provide computing and communication services at any point in time and space. Usually UIC refers to disappearing and invincible to the eye technologies that are incorporated into the natural environment which connect cyber and physical spheres of activity [41]. In the future, such systems will be everywhere, operating and responding in real time. They will follow users as they move around freely and respond to changes in user requirements or operating conditions [61].

iv) *Emotional Intelligence* is defined as the capability to perceive asses and manage emotions of one’s self or others. This can be achieved from several observations, including facial expression, voice expression, and physiological signals [62].

v) *Social Intelligence* is used to solve the problems of social life, to manage life tasks, current concerns or personal projects which the person selects for thyself or are imposed by society [13] in order to adapt to an environment.

vi) Embodied Intelligence [63] is consistent with the behavior-based approach and can be described as a shift from the process of ‘thinking’ to the process of ‘acting’. It is located somewhere between life and cognition and between living and intelligent behavior.

4.1 Entering into Android Reality

While Virtual Reality replaces the real world with a simulated one and Augmented Reality enhances the real environment with additional virtual information, Android Reality [47] is going one step further by combining the Real Environment (Robots

point of view) with the Virtual Environment (Robots operator point of view) into a new kind of mixed reality. Focusing especially on the Geminoid Robot -which is a duplicate of an already existing person- a mixed reality with blurry boundaries is starting to come into existence, challenging even our perception on visual reality.

In order to be present in the world, it is vital to be ready to engage, to cope and to deal with the world and also to witness events, people and things that are available [49]. Witnessing also requires a record or representation of what has been witnessed. In the Android Reality the robots' operator is engaging and coping with the world, dealing with the world and witnessing events, people and things but he is not physically situated there. His/her presence is substituted by the Geminoid. The Geminoid is inheriting all the intentionality from its' surrounding environment and transmits this information to the operator, just like in *mirror-touch synesthesia*. Mirror-touch synesthesia is a tactile hallucination triggered by observing touch to another person which enables the observer to simulate another's experience by activating the same brain areas that are active when the observer experiences the same emotion or state [64][65].

A special kind of mediation is required depending on the position and location of the operator and the robot, the interaction with the Geminoid suggests both indirect and direct interaction [58]. If the robot and the operator are located in different places then the interaction is indirect, if they are in the same room then is direct and the information between them has a bi-directional flow.

For the acceptance of a communication robot like the Geminoid as an equal member of the society, people should effortlessly be able to transmit their intentionality towards the robot. For that reason the robot should have a certain appearance, make balanced physical movements motions and gestures, express and/or perceive emotions, engage in conversation, recognize the presence of a human through its senses, be responsive to the users and generally be able to process social cues in face to face communication [50][52]. The more believable and competent it appears, the more users will have the impression of interacting with a human partner rather than just a moving manikin. Otherwise, the effects of the "uncanny valley" may arise causing responses of repulsion, horror and aversion to those who interact with the Geminoid. When a robot is trying to resemble to a human being without succeeding or when it fails to live up to the expectations of the situation [66], then it falls into the valley. Even slight improvements to the robots interface can add credits to the ease of interaction [53] and help it escape from the valley. This makes society to view the robot as being "one of us", because only then it can relate to and empathize with it [67]. Conversely, Hanson implies that even non-anthropomorphic robots can exhibit the uncanny effect if the "aesthetic is off" in a similar way that may occur with cosmetically atypical humans [68].

I have a disagreement with [56] when stating that "*the computer has to appear like human*". The robot does not have to appear like a human being nor has to be anthropomorphic. Anthropomorphism could be a possible way, but not the only way since there is not accumulating evidence supporting that point of view. Moreover, the most famous and up-to-date humanoid robot (ASIMO) does not have a human face, but something resembling one. According to [54] an anthropomorphic appearance is not a must in building -oid robots, but just an option. At this point in the timeline of research we are still looking for answers by posing questions and is too soon to draw conclusions and form certainties. Human like appearance is not ensuring natural interaction, it's the robots affective capabilities that would make the difference [55].

Nevertheless, anthropomorphism has the power to convey easier the code of interaction and the behaviors followed since it refers directly to human-to-human interaction [57]. Recent studies [69] indicate that the brain's baseline activity is tuned to interpreting and categorizing the world as social. Consequently, if the robot adopts another appearance this message might not be conveyed so obviously. Peoples' behavior towards a robot and their assumptions about its' capabilities are influenced by the presence or the absence of humanoid features and a different set of expectations is established each time.

The truth about human-robot interaction is that it can only be studied relative to the available technology [58]. Since the field of robotics is still progressing, so is the field of human robot interaction.

Chapter 5: Research Method

Following the established method of [4], we launched an online questionnaire to collect feedback from the society. In total we projected 15 videos, each one illustrating a selected facial expression of the Geminoid|DK; 7 with the empirically driven photographs, 7 with the theoretically driven photographs and one more video (the first one) that was used as a trial demo. The only difference this time was that the question was different.

After viewing the stimulus, the subjects had to answer the open-ended question: "*In which situation would you use a facial expression like this?".* The subjects were let free to respond as they felt like, without following any specific guidelines. Completely unstructured open-ended questions allow for a probability of receiving irrelevant answers. Nevertheless, it was a risk worth taking, because this is the only way for a subject to act with spontaneity and write down a situation that would result from a natural impulse. Spontaneity, which means acting outside of conscious awareness [70], is increasing the possibilities of a deep penetration into the physical character and the inner reality of the individual. Quantity is not an issue in this questionnaire. We only care to receive genuine answers that stem from the every-day life tasks of the subjects.

As we have mentioned in [4], "*This questionnaire should not be considered as a test, because examining whether people can recognise emotions through facial expressions or not is out of the scope of this study. With this questionnaire we don't intend to train the subjects that will take the questionnaire into recognising emotions or practicing faces. Therefore, there is no need to force the subjects to view each stimulus only once…. This questionnaire should also not be considered as a survey….There is no need to specify a sampling frame or to ensure sample coverage or select sampling method. The six basic emotions we examine here have universal status and are recognised worldwide regardless of gender, nationality, social or economic status and age…".*

The questionnaire was launched through the Facebook profile of the Geminoid|DK and some people were invited via private mailing lists to participate. Furthermore, whoever had the link could also share the page. An online questionnaire allows addressing questions to people with different backgrounds and age, thus, not only students or people related to a certain research field can be reached. Moreover, it can be conducted in a rather short period of time compared to live user trials, it provides honest responds and as a method it cannot influence the subjects' answers [71].

5.1 Implementation

For the implementation of the questionnaire, we combined together three open-source free-to-use applications offered by Google - YouTube, Google Docs and Google Sites (figure). Inside the Google Site we embedded the code for the video and the questionnaire form, building a functional platform to run the experiment.

Fig.3 – *Screen shot image from the webpage of the questionnaire.*

Chapter 6: Analysing the Results

6.1 Demographics

The online questionnaire was reached by a lot of people worldwide. From all these visitors, 89 people (41.6% males and 58.4% females) actually participated by filling and submitting it. Somehow, the overrepresentation of female respondents was anticipated, because women are usually more likely to participate in such activities than men [71].

All of the respondents were located in Europe, except for six of them who were located in the continent of America. These results can be justified if we consider the fact that Aalborg University is located in Denmark and the people who form the friend-of-a-friend circle, must have been also located within Europe (there was a link for the questionnaire that allowed sharing). Another explanation could be that in other continents the Internet still remains a scarce resource of information or even bigger problems might exist with lack of electric supply. The questionnaire was written in the English language and that might have been also a restricting factor for those who feel discomforted in using it or have never been taught.

