Journal of Advanced Zoology

ISSN: 0253-7214
*Volume **44** Issue **S-6 Year 2023** Page **757:766***

B.E.S.T: Basic Emotion & Sentiment Tracking

Suman Kalyan Giri[1], Singam Mohit Reddy[2], Shubham Kumar Nayak[3], Suchet Bhakhan[4], Meenakshi Sundaram A[5]

[1,2,3,4,5]*School of C&IT, REVA University, Bengaluru, India.*

Email: itsmeskhere786@gmail.com[1], mohit98.2011@gmail.com[2], shubhamnayak2703@gmail.com[3], suchetbhakhan15@gmail.com[4] , meenakshi.sa@reva.edu.in[5]

**Corresponding author's E-mail: itsmeskhere786@gmail.com*

Article History

Received: 06 June 2023
Revised: 05 Sept 2023
Accepted: 22 Nov 2023

Abstract

The emergence of depression, personality disorders, serious emotional disturbance & social anxiety disorder among children in our modern society is now alarming. Lack of interaction & communication is a major aspect of it. Nowadays, in nuclear family children aren't able to get much of interaction with elders which leaves them most of the time by themselves, this affects their emotional development & expressiveness. So, our primary focus is on development of a system which can be fitted into any preferable or favourite toy which will ease the process of developing a child-toy emotional bond. Later the same will help for tracking of emotion & sentiments as the relation which child develops with the companion toy helps the child to be expressive about his/her thoughts, feelings & day to day events. A subsidiary goal is to improve communication & interaction between child and parents.

Keywords: *Human-Robot Interaction; Child-Robot Relation; Companion Robot; Emotion Tracking; Sentiments Tracking; Face Recognition; Facial Expression*

1. Introduction

Our project idea revolves around the issue of Child Mental Health as this problem has rose in society quite recently as in modern society family size is shrinking as of that children are getting less interaction with elders as they are busy with their jobs. Currently, this issue has become quite serious which leads to loneliness and depression in children which also affects the parent-child relation. Children hesitates to share their problems or sometimes there is no one to acknowledge their problem. All they've got is their friend who is also a kid and has no idea what's going on and how to solve this problem, by the time parents/guardians get to know about some serious problem sometimes it's too late to respond. In such situation we can implement such system where children can interact with their friend or buddy which will make them comfortable and will allow them to open up & share their problems. Every kid has a special toy which kids always keep by their side and sometimes they also talk to it when they feel like sharing something and no one is there to acknowledge it. This toy will allow us to give our system a body with which the child is will be able to develop a bond. By integrating such system inside their favourite toy will help them to develop a better relation between them as child can become more expressive. This will allow parents/guardians to know what their child is thinking and what he/she is doing or is there some issue he/she is facing but not able to tell their parents due to some reason like fear of getting scolded or punished. This system will help to establish a better relation between child & parent. Recently depression, personality disorders, serious emotional disturbance & social anxiety disorder are some common terms used among parents/guardians as it has begun to target a huge number of children or it can be stated that it has been affecting a huge part of our society as it highly depends on life style & daily schedule adapted. Such disorders affect the way children grow mentally & learn things like social behaviour and emotional behaviour which can cause them difficulty to face a regular day to day social interaction among colleagues or family. Moreover, many of these cases can be diagnosed at early ages and can be avoided or cured if proper guidance and support is provided by parents/guardians as allowing proper attention to children & this can draw a

completely new life for children who are suffering. [1][2]. Human beings are social animals, so it is no surprise that social behaviour affects our brains profoundly and is vital for the growth of children. Group events that actively include children from their parents or other children contribute to good brain growth and social skills and are one of the best ways your child learns. Talking to your child personally not only facilitates the development of your brain's language centre, it also allows you to improve learner skills and interactions in your brain [9].

