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Integration of Emotional Assessment into E-Health Care Delivery: For Autism Spectrum Disorder: A Review

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Abstract
The deployment of emotional assessment into electronic healthcare is gradually finding its way into healthcare domain especially for people with autism spectrum disorder because of their inability to relate their feelings or emotions with people around them or their environment. Therefore the integration of emotional assessment for treatment of Autism Spectrum Disorder (ASD) patient will help improve the understanding of their emotion when feedback to them. This paper is to provide an overview of the state-of-the-art on the subject of emotional assessment in affective computing (AC) incorporated into electronic healthcare technology. The overview includes the basic terminologies and definitions, a survey of existing technologies and recent advancement in the field of Affective computing i.e. affective/emotional technology, the modalities used in gathering data to detect the emotional state of an individual suffering from ASD, e-healthcare delivery and finally, inclusion of emotional assessment in e-healthcare system. This paper also offers a comprehensive number of references for each concept, methods, and applications in the emotional detection in e-healthcare delivery.

1. Introduction

ASD covers a set of developmental disabilities that can cause significant impairment across several areas of functioning but general term will not describe all individuals with autism perfectly, because there is a saying, that if you have met one autistic child, you have actually met one, it cannot be generalize as each child suffer from different challenges. They are often called the “triad problems,” the essential features of autism include impaired communication (verbal and gestural), social interaction, and behavioural variability (i.e., restricted and repetitive pattern activities) that appear in the first 36 months of life ([1], [2]). Research shows that the prevalence rate of ASD in recent years rapidly grows at an alarming rate. In 2014, Centres for Disease Control and Prevention (CDC) in multiple communities in USA showed that about 1 in 68 children were identified with ASD [3]. Statistics also shows that in Nigeria, over 1.2 million citizens are with ASD; children and adults in Nigeria are diagnosed with different forms of Autism [4].

As a result of increase in diagnosed cases of ASD, software and hardware dedicated to persons with autism have been developed for several decades. These solutions reinforce ASD sufferers’ strong points and work on their area of challenges, helping them to increase their social communication and vocabulary skills by professionals. With advancement in technologies, studies have shown a chance of having a closer look at the world of autism, prompting a better understanding of ASD sufferers' emotional state and mental state, helping them to develop skills in emotion awareness. This review is therefore organised in the following sections: Firstly, definition and terminologies of Emotional technology in Affective Computing (AC) is analysed. In the next section, review of affective robot, interactive tools for assessment of ASD, recent advancement in emotion technology, an overview of the leading e-health care systems technologies in healthcare domain and also emotional integration in e-healthcare system majorly for ASD patients are provided. The final section offers conclusions on the analysed studies.

2. Affective Technology

The use of emotional understanding using computers becomes an integral part of Affective Computing which is a young field of increasing importance that combines engineering and computer science with other disciplines, such as psychology, sociology, education, cognitive science, and neuroscience. It is also apparent that humans, while extremely good at feeling and expressing emotions, still cannot agree on how they should best be defined [5] especially those with emotional disabilities. Emotion is an aspect of Human Computer Interaction that is the last and the least explored frontiers, which explained the fact that computers are viewed traditionally as logical and rational tools that is not compatible with the seemed illogical nature of emotions [6]. Some of the generally desirable or expected abilities of affective technology would include user affect detection and interpretation, system affective state synthesis and expression, and the ability to influence user. A number of research studies have been verified when improved measurement of specific physiological signals came to light. Generally, emotions are short-term, whereas moods are long-term, and temperaments or personalities are very long-term [7]. Furthermore, the physiological muscle movements, comprising what looks to an outsider to be a facial expression, may not always correspond to a real underlying emotional state. Emotions and human's psychological situation generally affect behaviour and reactions. Thus, if some emotion is detected that in some way may affect the behaviour of the ASD people, then the observer will be able to provide him with additional advice and guidance, preventing some reaction of the user that would be fateful.

There are three basic types of system applications using AC according to Picard ([6], [8]): emotions detection system, emotion expression system, and systems that "feel" an emotion (Affect sensing). A wide variety of applications that are based on AC have been and are still being developed in diverse domains, such as cognitive training, e-learning, gaming, health, music, virtual reality and driving.