Commenting on the pour scarcity of the results around the world, one could claim that maybe people are not interested in androids and in human-robot interaction yet and maybe think of it more like a future scenario. This is not the case since the Original of the Geminoid|DK, professor Henrik Scharfe, was voted as one of the most influential people in the world by Time Magazine [72] , which leaves no room for further speculations. People seem to have reconciled with the idea that the humanoid robots and the androids will eventually acquire natural communication interfaces which will replace not only mobile phones and computers, but also other people, as sources of information [73].

The dominant age group was the one between 20-30 years old, most of them probably students or just starting their career. This is a generation that was raised in a period of time that analog devices had taken a big fall and everything was becoming digital. Their adolescence coincided with the rise of computers and since then all their life is filtered through them. They like to search, obtain knowledge and question everything. Such a result was expected.

What stroke our attention, was the fact that we received four answers from people over 50 years old. Their interest indicates that they anticipate an interaction with an android robot and are curious about it. After all, three of the most useful applications of social robots (assistance to elderly, companionship and healthcare) [74] target, more or less, their age group.

6.2 Answering the Questionnaire

Open-ended questions call for a variety of answers. The results ranged from one-word answers to small paragraphs. There were few answers without content, mostly because of pour internet connection or other technical problems that prevented some videos from opening (as it was stated in the answer box). Subjects were also honest enough to state that in some cases they couldn't relate to such facial expressions and did not leave an answer.

In the cognitive process of interpreting the situations subjects described in terms of the relevant tasks they present, we found out that there are dozens of dimensions to

assess these situations, as there exist both countless memories, triggered by obscure cues, and many prior experiences that influence interpretations. We address this issue by choosing a specific life-transition for a society, the move from information era to the robotic era, and we concentrate on the ways in which individuals are coping with situations that are related to communicating with an android robot. In a transition, the analysis of the level of shared tasks that all society finds either more or less compelling as they enter the transition becomes easier [75]. For this purpose, we loosely define a society's *life*-task as the set of tasks that the person is working on and devotes energy to solving them during a specified period in life.

We conceptualize these life-tasks as "desired states that people seek to obtain, maintain, or avoid" [76][77]. We aim to investigate a broad taxonomy of tasks in various life domains and issues which society indicates to be relevant. The life-tasks were separated into three domains; the *collective memory life-tasks* which gather experience from the ancestral past of our species, the *current social life-tasks* which collect experiences from the recent history of our society and the *fundamental life-task* which is the one that has gathered the most responses.

From the results that are going to be presented bellow, responses that had nothing to do with life-tasks were excluded. For instance, an answer like "mixed feelings" or "Mild happiness" adds no information about life-tasks, but a decoding of the android. From the 89 answers we received for each one of the 14 different facial expressions, we will present only the ones that have an impact on our study.

Validating or refuting the research hypotheses from our previous study [4] is not possible, since we cannot count the answers in this questionnaire and therefore we cannot compare them (*H1:* Observers' judgments match with our knowledge of the emotional state of the Geminoid|DK, *H2:* The emotional state of the Geminoid|DK when mimicking the Original is equally or more understandable by observers than when following the theoretical approach of Paul Ekman and Wallace V. Friesen). Despite that fact, we can find resemblances or not and comment on them.

In the next subchapters follows a presentation and analysis of the answers. The subjects' descriptions of life-tasks provided a rich map of activity in the social cognition field.

6.2.1 Life –Tasks for the Emotion of Surprise

The facial expression of the Lower face surprise is depicted here, when the jaw is dropped causing the lips and the teeth to part, while the rest of the face is uninvolved.

a) Empirically Driven

Collective Memory Life-Tasks

1. “When there is a spider sitting on my food”
2. “If I saw a huge spider running towards me”
3. “You can use that face when you see a bug inside your food at the restaurant.”
4. “When I see rotten food”
5. “When i hear an unexpected sound”
6. “When something has fallen on the floor accidently”
7. “When i would find something i had lost and suddenly found it.”
8. ”see something interesting and nice”
9. ”something unexpected happens”
10. “Seeing something we did not expect”
11. “If somebody said something to me that I wasn't expecting.”
12. ”When something happens in front of me all of a sudden”.
16. When a friend tells me about a reaction she had that I could not expect it!
17. “When watching someone doing something out of character”
18. “When i see something that does not make sense”
19. When i do not understand something like; 'eeeeh whats going on here'
19. “When I will want to interrupt the other speaker because he is definitely wrong in what he claims right now.”

Social Current Life-Tasks

1. “When a friend says she had her purse stolen.”
2. “When somebody tells you that your sister had an accident”
3. “When I come home after a long and hard day and I find my boyfriend waiting me with a delicious dinner ready to eat on the table.”
4. “When i pass the exams”
5. “When a goal is expected to occur in football, and I am on the edge of my seat, waiting for it to unfold.”
6. “Someone at the pub puts chips in a hot chocolate and eats them.”
7. “I haven't money to do something”
8. “When you see that in your room entered a bird.”
9. “When a witness a car accident probably”
10. “A prank”
11. “If I'm at a doctor's office & he tells me to say "ahh" but I'm feeling particularly lazy that day”
12. “See a drunk person throw up in front of me”
13. “Wow”
14. “When you say Wow”

Fundamental Life-Tasks

1. “When it was my birthday and my friends were organizing a party and I didn’t know it”
2. “A surprise party or something”
3. “Getting a present”,
4. “Opening a present”
5. “If you receive a present”
6. “A new huge present”

7. “Read bad news”
8. In hearing of bad news”
9. “When hearing bad news”
10. ”After shocking news”
11. “Right after shocking news”
12. “When I learn something and the news are “Jaw-dropping”

Getting a present (and having a party) and receiving news are the two fundamental life tasks that correspond to this facial expression, with six responses each. Once a situation is evaluated, it is not unexpected or misexpected any more, therefore the individual is no longer surprised and moves into another emotion [10]. When receiving bad or good or shocking news, we cannot specify the transition to the next emotion. Bad news lead to fear and good news lead to happiness, but shocking news lead to nowhere specific. In a hypothetic dialogue between an android and a person, when the person says that he received shocking news, the android should respond with a facial expression. If the news is shocking in a bad way and the android smiles then the communication is disrupted.

On the contrary, when receiving a present or when having a party the sequencing emotion is always happiness. For that reason we choose “Getting a present and having a party” as the fundamental life task that corresponds to this facial expression of surprise. In the previous work, people judged this expression as a surprised one, and happiness was following second in results.

b) Theoretically Driven

Collective Memory Life-Tasks

1. “When I see enormous spider in the flat”.
2. “You are at the street and suddenly somebody runs away near
3. When something suddenly appears - maybe something I have found. Here it is.....”
4.“When I hear news I wasn't expecting from someone I know”.
6. “After having heard something really awkward”.
7. “Awkward situation”.
8. “What the fuck??”
9. “if i saw something or someone i didn't expect to”.
10.”If I saw someone doing something kind of gross
11. “When I see sth I cannot believe in my eyes”.
12.”When surprised and in disbelief of what I see or hear
13.”if I heard something that I have never heard of it again and it wasn't good
14. “Seeing something unpleasant
15. “When I see something impressive”
16. “When I see friend from the past”
17. “After a brainwashing”.
18. “When i like something, like a bird or something like that”
19. ”Discovering a deceit”.
20. ”Looks like he's yelling while being angry”

Social Current Life-Tasks

1. “If someone was dating the girl i like”
2. “when seeing a gorgeous woman, being with a less than average man, and I'm thinking "Damn, how the heck did he score that?!"”
3. “When i see a very handsome man”
4. “Listening about new unfair taxes”
6. “May be something bad happened watched on TV”
7. “When i see horror movies”
8. “When i would watch something on tv and get disgusted from.”
9. “My friend has the same boots as i bought”
10.“if i saw a kid scratch in my car”
11. “Someone tells me one of my friends had a car accident.”
12. “If you find you car damaged and you don't find any kind of note.”
13. “When someone tells me that i won the lottery!”
14. “if i realized i had read the wrong thing for an exam”
15. “Like I am surprised that a friend passed an exam that he/she told me it that it was impossible to pass. But meanwhile I am happy for him/her.”
16. “If someone I knew did something surprising like travelling for six months”

17. “When I see someone homeless out in the street.”
18. “My boss told me i have to work on Saturdays too...”
19. “If the cat does a poo inside!”
20. “When I say to my kid "listen now, there will be no more XBOX playing before you finish your homework!"”
21. “When i see a friend from the past.”
22. “Panathinaikos F.C. took cup”

Fundamental Life-Task

1. “When arguing with someone”.
3. “When challenged”.
4. “Before fighting with someone”.
5. “When you are about to argue about something that you don't like”.
6. "taxi-driver"-style: "You talking to me?".
7. “If offended face to face”.
8. “When reprimanding someone who has made a bad business decision”.
9. If someone said something I didn't approve of.
10. “When I want to object about something”.
11. “annoyed by someone”
12. “When I don't agree with someone or find his/her behavior unacceptable”

The fundamental life task from this facial expression is the moment just before you get really angry with someone and you are preparing yourself for a verbal or physical attack. People perceive this expression as an angry one, rather than as a bad surprise. The remaining answers are almost separated among surprise and anger, just like in our previous study were anger was chosen as the second best emotion for this expression after surprise.

6.2.2 Life –Tasks for the Emotion of Fear

Here are the facial expressions for Horror. There is a slight or lack of involvement of the brow, revealing a frozen fear, combined with the less stretched fear mouth and the fear eyes. The face looks shocked and resembles the surprise mouth.

a) Empirically Driven

Collective Memory Life-Tasks

1. An agry rottweiler is starting to run after me.
2. When I see a cockroach in the room.
3. looking at spiders
4. being scared by a dog barking
5. attacked by someone
6. Surprise with a hint of danger, just before something threatening happens.
7. Surprised with little bit scarceness or nervous.
8. wtf is this!?
9. when i was scared as hell! something terrible poped in front of me
10. something unplesant/unexpected came out
11. When suddenly surprised about something i had seen.
12. if something i saw scared me
13. Fear of seening something scary and shocking
14. When I find it out something unexpectedly that surprises me or even scares me.
15. after seeing something scary as a suprise in front of me.
16. when i see something that frightens me
17. after having seen something scary
18. Something surprising happens
19. Looks like a something scary, that surpriced him happened
20. When somebody says something totally unexpected
21. Purely surprised.
22. when suprised and bit afraid
23. something not well surprised me
24. When you are surprised and taken aback.

25. When I am surprise by something horrible
26. when one sees something unpleasant
27. surprised while moderately disgusted
28. if i saw something i really wanted to see
29. if I was in a strange situation and I was surprised of seeing something differen
30. when I am at a loss of words
31. surprised about having unexpectedly found something quite bad
32. I when I see sth that stuns me, in a negative wayooking something strange
33. When I see something unexpected
34. Get surprised
35. When surprised
36. when i would see something scary and thes realize it is a joke
37. when I'm scared
38. Getting to understand something
39. When I am very surprised

Social Current Life-Tasks

1. When I'm very concentrated on doing something and my sister comes up and scares me screaming something at me.
2. you need a toilet and you find only a dirty one.
3. when i am watching a thriller on television.
4. This looks like we are in the zoo and e see a big lion,so it is fear and surprise together.
5. When i see a magic trick.
6. Discovering that I nearly stepped into a pile of dog poop
7. i win in card games
8. when i see my sister, after a long time
9. incredible goal at football match
10. when I walk in the room and my baby is trying to explore what would happen when he puts its small finger in the electric plug
11. Someone threw me a surprise party - a big surprise!
12. if i just walked in on a surprice party
13. When I touch something and it goes bang!
14. my face when::: Reallyyy!!!!!!!!!!!
15. I would look like this if pigs flew by outside my first floor window
16. watching a horror film
17. during a horror movie when something appears on the screen out of nowhere
18. My boyfriend proposed to me

Fundamental Life-Task

1. "ooh its a car coming"
2. when an accident happened
3. you just sow car crash
4. Watching a car accident take place in front of me.
5. watching a car accident happening in front of me
6. after an accident
7. having an accident
8. Seeing an accident

This is the face reveals that something bad is going on and almost all the answers we collected seem to understand it. Many categorized is as a bad surprise though, just like in the precious study. The fundamental life-task is when witnessing or participating in a car accident. In spite of the fact that we pass many hours of our lives inside a car, the fear of having a car accident is probably one of the greatest fears ever.

b) Theoretically Driven

Collective Memory Life-Tasks

1. when i see a bug in my house
2. if i am alone in a forest and suddenly a bear appears
3. When I am swimming and see a leech in the water!
4. facing a wild bear while camping
5. Surprised by something that it also a little frightening - but mostly surprised. Seeing somebody whom I thought dead, I think would make me look like that
6. If I become a zombie
7. watch a dead person
8. When I experience a danger of something falling,
9. when i see/hear something that can freeze me
10. when I see something scary, for example when I see a suspicious man walking towards me
11. When see something scary:)
12. Kind of scary no emotion face
13. right after being scared of a sudden fact
14. when i see sth scary
15. When I am negatively surpised by something or someone.
16. When I'm surprised or shocked
17. When surprised by something I may be a bit afraid of
18. if someone said something insulting to me
19. when im mildly annoyed about something
20. When i find out somebody i knew died
21. i've just heard some really bad news
22. Learn something new, surprising me in a neutral way.
23. when something unexpected happened which puts me in a difficult situation
24. hearing something impressing
25. When surprised in safe surroundings
26. I can't believe my eyes
27. when offended
28. when I am negatively surprised by something I see
29. When someone was told some surprising news that he did not quite like.
30. When faced with something so surprising, my jaw figuratively drops on the floor.
31. Stunned
32. When in disbelief at something. Eyes would need to be open wider, though - maybe eyebrows raised if the Geminoid has the capabilities for that.
33. When somebody gave me something I really wanted.

Social Current Life-Tasks

1. “When watching a thriller film in tv. Bit surprised and afraid.
2. tsunami
3. if some one beat me in a sport by luck
4. Where is all the beer gone?
5. this could be an expression of surprise for a gift
6. when i went to my mother in hospital.
7. Seeing an accident
8. My boss is having an affair with the secretary
9. My mom says me she's pregnant of another man.
10. If I saw someone doing something awful like hurting an animal.
11. See a naked man running in the streets.
12. When I am watching a movie ... maybe a thriller
13. When I I hear that something unexpected happened to a friend but is not that sad after all. Like missing the plane because of the traffic.
14. when my friends tell me about some test
15. When you ask "The test is tomorrow?"
16. When somene tells me, today we have a test!And I didn't know it. In other words, this is bad surprise.

Fundamental Life-Task

1. “When arguing with someone”. unexpected news
2. “WTF!!