2.1. Emotion Detection Methods and Techniques

The measurement of human emotion plays a crucial role in AC. Howbeit, due to the complexity of emotion detection, labelling of emotions into different states as led by various researchers use pattern recognition approach for recognising emotions, using different modalities as inputs through Audio (speech) & Visual (facial expression, body gestures and postures) to the emotion recognition models as well as explicit internal physiological changes via Sensor, such as skin temperature, blood pressure, heart rate, respiration, and sweating. As defined by Ekman (FACS) in automatic understanding of affective state focused on classification of basic emotion of the universal expressions [9] anger, disgust, fear, joy, sadness, and surprise. Communication is realised through multimodal sensing and expression of affect i.e., fusion of the different modalities into one emotion channel. The most prominent techniques are based on one or more of the following measurement of modalities:

2.1.1. Facial Expression

Detection techniques are based on the assumption that there exist distinctive human facial expressions associated with each of the basic universal emotions [9]. The computer needs to be empowered to recognize human facial emotions as well as being able to express them. There are various techniques used for the detection and recognition of facial features and expressions, some are briefly review below:

In 2013, [10] focused on the analysis of principal facial regions using principal component analysis and neural networks, the classifiers were built in a group of fifteen (15) neural networks. Only one ANN into this group was used for region detection and the other fourteen were used in learning to recognize seven universal emotions over eyes and mouth regions. Their conclusion was that, the conducted experiments showed a 46% to 80% rate of successful recognition that was reduced to the average precision of 70%.

The ANN can be reinforced with the use of hybrid approach, in the work of [11], the ANN are often combined with Hidden Markov Models (HMMs) and is employed in facial emotion classification. This analysis used an ANN to estimate the posterior for the discriminant HMM, and it achieved positive results on the recognition of emotion in the upper and lower parts of the static image separately.

In [12], they focuses on a system that recognizes human's emotion from a detected human's face analysing information conveyed by the regions of the eye and the mouth into a merged new image in various facial expressions pertaining to six universal basic facial emotions (happiness, sad, fear, disgust, anger, surprise). The output information obtained was fed in to machine capable of interacting with social skills, in the context of building socially intelligent systems. They employed classification technique of feed-forward neural network trained by back-propagation. It is shown by their experimental results that the algorithm can detect emotion with good accuracy.

In 2015, [13], carried out an experiment on a system which automatically recognizes the emotion represented on a face using Bezier curve based solution together with image processing in classifying the emotions. Their experimental results show average 60% of success in the analysis and recognition of emotion detection.

Gaurav [14] presented a study on using Principal Component Analysis for facial expression detection; 3 training images and 6 testing images from each class of expression and decreasing the number of testing images from 30 subjects with different expression database was used.

The artificial robots or virtual human characters (avatars) that can mimic the human facial expressions has been used in various studies as emotionally-expressive avatars have also been used in therapies and learning experiments for autistic people [15] with the ability of the computer to respond to user frustration by expressing empathetic emotions through facial expression of an avatar.

2.1.2. Body Language and Posture

Posture-based affect detection has been widely used. Many studies have been carried out to describe how specific body features may be used to recognize specific affective states. Some researchers have focused on assessing only a reduced set of basic emotions, in a manner similar to that used in the facial expression technique, in order to simplify the posture-based affect detection process ([8], [16], [17]).

2.1.3. Emotional Vocal Expressions

This detection technique relies on recognizing emotions through the affective information transmitted in speech or other utterances that include García-Betances, Fico, Salvi, Ottaviano, & Arredondo any type of vocalization [18]. Recognition of emotion in speech is one of the key disciplines in speech analysis for next generation human–machine interaction. The transmission of affect is communicated through the message said and through the non-verbal paralinguistic features of expression such as speech, tone, pitch. They have been used for the decoding of affective signs beyond basic emotions, such complex emotions as stress, depression, boredom, and excitement [8].

Research into emotionally expressive speech is very significant for people with Autism Spectrum Disorder. Inspite of normal early language development, individuals with ASD are often characterized by abnormal prosody and impaired semantics and pragmatics as well as poor social skills and emotional behaviour [8]. Javier et al. [23], conducted a research which was to perform parameterization of audio data for the purpose of automatic recognition of emotions in speech and evaluated six different kinds of classifiers to predict six basic universal emotions from non-verbal features of human speech. A collection of audio data from several videos related to human emotional expressions were gathered and turned into a data set. The classification techniques used information from six audio files extracted from the eNTERFACE05 audio-visual emotion database. Their best results are obtained by MLP, BN and polynomial SVM with degree 2.