3. unplesant surprise
4. When I see something that i donts expect to see...something unsusual
5. When seeing someone or something i didn't know was there.
6. Something unexpected happens.
7. something unexpected happened
8. If I heard something I never heard before
9. If I saw something unbelievable but wasn't really feeling it
10. I can't believe my eyes
11. when you something you didn't exspect in that moment
12. When I am suprised but not beleaving what I'm hearing

People fear harm and the anticipation of pain. In fear the future dominates the present and gives it a new significance in addition to its own. We can have fear for expected and unexpected situations. To the former we are adjusted by habit and the sequence of events in it is anticipated. The other class of events is sprung on us without warning and is more likely to injure us than those that which are expected [78]. The less one knows, the more things seem unexpected to him and thus fear is prevailing. It's the fear of the unknown.

The facial expression depicted here is the one of horror fear and the fundamental life task of an unexpected situation is a perfect match.

6.2.3 Life –Tasks for the Emotion of Disgust

The facial expression of these photographs is Contempt. It is considered a very close relative of disgust, represented by a unilateral contempt mouth with slight pressing of the lips and a raising of the corners of the mouth on one side.

a) Empirically Driven

Collective Memory Life-Tasks

1. I'm feeling blue today
2. When I say, what is this? Disgusting!!a rotten fruit for example
3. when worried about whether the dog sitting next to the table will attack
4. When I hear something sad but not something closely related to me
5. learning about something that you cannot change
6. when i see blood
7. A little bit disappointed of something
8. Reading about something that you were not expecting for.
9. When I am sorry because of something morally wrong which has been done.
10. When somebody is telling me in a bad way something I did wrong.
11. embarrassed and look down to avoid eye contact or make the others feel sad for me
12. d Somebody caught you in a lie
13. disappointed from an unsuccessful effort of me
14. It looks a bit apologetic, so when I'm feeling guilty.
15. Maybe when I am doubting something or trying to understand it
16. when I am sad or disappointed with someone
17. When thoughtful or when i have got bad news.
18. i lost something important
19. When I am depressed
20. While thinking of something depressing.
21. not feeling good
22. when i feel sad
23. when content
24. When you are sad and you don't know what to do

25. When someone i know has let me down.
26. dunno.. something bad happened
27. If something really bad just happened.
28. as if i am going to open something i don;t want to.
29. When I found out about a friend's lie
30. My face when: "I don't care, finish this now!!!"
31. thinking about something else while someone is talking to me and i want to seem friendly
32. Looks like someone who just found a simple solution to a problem, that he and others are working on, but haven't told it yet.
33. When I am looking at something interesting
34. He is looking something with affection.
35. While watching something weird
36. when I am thinking
37. thinking about something funny or happy
38. thinkful moment
39. if i'd like to focus on something
40. skeptical and sad
41. if I want to remember something
42. It feels like looking at something one finds interesting, being into the moment, and waiting for something to happen.
43. having doubts
44. I am focused on something
45. when really sad
46. slightly good news
47. when bored
48. When I'm afraid of something anf that make me sad not angry

Social Current Life-Tasks

1. “someone dirties your suite with something and you don't want know what should it be.
2. Feeling tired after a stressful day
3. when i failed to pass my English examination
4. hard days night with bad simulation results :-p
5. following (with my eyes) a cat chasing a laser pointer
6. I got rejected from an interview that I really did not want

Fundamental Life-Task

1. mourning about a loss
2. if someone i know died
3. I had a loss of someone i cared about.
4. When i remember my dead grandmother.
5. Someone close to me died a couple of days ago
6. When someone has died
7. contemplating on a loss
8. In a funeral
9. if my dog died

The fundamental life task is related to loss and death, two characteristics that are far from the emotion of disgust and contempt. The Geminoid technology does not possess many actuators around the mouth and lip area and is difficult to reveal such an emotion persuasively. Apart from that, a bowed head, like the one in this facial expression, is proposed by many researchers as a component of sadness [79]. This is a fact that can explain these results.

Previous work revealed exactly the same result, with sadness being voted as the dominant emotion.

b) Theoretically Driven

Collective Memory Life-Tasks

1. when i see a disgusting food
2. “if i did something bad and anyone found out
3. When I'm bored.
4. Bored
5. Passive mode, just waiting for whatever to happen, a bit bored
6. I am bored
7. I don't find any emotion I think bored
8. when apathetic and little happy
9. When nothing happens
10. oups, i did it again
11. When i smell something that is not pleasant!
12. when someone annoys me
13. depressed
14. in a normal situation
15. learning about a death
16. when I am scared
17. when I'm content
18. feeling content
19. When I am contented with life
20. You are trying to hide your disliking about someone
21. When feeling somewhat morally superior to someone - it's smug.
22. When I critisize
23. when in a discussion, and your are indifferent within a topic or just don't care.
24. I am slightly indifferent with the situation, but whatever you do, I will be ok with it. I would respond with this look if my wife asked me whether I wanted pizza or steak
25. if i did't want to see the person accros me
26. hearing bad news
27. after hearing something i didn't like,like bad news
28. When you are wondering what is going on actually
29. A I am concerned/worried about someone
30. I was anoid with someone
31. When I am alone and missing my family.

Social Current Life-Tasks

1. “when someone is photoshoot me for something official
2. When I want to have my profile picture taken for ID
3. being taken a picture for the identity card
4. When a need a photo for my id card
5. while taking a picture
6. to take pistures for my id
7. when we have an official photo taken
8. when I am with friends and they are insisting we take a photo and I am reluctant but go with it anyway, faking a smile.
9. Stoned
10. porn man
11. when I give a job interview or talk to my employer
12. when I am serious, like in an interview
13. When I'm a bit tired from work
14. When I have a good reference letter by my employer.
15. he is in an elevator or something
16. you don't have an umbrella in a rainy day
17. when i go for shopping
18. i do my sport
19. When I see poor man on the street.
20. When I want to go to sleep but I annot because I have work to do.

Fundamental Life-Task

1. “If I was somewhat happy but mostly calm
2. slightly happy
3. Having a positive thought.
4. joyful passing thought
5. when something good happened yesterday

6. I feel fine
7. is a little happy, i like my day or something like that, i don't have any troubles
8. if i was mildly amused about something
9. When you are happy and beginning to smile.
10. When I'm having a nice talk with somebody and we agree with each other.
11. Being with friends
12. When i hear something good for someone i just know.
13. happy and self confident at the same time

As we mentioned before the emotion of disgust and contempt is difficult to be expressed in the Geminoid face. The fundamental life task here reveals a happy, calm and enjoyable moment with positive thoughts and surrounded with friends. A possible explanation is that a unilateral contempt mouth with slight pressing of the lips and a raising of the corners of the mouth on one side, due to the limitations of the technology, looks like a happy face because currently it is not possible to raise only the one corner of the mouth.

In general, the results for both the empirically and theoretically driven photographs for the emotion of disgust match the results we found in the previous project. Disgust is one of the four negative emotions along with anger, fear and sadness [80]. Based on this fact, we can consider the empirically driven life-task of death and loss to be more truthful and closer to the concept of disgust, than the theoretical one of a happy and enjoyable moment.

6.2.4 Life –Tasks for the Emotion of Anger

a) Empirically Driven

Collective Memory Life-Tasks

1. “Little bit mad at somebody
2. when i saw an enemy face
3. Someone took my breakfast.
4. if i dropped my sandwich on the floor and wasnt able to salvage it
5. When eating to much and felling a bit sick
6. if i was really angry with someone
7. when I am serious about something
8. Killing mood
9. not liking something
10. hey, why u look at me?
11. like saying "you talking to me??"
12. When you ask "Are you kidding me?"
13. when something/someone irritated me.
14. if someone did the opposite of what i told them
15. I would use that expression when angry or suspicious
16. To communicate dissatisfaction
17. after having heard something weird
18. When scared
19. When someone has died
20. When I am sad
21. when I am confident
22. Ready to explode about a serious betrayal
23. sort of calculating way. Like I know more than you think I do.
24. after hearing some bad news,like a verdict or a loss.
25. When I criticize
26. When my brother has broken smthing.
27. bad taste
28. when i am thinking of something bad
29. If I was feeling disappointed in myself.
30. when i am dissapointed
31. Boredom

32. if I was bored
33. when bored

Social Current Life-Tasks

1. i have told my neighbour not to park in front of my car...this is the look i have next time i see his car in front of my parking slot
2. When I feel I don't fit in a new group of people (in a birthday party of a friend for example).
3. when i succeeded in exams of school.
4. when what i want to wear is dirty
5. i saw this expression on robert deniro in taxi driver when he said " Are you talking to me?"
6. when watching caterpillar closeups in a documentary film
7. probably didnt do as well as expected on an exam
8. A comment from a rude waiter
9. Um... when seducing someone in a bar. I can't watch it again, but I think one eyebrow is higher than the other, which is somewhat alluring. It is SO WEIRD to see this facial expression on a robot.
10. If I were a guy flirting with someone
11. When you are flirting and you are confident about yourself.
12. Flirting
13. I have no money left

Fundamental Life-Task

1. “When arguing with someone”. Hearing an excuse from someone that i know it's not true.
2. you are speaking with a selfish and boring person
3. when I feel the person I am talking to is making fun of me. t someone makes fun of me
4. When somebody has offended me.
5. When listening to someone annoying but wanting to hide my real thoughts about this person
6. Someone is talking to me in a very annoying way.
7. mad at someone
8. personal disagreement with someone
9. Disagree with someone
10. when I look at someone I dont like
11. after listening to something stupid
12. listening to someone I don't like

This facial expression seems to be very strong and passes immediately the message of anger. The fundamental life-task is about speaking to someone who is annoying you and builds your anger by making stupid, boring or offending comments. Again there is complete agreement with the previous studies. What is surprising though is the fact that many subjects received this angry expression as a confident one, revealing a flirty mood. When android robots ever reach to the point of seducing others (robots or not), well… we have “the look”!

b) Theoretically Driven

Collective Memory Life-Tasks

1. “When i have eye contact with someone and want to show him that i am a bit annoeyed with what he did.
2. when i am preparing to avenge the person who hurt me.
3. see enemy approaching
4. When there is something interesting, you are curious:)
5. if i saw somethning i didn't like
6. Recalling an unpleasant memory.
7. You sow somebody doing something bad
8. when someone insults me
9. when: "uhmmm, this is wrong"
10. When something doesn't go the way I expected it to.
11. When a friend is talking to someone I don't know
12. When I feel bored
13. I am bored
14. when i am thinking of something
15. When I smile to someone when I'm being polite
16. annoyed by someone

17. annoyed
18. when bored and a little annoyed
19. confused situation
20. being a little afraid
21. When I have fear for the possible reaction of my friend on something I did.
22. it looks like a mix of being in an uncomfortable situation, and being unable or hesitant to do anything about it. It looks more like frustration.
23. when I try to hide my emotions
24. when i want to stay expressionless
25. difficulty in expressing emotions
26. no apparent emotions
27. looks like neutral expression

Social Current Life-Tasks

1. "A strict & disciplined face of someone teaching"
2. I'd use this face when listening to a lecture.
3. you would enjoy a nice sunny day, but you have to be in your office without window.
4. I realize I have one day less that I expected to study for my exam.
5. Waiting for test results
6. When i find out that a guy i knew has become a robber.
7. when I know the politician is now lying, but I can't stop him in front of all this crowd and security, I have to keep to myself for now!
8. When my boss is judgemental on me with no reason.
9. saw my ex with a new guy.
10. My boyfriend didn't clean up after himself
11. when expectedly losing a card game
12. if the girl i liked kissed another boy in front of me
13. not paying bills
14. for a photo on an id card.

Fundamental Life-Task

1. "When arguing with someone". When someone has upset me
2. When I'm not agree with somebody's way of think.
3. When I disagree during a conversation
4. When someone verbally abuses me
5. when someone swears at me
6. When indifferent or sad about something i have heard
7. after a disappointment like hearing something bad.
8.

The fundamental life task in this occasion is almost the same with the empirically driven video, only here the disagreement is strictly restricted to verbal reactions and the anger is milder. After all, the answers indicating that the face is expressionless or neutral form the second best option. The results agree with the previous work.

6.2.5 Life –Tasks for the Emotion of Happiness

a) Empirically Driven

Collective Memory Life-Tasks

1. "if the girl i like smiled at me"
2. If I was pretending to smile
3. when I'm sarcastic
4. bittersweet
5. Being polite
6. listen sth good
7. When you hear good news
8. when hearing sth familiar to me
9. when i hear or see something funny
10. when I hear something funny
11. Funny, right?
12. When talking with a friend.
13. When talking about things or people i care for.
14. you are speaking with a funny people in a nice day on a

balcony
15. see something beatifully unexpected or meet someone familiar by chance.
16. in case that somenone said something funny
17. to make chit chat with someone I just met
18. discussing something
19. happy conversation
20. Discussing with friends.
21. If I was laughing with my friends.
22. When I'm pleased of hearing something from a close friend of mine
23. When I agree with someone or when I realize that another person's statement/opinion is correct
24. When i see a friend of mine.
25. if I want to show on other people that I was surprised but I wasn't really
26. when surprised
27. When I am surprised
28. When I have I good time.
29. Orgasm
30. when i found the solution to a problem.
31. in hearing of surprisingly good news
32. When I get happy for something
33. I am having fun right now
34. Happy for something good:)
35. after having drunk a lot of wine

Social Current Life-Tasks

1. “enjoying a picnic in the sun.
2. When you say "Happy birthday"
3. like hiiii
4. watching a football game
5. I got a new pair of boots
6. When I have a present.
7. when i win a game
8. when i have free time
9. Read a funny article in a webpage.
10. when my sister graduated
11. When I see a funny series on TV.
12. A nice surprise, like my boyfriend bringing me flowers
13. when i eat a ice cream XD
14. This could be disgust, because sometimes when we see something really disgusting we somewhat smile in a rare way and say something like,agkrrr put this out of here!!Like really really dirty socks for example.

Fundamental Life-Task

1. laughing at a joke
2. hearing a funny joke
3. when i hear a joke and it is good
4. After a funny joke
5. When I here a nice joke
6. When someone has has told me a joke!
7. When faking a laugh at a bad joke
8. bad joke
9. When listening the end of a mediocre joke, but being polite and smiling more than I feel because I should not embarrass the person who said the joke. Or when I already expected/knew what the ending of the joke would be.
10. laughing at a not so good joke
11. heard a really good joke. my smile is kind of creepy though!
12. having just heard a joke, slightly laughing
13. something good happens, someone tells a joke
14. if I was in pleasent company and someone just told a joke
15. Perhaps upon hearing a joke of medium intesnsity, that would provoke a laughter out of me, but I would roll on the floor, holding my sides.