In [21], focused their research on speaker dependent-problem, they compare a large set of machine learning algorithms, ranging from neural networks, SVM or decision trees using large database of thousands of examples they presented an algorithm that allow a robot to express its emotion by modulating the intonation of its voice.

2.1.4. Physiological Changes

The measuring of physiological data or signals is possible through the recognition of emotion reaction that constitutes a direct information channel for emotion. Some AC systems already use physiological signals to identify different emotions and to detect patterns that correspond to the expression of a particular emotion. Methods that use physiological data or signal recognition usually are included within what is referred to as machine learning techniques ([8], [17], [22]). Several non-invasive measurements can be acquired by recording electrical signals produced by the brain, heart, muscles, and skin [16]. These measurements can be obtained through wearable sensing devices or through devices embedded in the surrounding environment or swallow-able pills. The signals that has been used for emotion recognition include electromyogram (EMG), electrodermal activity (EDA), electrocardiogram (ECG), and electroencephalography (EEG), as well as some other more recent techniques in the field of neuroimaging ([8], [22], [23]). They are briefly discussed below:

(i). Electrodermal Activity (EDA)

It is also referred to as skin conductance activity because of the underlying principle of measurement. EDA describes alterations in skin's ability to conduct electricity that occurs due to interactions between environmental events and an individual's psycho-physiological state. It is more related to sympathetic autonomic nervous system activity that innervates the eccrine sweat glands; and has been associated with measures of emotion, arousal, and attention (Handbook of psychophysiology, 2000). The EDA reading is typically characterized by two components: a tonic baseline level and short term phasic responses superimposed on the tonic baseline level. Phasic responses (momentary increases in skin conductance) determine the event-related responses that occur in an individual, due to environmental stimuli. A stimulus may be anything from a thought burst to a deep sigh. EDA is one of the fastest, most robust and well-studied physiological measures. It has been previously employed in assessing the response of autistic children in therapy. Traditional electrodermal measurement tends to be more difficult for children than for adults due to difficulties with the application and tolerance of the sensors with the wires attached to different part of their body. Moreover, children with ASD may have difficulties with comprehension, high sensory discomfort, and behavioural noncompliance that represent challenges to the feasibility of traditional EDA measurement. A recent development is wireless wearable wrist sensors that approximate the size and appearance of a watch ([24], [25]) and can be worn continuously during naturalistic laboratory tasks, thus allowing the integration of EDA data with behavioural observations of emotion. A pilot study, for example, was conducted for children with ASD in which the wrist sensors are used to track arousal across a series of naturalistic and structured parent–child and child alone laboratory tasks [26]

(ii). Electromyogram (EMG)

An electromyogram (EMG) measures the electrical activity of muscles when they're at rest and when they're being stressed. It refers to the muscle activity or frequency of muscle tension of a certain muscle. Muscle activity has been shown to increase during stress. Firing from the muscles in a state of fatigue or mental stress could indicate unconscious clenching due to stress [27]. Nerve conduction studies measure how well and how fast the nerves can send electrical signals to control the muscles in the body with electrical signals is called impulses.

(iii). Electrocardiogram (ECG)

The ECG records the electrical activity generated by heart muscle depolarization, which dissipate in pulsating electrical waves towards the skin. ECG signal is the manifestation of contractile activity of the heart. Heart activity is a valuable indicator of the individual's overall activity level. It can be picked up reliably with ECG electrodes attached to the skin. For example heart rate accelerations occur in response to exercise, emotional states, loud noises, sexual arousal and mental effort [28]. Lower heart rate is generally associated with a relaxed state or a state of experiencing pleasant stimuli.

(iv). Respiration

Respiration is an indicator of how deep and fast a person is breathing. Emotional excitement and physical activity are observed to lead to faster and deeper respiration [15] Peaceful rest and relaxation lead to slower and shallower respiration. A state of stress would therefore be indicated by frequent respiration; however, sudden stressors such as startle tend to cause momentary cession of respiration.