The fact that the fundamental life-task has to do with a joke is an instant indication that the message of the photograph was transmitted. Something funny is going on because someone said a joke. The task of being with friends and having a good time

was the second best in the results and can be described as a prosperous situation to tell a joke. Even if the joke is bad, the usual response is to laugh out of politeness. Therefore the facial expression can be used for this life–task. Laughter has been evolved in the human race as an anti-dote to protect us from the depressive influence of the shortcomings of our fellowmen. The previous results are in agreement with these.

b) Theoretically Driven

Collective Memory Life-Tasks

1. “Gloat
2. ha ha (ironically)
3. revenge moment
4. When my work is well done.
5. you heard a funny joke
6. When something good happens, someone tells a joke, seeing someone you recognise
7. after a not so funny joke
8. laughing at a good joke
9. When I hear pleasant news
10. slightly good news
11. When I am thinking about something nice
12. unexpected visitor
13. Getting to eat what really want
14. I got a great gift
15. surprised with an unexpected gift
16. When you say "I like this food"
17. after hearing the end of a happy story.
18. when i hear or see something good
19. When in disbelief, like when someone has just told me a slightly offensive secret.
20. if I want to ask something
21. when I am told an answer I was looking for (but didn't care too much)
22. when surprised
23. when I see/learn something surprising, maybe negative, but that does no concern me
24. someone tries to hit you
25. when I' happy but I'm not sure if this will keep
26. Happily surprised at sth minor - someone

Social Current Life-Tasks

1. “when i smile in front of a camera for a family photo
2. pose for the camera!
3. If the girl i like hugged me for no reson
4. I see that a puppy likes my cuddles
5. when there is a goal
6. i have relationship
7. watching funny "fail" compilations on youtube
8. if someone says "i'll buy the next round"
9. When i found out i have passed a test.
10. when i pass a lesson in university
11. You just got a job
12. When I find out that I am the winner of a contest and get a free trip abroad.
13. we're going to the beach today?? yoohoo!
14. when I watch something like a documentary..
15. when I see something I like on a shop, or when I find something I had lost
16. hi sweet baby
17. seeing a not to funny video on youtube

Fundamental Life-Task

1. When i have heard something funny, or meet a good friend
2. When i am with my beloved friends.
3. happy to say a hearty hello to a friend
4. If I were pretending to be having a good time
5. When I see a friend I havent seen from a long time.

6. I see a familiar face i've missed and havent seen in a long time, a "welcome" smirk usually a face that goes with a hug
7. Polite conversation
8. When I like what I see e,g, a good friend.
9. When I am with friends
10. If I was having a nice conversation with a friend.
11. Listening to friends' news
12. seeing someone I haven't seen for a long tim
13. if i saw someone i love i didn't expect to see
14. see long lost relative
15. Trying to seem polite when meeting someone for the first time.

The fundamental life-tasks of happiness are very social. Expressions of happiness occur when you are surrounded with friends and rarely when doing things on your own. This task, like the previous one, describes again a situation when you are with friends. Only this time you are not laughing out loud, but just enjoying their company. The previous results indicate also happiness. The positive emotions can be expressed clearly in the face of the Geminoid mainly because of the range of the actuator that controls the move of the cheeks.

6.2.6 Life –Tasks for the Emotion of Sadness

a) Empirically Driven

Collective Memory Life-Tasks

1. “when i learned that something bad happened to a friend of mine
2. When ignore something/somebody
3. When I'm missing someone and thinking about him/her.
4. When something disapoints me
5. when I’m content
6. When sad
7. if i was in a terrible psucological situation
8. resignated
9. disappointed
10. When not paying attention at all. It seems blank, a bit melancholy.
11. He is just sitting there in his own thoughts
12. When I am sad and in my thoughts
13. in a grim situation
14. If I was depressed
15. I think that a person did something worth of despise.
16. When I have doubts or when I reconsider a matter
17. When i hear bad news about me.
18. Funeral
19. contemplating on a loss
20. When I am sorry because of a loss
21. seeing something or as looking at someone who is frowned upon
22. . When I have a bit of melancholy
23. when smelling something bad
24. After listening to bad news
25. when I am among strangers
26. if I want to sleep and the other people talk me
27. being a little afraid
28. when bores
29. I am bored
30. bored
31. day dreaming
32. looking at sth that’s indifferent to him

Social Current Life-Tasks

1. “When I watched all of the "Two and a half man"
2. you have hit a dog's shit on a pedestrian way
3. Seeing a dog chasing his tail.
4. your pet just died
5. maybe my cat died
6. when i haven't money to do something.
7. when i must wake up early
8. when i fail to exams
9. if i got mad at a teacher
10. I got a bad grade
11. if i just lost my boyfriend
12. if i play the card game Uno with my friends and i loose
13. when a friend says something nice in instant messaging like "I miss our old days, do you remember the fun we had?"
14. I would look like this if I found out that they had just cancelled the Champions League match of the evening
15. It mostly looks like he is trying to hit on some woman and he's trying to make a sexy face. I see some confidence, a little bit of lust and some joyfull impishness.
16. may be a movie about relationships
17. workin in something with the computer
18. Watching ungly pictures
19. or example when I see how people abuse the animals, I'm angry and disgusted
20. when I am breaking up

Fundamental Life-Task

1. “Lost in thought
2. when apathetic and little sad
3. When I am thinking something sad or I heard bad news
4. when I'm thoughtful or when sad.
5. When I need to figure out the solution to a difficult problem
6. when i'd be focused and dedicated in something
7. When you focus on something that you like.
8. This expression just shows focusing and interest
9. when I am really sceptical about sth, probably bad
10. when I sit on the bus thinking of something sad but not wanting to show it
11. It is sadness, when I am thinking this should not have happened...something like this

Before commenting on this life-task, just remember the fundamental life-task of the empirically driven disgust. The majority of the subjects answered death and loss. The Geminoid in this expression is also bowing the head, but the results are not sad enough. The fundamental life-task is describing someone in times of solitude when thinking about events that have happened or could have happened in the past and possible future chronicles. This is probably the situation when one experiences the “dead eye phenomenon”.

b) Theoretically Driven

Collective Memory Life-Tasks

1. Impassive attitude to something i don't care about attitude *boredom
2. When i'm unimpressed, supine
3. in an ordinary moment
4. When I am talking to someone stupid.
5. when something smells bad
6. when i just had a fight with someone
7. If someone said something rude to me
8. when getting ready to argue with someone.
9. if some one did somthing i didn't want them to do
10. When you lost something important
11. When I miss my family.
12. While being a little bit angry.
13. when i am hungry
14. relaxing
15. Content
16. Normal
17. Boring
18. Happy of myself
19. when having different beliefs with someone
20. if i was abit upset
21. When you have so many work and you are tired
22. In a neutral situation
23. with strangers
24. nostalgic thoughts
25. emptiness
26. almost apathetic
27. if I want to tell something serious and I didn't want to be sad the other people a lot
28. tires
29. serious
30. when scared
31. when I think of something bad/sad
32. Someone says to you something wrong
33. waiting for something
34. when happy but confined
35. it seems like a seductive look....
36. in fear
37. waiting for news
38. when i'm unimpressed
39. apathy but now focused on what is in front of him

Social Current Life-Tasks

1. “When my family is watching a TV show I don't like.
2. you lost your job
3. When expecting the results of an exam test.
4. I put sadness because it is closer to boredom that I was looking and I couldn't find. This looks like me when I attend clases at University.
5. Maybe, i will use this facial expression when I'm teasing someone..
6. when my mother change my things position
7. Listening to the whining of my girlfriend.
8. when my boyfriend does not clean the house, and i am ironic about that.
9. i said something to my girlfriend and i wish i hadn’t
10. when i see the people to mistreat animals
11. if my dog died
12. If the dog has ripped the curtains
13. When i see someone being bullied
14. when watching an unhappy ending in a film
15. Having eaten a nice cake, and leaning back - happy and laidback. Slightly indifferent and lazy too
16. when someone is photoshoot me for something official

17. in a bus
18. when taking photos for ID
19. when I have to read something that I dont like

Fundamental Life-Task

1. 1. “I am thoughtful about problems in my life.
2. When i'm thinking and maybe when I remember moments tha weren't very pleasant
3. if thinking that something went wrong
4. remembering of an unpleasant situation
5. Lost in thoughts, face relaxing and you often get the comment "Why so serious?"
6. looked vary stoic
7. serious and self confident
8. peaceful and calm
9. something getting serious

Similarly to the previous one, this fundamental life task describes the situation when lost in thought, a bit serious, calm and peaceful but not to such extends as in the previous one. Maybe this can be the stage before you realize how serious the problem you have is. This facial expression may go before the empirically driven one.