(v). Photo Plethysmography (PPG)

Throughout the cardiac cycle, blood pressure throughout the body increases and decreases even in the outer layers and small vessels of the skin. Peripheral blood flow can be measured using optical sensors attached to the fingertip, the ear lobe or other capillary tissue. While not as accurate as ECG recordings, PPG clips use dry sensors and can be attached much quicker compared to ECG setups, making their use easier and less bothersome for participants.

2.2. Multimodality

As already mentioned, affect recognition can involve the integration of different modalities, such as facial expression and gesture, vocal emotion recognition, as well as a variety of physiological signals. In some cases, the information obtained by any technique on its own is ambiguous, unreliable, or does not exactly match the user's real emotions. In addition, some emotions can be manifested simultaneously via multiple modes. For example, anger can be expressed by facial, vocal, gesture, and physiological changes. Audio and visual-based emotion analysis and processing as well as to compare the relative merits of these two approaches to emotion recognition and to determine to what degree the fusion of these two approaches is achievable and helpful. As a result of this, some studies have proposed a technique called multimodality, which integrates information obtained from several modalities and methods. A process of merging EMG signals from the face, ECG data, respiration rate, and skin conductivity has been used to identify emotional states of individuals with diverse challenges in health domain in the likes of Huntington's disease, Parkinson's disease, and Autism Spectrum Disorder etc.

Multimodal Fusion

The euphoria to recognize human emotions plays a major role in applications ranging from HCI and entertainment to psychology, education and even in health domain. Emotion recognition is a key first step in enabling affective functionality. The current trends in technology used in recognizing emotion depend heavily on multimodality, utilizing data fusion and classification of physiological signal analysis, vocal expression, and facial expression body gesture and posture analysis.

Human communicate via many non-verbal channels such as facial expressions, voice characteristics and bodily gestures. We hypothesize that fusing information from various modalities in affective computing increases performance over single-modal approaches in many applications. In addition to externally observable affective behaviour patterns, physiological signal can also be utilized. Physiological signals that we have used include central nervous system signals (EEG) and autonomic nervous system (sympathetic and parasympathetic; heart rate variability, EDA). The combination of modalities such as facial videos, voice recognition and physiological signals by using machine learning techniques for classification of emotion such as support vector machines (SVM), k-Nearest Neighbour (k-NN), Neural Networks, linear discriminant etc.

The importance of fusing multimodal signals including physiological as well as visual and audio sensors cannot be underestimated. Such fusion offers the possibility of a better understanding of the emergence of emotional states from the interplay of their behavioural and physiological constituents, as well as a better understanding of children's emotional interaction and development.

2.3. Affect Sensing

The ability to sense a person's affective-cognitive state is the first step in mindreading. Despite many advances in brain imaging, there has not been any technology in existence that is capable of reading innermost thoughts and feelings and communicate this to another. However, there are a growing number of portable sensors that can capture various physical manifestations of affect. These novel sensors are like perceptual mechanisms as discussed above. Although they started off as bulky, affective "wearables" are now embedded in jewellery or woven into clothing [29]. Affective wearables are different to existing medical devices that measure similar signals, in that the wearer is in control. Affect-sensing swallow-able pills measure hormone and neurotransmitter levels and then send the measurements wirelessly to on-body portable devices; new implantable and swallow-able sensors are already in progress, exploiting Nanotechnology. If the primary deficit in autism is indeed one of integrating information at a global level, it is easy to imagine how theory of mind or empathy would suffer. This is because different affective modalities often complement each other, or substitute for each other when only partial input is available, or may contradict one another as in deception.

Many individuals with ASD prefer to communicate with and through computers because they are predictable and place some control on the otherwise chaotic social world [30]. Affect sensing and affect recognition are technologies that are readily applicable to autism interventions. They can help increase self-awareness, and provide novel ways for self-monitoring. Technology may augment people's capacity to empathize and improve their people intuition (typical or atypical persons) in at least three ways: increased self-awareness, improved communication with others, and better social learning. For instance, a wearable system that continuously measures stress or anxiety signals can help the wearer monitor and regulate arousal, creating self-awareness and encouraging people to change perspectives in situations of over or under arousal. Another application is a personal anger management wearable system that would detect states, such as anger, and attempt to calm the wearer, perhaps even through empathizing verbally with the wearer [31]. Technologies that sense various aspects of the person's affective and physiological state can be used for self-monitoring. Affect sensing and emotion recognition technologies used development approach and a user-centred design and to ensure that individuals with autism and their caregivers are involved in the development phases of intervention technologies that is needed the most.

3. Interactive Tools for Assessment of ASD

Nicolas [32], stated that Information and Communication Technologies (ICTs) can compensate and support education of students with special needs, and particularly people with ASD. ICTs make it possible to create controllable predictable environments; they offer multisensory stimulation, which is normally visual; they foster or make it possible to work autonomously and develop the capacity for self-control and are highly motivating and reinforcing [33], encouraging attention and lessening the frustration that may arise from making mistakes [34].

With new technologies, one are able to get a closer look at the lonely world of autism, prompting a better understanding of ASD sufferers' mental state and helping them to develop skills which would not be possible without the subject-technology interaction [35]. Specialist literature contains numerous reviews of studies including technology as support and help tools, proving the benefits of their use [36].

In [35], an extensive review of the interactive technologies that have been developed to support the interaction of ASD patient was analysed. Recent ICT applications in autism include the use of interactive environment implemented in computers and special input devices, virtual reality, avatars. Several researcher developed virtual environment aiming to stimulate people with Autism Spectrum Disorder in social and different exercises such as Brain-Talk [37], a café and bus interaction among adolescents [38], recognising body language and facial expression in avatars, communication in cafeteria, interaction in birthday party, learning to cross [39], emotion recognition in avatar, interpreting emotions and causes of the emotions [40] and educational games provided by Kinect [41].

The use of interactive technology helps in improving the life of people with ASD in different areas where they have been challenged according to literatures since the technologies use developmental approaches and they are user centred. The application of technology produces great impact in the lives of autistic patients and their caregivers when properly applied.

3.1. Dedicated Application

Several software applications have been developed to facilitate communication for people with ASD. In 2011, e-Mintza was developed to easily adapt to user's needs [42]. Zac-Picto is also a tool developed to assist professionals and parents to work with autistic patients, providing a visual organiser enabling organisation and structure of communication space through social network for the carers of patients with autism: be it therapists, parents or teachers ([43], [44]). Let's Talk! is a design which enables communication by selecting images and sounds from programme ([45], [46]). Emotion recognition skills [47] computer games was developed to explore prosodic focus and linguistic components of spoken phrases [48] learning about colours etc.

3.2. Affective Robot

Individuals with ASD have special challenges in the areas of social communication, social interaction, and repetitive behaviours. From an affective perspective, individuals with ASD often have difficulty recognizing emotions in others and sharing enjoyment, interests, or accomplishments, as well as in interpreting facial cues to decode emotion expression. Many individual with ASD also indicate interest for routines, indicating that the uniform, predictable interactions offered by translational applications such as embodied conversational agents and robotics may also be particularly beneficial for these individuals (either children or adult). This section reviews recent studies on translational applications to facilitate the socio-emotional development of children with ASD through the use of agents and robots.

There is great promises in the use of conversational agent (embodied) applications for individuals with ASD that are yet to be explored. Activating self-recognition and expression of emotion in ASD patients, systems might detect facial and physiological signals in individuals with ASD prompting them to report on their emotional experiences by mapping out their emotional experience to sample emotional faces in affective robots or agents such as avatar. Diverse research groups have understudied the response of individuals with ASD to both humanoid robots and non-humanoid toy-like robots in the hope that these systems will be helpful for understanding affective and other challenged areas seen in individuals with ASD utilizing robotic systems to strategically build a novel interventions thereby enhancing existing treatments/therapy for individual with ASD [49]. There are studies that analyses the behaviour of patients with ASD in response to robots designed to work on areas affected by this disorder. Research has significantly shown that ASD patients relate well with robots because of their predictability and they interact with people in a simple manner [35] unlike in real world. Different studies that aim to analyse the behaviour of autistic patients when interacting with robots equipped with social capacities used in therapies ([50], [51], [52]) real time tracking to adapt and generate reinforcement and message through head movement by robot [53]. According to [35], it was observed that social robots and virtual reality are the most interactive technologies to improve communication and interaction because they focus on engaging the users or participants in social situations they are capable of relating with.