In the previous study of this facial expression, anger was the dominant emotion followed by sadness. An explanation might be that sadness very often blends with anger (and fear). Anger also can be also be exaggerated or simulated to conceal the distressed or sad expression.

6.2.7 Life –Tasks for the Neutral Face

a) Empirically Driven

Collective Memory Life-Tasks

1. When i read something or listen to a conversation to which i have an opposing opinion
2. when i am lost in my thoughts
3. either; pensive, reflectful or thoughtful, not necessarily sadness.
4. this expression could be used if you are disappointed by someone
5. when I excpect something and is not happening
6. When something is annoying or someone says something irritating
7. When somebody annoys me.
8. when i hear something i don't like
9. when i dont feel good
10. if i though of something bad
11. accept bad news
12. When I have a serious conversation with someone
13. When I walk in the forest and suddenly see (for the first time in my life) a fox near to me, and I don't want to scare it away so that I could see more of it!
14. After hearing an answer that i didn;t want to hear.
15. Somebody asks you did your mother died
16. When I experience a loss of something I liked,
17. When I someone is overly talkative and wait for the end of his story.
18. i'm about to cry
19. content
20. content about something
21. When someone oi talking to me and I listen to what they saying and paying attention
22. when I miss someone that I cannot see for a while and I think of him/her.
23. When annoyed with somebody's behaviour, and trying to persuade them that I am tougher than them

24. if you found out something you didn't want to happen
25. just sitting
26. It's quite stern. Reprimanding someone, or trying to explain just how serious something is.
27. None
28. normal
29. When i'm thingkin
30. want to punch someone
31. after a fight
32. when i get angry
33. don't like this
34. if lightly insulted
35. When I get upset with something
36. if i was angry
37. when slightly angry
38. when i'd be angry and worried
39. when I look at someone I don't like
40. When I am lost in my thoughts
41. wher you don't want to show emotion
42. If I was upset with someone but didn't want it to be obvious
43. Listening to someone's problems/ someone in general
44. Serious, no emotion
45. Boooriiing....
46. When someone is content about something, satisfied.
47. when something getting serious
48. when i am listenung to something someone else is saying
49. When apathetic or a little bit sad
50. bittersweet news
51. if I think anything
52. Thinking, concentrated
53. when focused on something
54. not indicative for something
55. when I see something wrong happening, to give a strict look at someone
56. If you are focus in something
57. nutrual expression...
58. when i am bored
59. apathy-someone whos doesn't care about what 's going on-lost in his thoughts

Social Current Life-Tasks

1. When see someone peeing on the street.
2. its a serious face without apparent emotions. In a photo or at an official ceremony
3. when I am in public places but don't interact with people (e.g. on the bus) and I am tired
4. When taking a photo for an ID, passport, etc. where my facial expressions have to be as neutral as possible.
5. My cat has died!
6. When I see a man scratching his penis (it happened recently, that's why that came up to my mind first).
7. when i am fighting with my husband
8. My sister tells me she dropped my expensive phone on the floor after I told her to be very careful.
9. Finding out that i have not passed some kind of tests.
10. when i have written a long piece of text and my computer malfunctions and i realize that i have lost it all.
11. Whe when my dad said that we have no money for road tripn i see some bad news on the tv
12. something I wanted for lunch was not available
13. Clearly someone did something to dissapoint him, look a lot like a parrents angry face
14. When you are a teacher and your students do something wrong
15. Opening a box

Fundamental Life-Task

None

There was no agreement among the responses that could allow us to define a fundamental life-task. There are hints of sadness, neutrality, anger, disgust/content but not a strong indication. After all, this is the neutral face and usually it is more "serious". To justify the anger results, we can go back to the previous study and see

that for two judgements the Geminoid could be characterised as frozen-affect expressor for the emotion of Anger. There is a possibility, but very slight.

b) Theoretically Driven

Collective Memory Life-Tasks

1. “nothing there...passive, awaiting input
2. when nothing happened and i was normal
3. when don't care about anything
4. When the sun is shining outside
5. It's not sadness exactly, I'd use this facial expression when remembering some nice moment.
6. feeling bored and lonely
7. When I fell angry about someone or something but I do not want to clearly express it
8. When mad about something
9. when i'm really bored
10. if i didn't want to talk to someone
11. When I disagree during a conversation
12. When my day is not going well.
13. Cool
14. When apathetic
15. if I don't want to show my feelings
16. absent-minded
17. normal
18. after being dissapointed from from someone i had bigger expectations from.
19. Your friend needs a good advice but you are not good with words
20. huge fight with someone i care about
21. When I experience something boring
22. neutral face
23. If i did something i didn't really wanna do
24. When listening to someone. It has a very slight smile, but looks a bit disinterested as well - something that is probably fixed as soon as there's eye contact.
25. felicity
26. don't feel anything
27. If I was feeling neutral
28. just natural
29. He looks just serious to me. A normal face with no particullar expression.
30. mixed bad and good moments. neutral situation
31. no emotion,serious
32. if i wouldn't have any emotion
33. no apparent emotion, a straight face
34. looks like neutral expression
35. neutral situation
36. Listening
37. reserved anger about news
38. waiting
39. thinking about future
40. something bad happens
41. i am serious
42. when bored
43. being angry
44. Very neutral face, would expect him to be listeningI d say, a neutral expression.
45. when want to convey some displeasure to someone without being too strong about it
46. disgust with a touch of indifference. Used when saying to somebody "I would not do that. Thats disgusting. But hey, its your choice!"

Social Current Life-Tasks

1. “when i can't do well my work.
2. If I woke up early on a Monday to go to work.
3. Again, it reminds me of somene tha is bored, in opera for example.
4. Again, the neutral photos, but with a hint of irritation. Perhaps, after 4 or 5 failed shots at the photographers shop, where I have to take another, but I am tired of it. "Let's get this over with, and b done with it already." would be a thought bubble for this one, in my opinion.

5. When I see a debate on TV.
6. Seeing spoilt waiting the bus food
7. When I don't like what I hear
8. When interviewing someone
9. A group member didn't deliver on time
10. when I am waiting in a queue
11. in an neutral situation, like when I watch tv
12. Profile picture again but in a sadder mood
13. when someone is photoshoot me for something official
14. When I need a photo for my id card
15. My sister tells me she dropped my expensive phone on the floor after I told her to be very careful."
16. Trying to enforce my decision to my children.
17. if i lost my dog
18. when my granma died

Fundamental Life-Task

None

This is a natural neutral face, with hints of almost all the emotions. The apathy that many refer to is a general problem of the android robots of this time. The lack of sparkle in their eyes is very common for such robots. They always have this dead eye, the constant lack of reason and calmness.