However, effectiveness in ASD intervention, efficient therapeutic approaches to robot systems should be given the capability to perceive the environment (through its vision) and users' behaviours, emotional states (through physiological sensors), and activities. Systems capable of such adaptation may ultimately be utilized to promote meaningful change related to the complex and important social communication impairments of the disorder itself. Although hope is not dashed as sophisticated clinical applications of adaptive robotic technologies may demonstrate meaningful improvements for young individual with ASD, but it is of importance that great difficulty will be encountered to constitute sufficient intervention paradigm addressing all areas of challenges for individuals with these disorder. However, more sophisticated multi-skilled specialized adaptive robot with meaningful effects on skills crucial to neurodevelopment sufferers should be built to discern the intervention that could be used for each of the individuals with ASD, since each of them does not suffers from the same impairment of disorder.

4. Recent Advances in Emotional Technology

A truly intelligent computer cannot be built without having emotional intelligence. The intelligent agents are expected to monitor own and other's emotions, to identify difference in emotions labelling them appropriately, and to use emotional information to guide thinking and behaviour. Researchers have provided perhaps the most relevant approach to this concept, and define it as the ability to perceive accurately, appraise and express emotion; the ability to access and/or generate feelings when they facilitate thought; the ability to understand emotion and emotional knowledge; and the ability to regulate emotions to promote emotional and intellectual growth. Emotions are fundamentally about action that allows people to react to significant stimuli in the environment or within themselves, in complex patterns of behaviour involving various mixtures of multimodalities. Recent advances and opinions suggest that the ability of an intelligent assistant to understand the emotional state of those they are dealing with, which could be a key factor to helping such individuals improve skilfully on their way of lives.

4.1. Pervasive Computing

Pervasive computing technologies have the capability to support patients with autism and their caregivers. Pervasive computing infrastructure provides location-based applications and delivers context-aware services to nomadic users. It works continually to aid record collection and analysis, decision making, communication, and assessment of patient's internal states. The major challenge with autistic patients is their inability to communicate when they are upset or uncomfortable with something, however, pervasive computing might create awareness for caregivers to sense when a child is upset. A defining characteristic of children with autism is stimming (self-stimulatory behaviour), that may include rocking, hand waving, clenching of the fists, or non-word vocalizations. It has been stated by some researchers that the amount of stimming might indicate a child's affective state [54]. Monitoring stimulatory behaviour might give caregivers a better idea of treatments' effects or when the patients' right can be most receptive to learning. Recent research has shown technology to be a means for detecting self-stimulatory behaviours using wireless body-worn sensors. A proof-of-concept system capable of collecting data from patients with autism and providing automatic indices into that data to aid researchers' analysis of autism [55].

In the study, wireless Bluetooth accelerometers was used to gather data minimizing the number of sensors needed for as many stimming behaviour as possible, three accelerometers were fixed to the subject's thigh, waist, and wrist using Velcro straps using the Georgia Tech Gesture Toolkit for recognition experiments. Their results showed that automatic indexing into data is possible. Even though accurate detection of stimming event was discovered, labelling the type of behaviour correctly was not known [56].

Clearly, there is added-value in both applications and services to those users if they can be customised and/or personalised to each user. Such customisation can be achieved by transmitting immediate personal information to the infrastructure, adding expressed preferences stored in a user profile, and delivering services according to user-defined policies. It is evident that users are willing to trade personal information in return for value-added services. Increasingly, though, as the sensor technology improves, physiological signals, from galvanic skin response to brain activity (via electroencephalograms) will be a type of personal information traded in return for such services.

4.2. Ambient Technology (AmT)

According to Raffler's definition [57], ambient technology is "a digital environment that proactively, but sensibly, supports people in their daily lives." Ambient Intelligence incorporate the Networks, Sensors, Human Computer Interfaces (HCI), Pervasive Ubiquitous Computing and Artificial Intelligence (AI) resources to provide flexible and laying emphasis on the enrichments on the environment acting intelligently. The fundamental reason behind AmT is that empowering an environment with technology such as sensors technology and devices interconnected through a network [58], systems can be developed to intelligently take decisions enabling the user to be at an advantage of that environment based on real-time information gathering and historical data in the data warehouse. The capability of the AmT to identify the user, learning or knowing the health status can activate exhibition of empathy with the user's mood and current situation, from the data gathered from the user's environment. AmT also, brings about Smart Homes, enabling technological development enhancing the trend of bringing the healthcare delivery system to the patient as opposed to the traditional health care delivery system such that sensor technology are deployed into the homes enabling information gathering through different sensors in that home. One of the expected benefits of this technology is the increased in monitoring lifestyle patterns or the latest activities and providing assistance when a potentially harmful situation is acclimating.

5. E-Health Care Delivery

E-health care is one of the areas that have received great attention by the AC field. Internet-based communication technologies have enabled patient monitoring status and more [59]. Communication between the caregiver and the patient through emotional channels in such environments has shown to be of vital importance to the patient [60]. The concept of e-health can be originally traced to the possibility of medical care delivery to people, reducing physical barriers such as geographic location from health practitioners. E-Health (also written as eHealth) is a relatively recent term for healthcare practice supported by digital technologies and telecommunications, such as computers, the internet and mobile devices, to facilitate health improvement and health care services.

The World Health Organization defines eHealth as 'the cost-effective and secure use of information and communications technologies (ICT) in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research [61]. Research have shown systematic review of the term's usage, offered the definition of eHealth as a set of technological themes in health today, use of e-Health is often used alongside traditional "off-line" (non-digital) approaches for the delivery of information directed to the patient. Example of such is the e-Health platform that involves different accessibility to various health resources, health education and health administration. There are different types of eHealth namely: Electronic Health Record, Health informatics, Telemedicine, Telehealth, Clinical decision support system, Health Knowledge Management, Virtual healthcare team, mHealth, Clinical health IT e.t.c

E-Health requires a strong and reliable broadband connection infrastructure which includes wires, cables, microwaves and optic fibre, for signal transmission that must be maintained for the provision of quality health services. Historically, this has cost providers or patients out of the service, but as the infrastructure improves and becomes more accessible, telehealth usage can grow. E-Health service delivery can come within four distinct domains namely, live video (synchronous), store-and-forward (asynchronous), remote patient monitoring and mobile health.

i Live video involves a real-time two-way interaction, such as patient/caregiver-provider or provider-provider, over a digital (i.e. broadband) connection substituting face to face meeting to consults which saves time and cost in travel.
ii Store-and-forward involves gathering, recording, and forwarding of data to the telehealth service provider.
iii Remote patient monitoring includes patients' gathering and transferring of medical and health data to a provider elsewhere that continuously monitor the patient's data especially for cases that requires on-going care such as rehabilitation, chronic care, or elderly clients residing in their own homes.
iv Mobile health includes any health information, such as education, monitoring and healthcare that is supported by mobile communication devices such as mobile phones or tablet computers. This might include an application, or text messaging services like appointment reminders or health alarm warning systems.

A study was carried out comparing outcomes of data and costs for implementing evidence-based Applied Behaviour Analysis (ABA) procedures to reduce problem behaviour by using 3 service delivery models: in-home therapy, clinic-based telehealth, and home-based telehealth. The service delivery models trained parents to conduct Functional Analysis (FA) and Functional Communication Training (FCT) to their children [62] it was concluded that the delivery models are effective and the home-based telehealth was the most cost effective.

Hepburn et al. in [63], conducted a pilot study on telehealth delivery of cognitive-behavioural intervention to youth with autism spectrum disorder and anxiety. This study is motivated by the challenges of youth with ASD frequently experience significant symptoms of anxiety with limited access to the available intervention especially for families in rural areas. The primary objective is to examine the feasibility and preliminary efficacy of a tele-health version of an evidence-based approach to anxiety intervention for youth with ASD. In order to examine the feasibility of a preliminary efficacy of a telehealth, the multi-family treatment model of the FYF program was implemented, a platform that allowed for up to six simultaneous users were used. The screen configuration included a window for each of the participating families and therapists; webcams and either headsets or built-in microphones, each parent and child at each participating home could hear and see every other dyad. This work is limited due to the fact that the sample size was quite small and generalization of findings is limited by the relatively narrow range of participant characteristics described.