Chapter 7: The Entity-Relationship Model

Trying to connect and manage this large body of data and the information we have gathered so far, we resorted to the concept of the *Entity-Relationship (E-R) model* [82][83]**,** which is a popular high-level conceptual data model, easy to understand, accurate and efficient. It is based on a perception of a real world that consists of basic "things" or objects, called entities, and of relationships among these objects. The E-R model is illustrated through a special diagrammatic technique which will be explained below.

An entity is an "object" of the real world, distinguishable from all the others. For instance, a person or an event can be an entity. Each entity is described by a set of properties or attributes, and the values for some set of attributes may uniquely identify an entity. An entity set is a bundle of entities of the same type that share the same attributes. A relationship is an association among entities. For instance, "father-son" is a relationship between two "person" entities. Mapping cardinalities, express the number of entities to which another entity can be associated via a relationship set. For many-to-many relationships the line connecting the entities and the relationships should be undirected. Two entities in an entity set are not allowed to have exactly the same value for all attributes. A *key* allows us to identify a set of attributes that suffice to distinguish entities from each other. Keys also help uniquely identify relationships, and thus distinguish relationships from each other. In an E-R diagram, the key attributes are the underlined ones. Lastly, if an attribute has more than one value, then it is called a multivalued attribute and is depicted by a double ellipse.

In our model, we can define three entity sets, one for the basic emotions, one for the fundamental life-tasks and one for the facial expressions in the form of Action Units (AU) [84]. Action Unitis describe all the possible facial actions that can change the visible appearance of a face. In the beginning, I was thinking to treat the facial expressions as a property of the entity set of emotions, but that would imply that each emotion corresponds to precisely one facial expression which is not the case. Treating facial expressions as an entity set, permits emotions to correspond to several facial expressions. Moreover, we should have in mind that an emotion might appear in different parts of the face. One of the attributes of the entity basic emotions is the "Faces" of emotion. Every emotion can appear on different parts of the face and have distinct characteristics. Let us consider the emotion of anger. There can be the anger brow or the anger eyes or the anger mouth or or the full-anger face or blends of anger with other emotions and combinations of them [10].

In our model all the cardinalities are many-to-many since all the entities are associated with any number (zero or more) of other entities and vice versa. For example, it is possible for one basic emotion to have evolved from many fundamental life-tasks, whereas it is also possible that one fundamental life-task to have caused the "creation?" of more than one basic emotions. Hence, many basic emotions might have evolved from various life-tasks.

The process of finding the life-task is depicted in the directed graph of Figure 1. We move from the basic emotions to the fundamental life tasks, then to facial expressions and then to basic emotions again. The six basic emotions are universal and the AUs that describe the facial expressions and movements are also universal and stand independently. Therefore, after discovering the life-tasks the database is considered complete. A complete database means that we have the power to make

queries towards the opposite direction also. In an E-R model, all the relationships are bidirectional. In one direction, the active form of the verb applies, when in the opposite direction, the passive form of the same verb applies. If there cannot be applied a passive form verb then we have to research deeper. Asking the database questions in every direction (choosing thoroughly the verb) and testing afterwards the results through series of experiments, we can ascertain the strength of these relationships and confirm them or refute them. We have built a generator of queries!

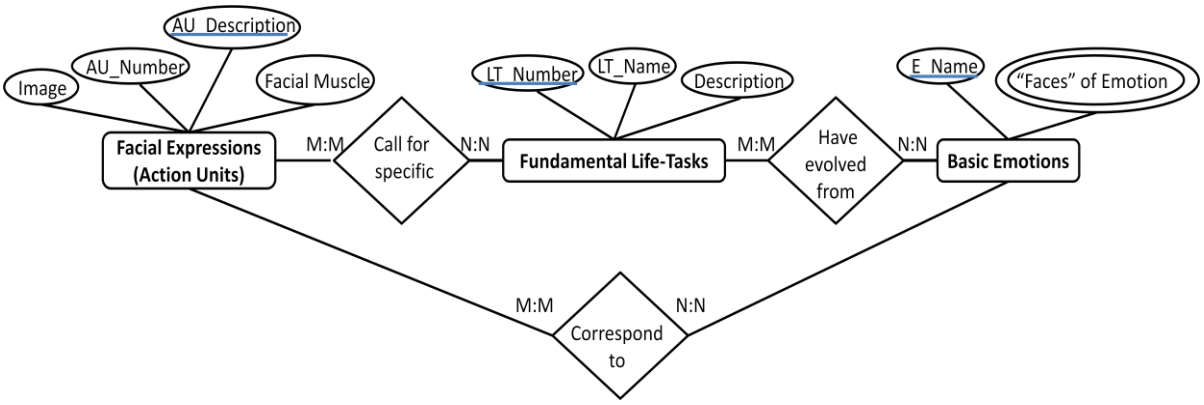

Fig. 4 - *Entity – Relationship model connecting emotions, facial expressions and life tasks.*

This E-R model (Fig. 4) can be applied to any android robot or to any human being, provided that there is a list with fundamental life-tasks. It functions as a behavioral map for a specific android robot or man. The more we enrich the data base with life-tasks (after an experiment or an observation), the more we can understand the nature of the relationships, the essence of the entities and further potentials and possible future actions unfold.

Chapter 8: Conclusion

We have presented the reflection of our society through the eyes of the Geminoid|DK android robot by using the android robot as a mirror. All the intentionality directed towards the android was collected and analysed in order to find the fundamental life-tasks of our society. Throughout the way to the fundamental life-tasks, we had emotions as our guide.

Android Reality needs an adaptive interface able to communicate with and understand its surrounding environment. Needs to have believable characteristics and be able to actively engage in situations. The process of familiarizing ourselves with the robots renders us aware of the mechanisms applied in us and therefore makes us capable of building robots that will truly assist our society.

The results of the questionnaire revealed an incapability of the Geminoid to reproduce certain emotions (mainly the negative ones, disgust and sadness). In other occasions, the indented emotion was misunderstood. A necessity of the Geminoid at this point is to be able to reveal these emotions through a more flexible face. This can be achieved by adding actuators to the facial areas of the *levator labii superioris alaquae nasi* muscle which makes the nose wrinkle, to the *levator labii superioris* muscle which raises the upper lip, to the *depressor anguli oris* which is a lip corner depressor, to the *incisivii labii superioris and incisivii labii inferioris* that make the lips to pucker and to the *orbicularis oris* which tightens the lips. Maybe it is not possible to install so many actuators in the area of the mouth, but even if only one more fits, the difference will be notable. Another addition could be to make the already installed actuators operate independently. This will be like doubling the already existing actuators. The price to pay for natural facial expressions is increased complexity and more tasks for the operator.

Extending this work with the E-R model, we have the opportunity to test various approaches to emotion (basic emotion approach, appraisal approach, commonsense approach) by simply changing the direction of the relationships and by picking appropriate verbs to ask our queries. A reverse process of what we have done, can map a route for further development of android faces. The life-tasks will be the stimulus and the responses will be about facial expressions.

The expectation that robots will eventually become parts of our society has brought discussions of societal consequences and reactions to robots. Through this study we hope to have made clear that advances in robotic technology can only help us "know thyself", provided that we also follow the other phrase that was carved in Delphi stating "Nothing in Excess".

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