Another telehealth system which has given optimal results in this field is the one developed by Parmanto *et al.* in [64]. The system included videoconferences, recordings, images and videos, *etc.* facilitating face to face assessment of persons with ASD without having to go to therapies or clinics, or travel a distance for appointment with specialist.

6. Emotion Integration in E-Healthcare

Emotion consists of more than its outward physical expression especially for people challenged with Autism Spectrum Disorder; it also consists of internal feelings and thoughts, as well as other internal processes of which the person experiencing the emotion may not be aware. This has prompted researchers in the engineering and computer science field to develop automatic ways for computers to recognise emotions.

In [65], they provided a redesign of therapeutic process for ASD patients tailored along EDA measurement obtained during therapy session from the EDA sensor attached to the patient’s body, the measurement gave insight in to the redesigning of the therapy processes. From these generated insights, therapists were able to directly design better therapeutic process for the children. Limitation: is that result is specific to each patient. Also, it is not enough to classify emotion based on EDA measurement alone.

In [66], they built an integrated platform for the affective assessment of individuals based on the utilization of the latest technology advances in biosensors, medical wearable devices and systems, signal processing and decision support techniques that classifies the subject's basic emotions (into one of the pre-defined emotional classes) using the outcome of the feature extraction module, communication standards, security mechanisms, and facial muscle activity representation. The classification into predefined emotional classes was achieved using Support Vector Machines (SVM).

Lisetti and LeRouge in [67] conducted a study, developing a model of user’s emotions (known as MOUE), investigating the input processing the patient’s sensory modalities via visual, audio and kinaesthetic (V, K, A). Also, they investigated, based on the integrative exploration to offer the healthcare provider with an easy-to-use and useful assessment of the patient’s emotional state in order to facilitate patient care, they proposed to expand how emotional state assessments influence responses from healthcare professionals and how MOUE can be accepted into the healthcare environment with the application of “Wizard of Oz” a computer-mediated communication type studies [68].

In 2003, [69] focused their work on an affective character-based interface that addressed user emotion. In these study ProComp+ unit sensors was used to record subject data, decision-theoretical agent was used to derive emotion from the user physiological input and select response for the Empathic Companion. Visual C++ was used for the physiological interface, deployed HTML JavaScript for Agent control interface.

Current systems facilitate collection of vital sign data remotely, such as ECG, blood pressure, oxygen saturation, heart and breath sounds, verification of compliance with medicine regimes, assessment of mental or emotional state without the need of physical presence by the caregiver.

7. Conclusion

Research has shown that the medical community are aware of the crucial role emotions play in the preservation of human’s mental and physical health. The evolution of AC in the late 90’s has provided the medical practitioners with technologies that helps with better understanding of emotions, recognizing their impact on health, and prescribing new techniques for diagnosis, therapy, and treatment of emotionally-influenced disorder/diseases. Monitoring of patients’ emotional state using physiological signals has been a primary feature of the existent and emerging applications in e-healthcare and ambient assistive living. Advancement in each of the three sub-areas of AC (speech, face and gestures expression, physiology), will yield enormous increase the interest for emotional-intelligent applications in the medical informatics domain. Picard was among the first to propose that emotion could be modelled using the nonlinear sigmoid function. Since then, the affective computing community has come to realize that merely combining or fusing various verbal, non-verbal, and behavioural signals is not sufficient for inferring emotional states.

Furthermore, these signals or variables do not exist in a vacuum. It was said that for inferring, differentiating, and expressing emotional states accurately, researchers must note that these signals are triggered as they intermingle with each other. Through such intermingles, a pattern would then surface to stipulate a particular type of emotion in the likes of fear, anger, surprise, satisfaction, etc. Moreover, activation of these signals is usually triggered by one or more events.

Therefore, the integration of emotional assessment into e-health care domain increases the potential impact on providing quality care for autistic patients, employing multi-modalities to develop an intelligent interface including avatars (able to express emotions), serving as medication reminder, showing empathy to the user raising an alarm system when certain negative emotion is detected, which tends towards helping to bridge the gap or distance between a patient and healthcare provider and patient emotional state monitoring in healthcare context.

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