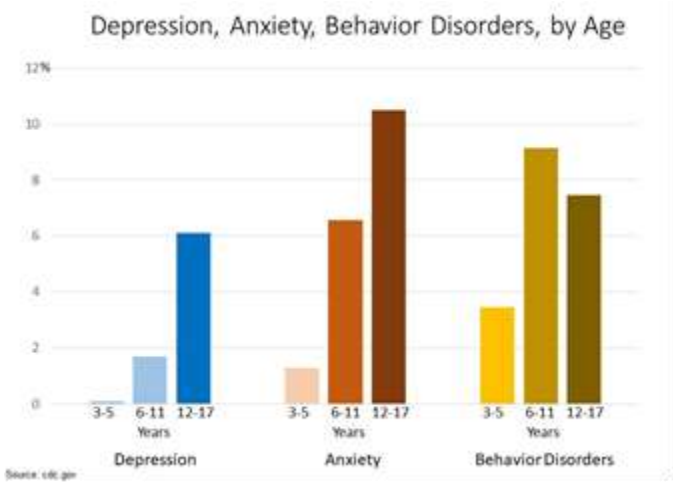

Fig 1: Graph for depression, anxiety & behaviour disorders

From childhood, by their daily experiences, children grow brain associations. They are formed by constructive relationships with their parents and caregivers, as well as through the use of their senses to communicate with the environment. The everyday activities of a small child decide which neural bonds form and which can last a lifetime. It is all about the amount and level of attention, relaxation, and contact they get in their early years. Children who have more supportive relationships with others in their early years grow up to be happier and more competitive in school and in life. Unfortunately, the reverse is also real. Vulnerability to family abuse, and a lack of access to high-quality early childhood opportunities may all have a detrimental effect on a child's early brain growth and, as a result, long-term progress [8].

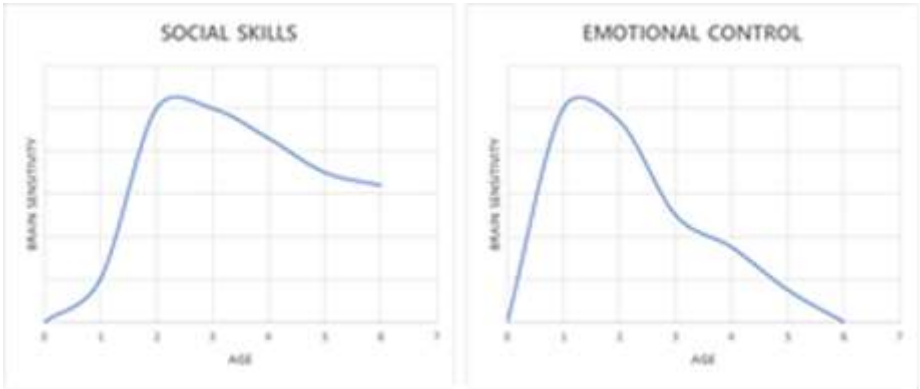

Fig 2: Brain sensitivity with age towards social skills & emotional control

To achieve a title of good companion the system shouldn’t just gather and analyze the surrounding but also it should give relevant responses and feedback. A relation works on interaction from both sides. So, such interactions helps the human counterpart to understand the intensions and beliefs of the companion agent. Such systems are expected to be autonomous and are targeted to communicatez with naïve as well as experts in natural and inherent manner [3][4]. Along with time if the relationship holds well then the relationship evolves from a simple friend/advisor to something more complex like teacher/guardian with this evolving nature it’s really important to track it which we will be allowing parent/guardian to have completely sole autonomous over the interactions made by the system [5]. Personalization of robot is really necessary when it is intended for long-term human-robot interaction. Over time some repetitive interactions with same set of actions and reactions may reduce the engagement factor of robot as the novelty effect passes away with time [6].

A study under Institute for Health Metrics and Evaluation states that in 2019 nearly 798 million people are suffering from some kind of mental health disorder. This figure slightly rounds off to one out of every ten people i.e. 10.3% globally. It is also observed that countries with low income are more likely to ignore the issues regarding mental health disorders [7]. Hence, the following table summarizes the data on some of the major disorders observed globally such as various disorders like eating disorder, anxiety disorder, bipolar disorder, alcohol use disorder, drug use disorder, schizophrenia & depression.

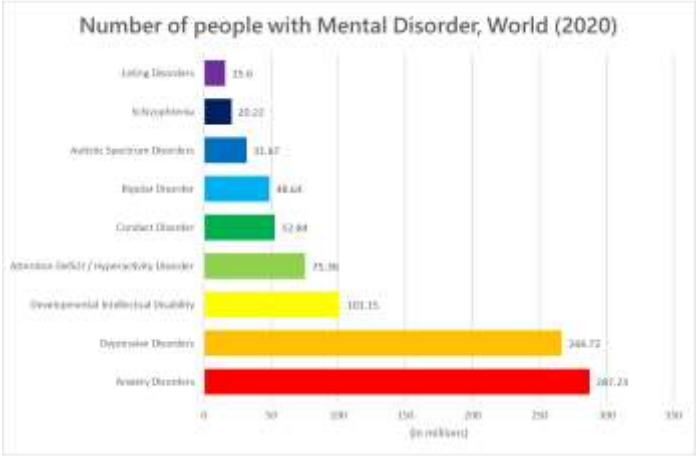

Fig 3: Number of people with mental disorder, World (2020)

So, it is quite evident from the above insights that anxiety disorders & depressive disorders are the most common among people who are facing mental health issues. Hence, following insights will explain regional distribution of disorders.

Fig 4: Percentage of population with Mental Health Disorders, 2020

In the above representation of global distribution of mental and substance use disorders is very high in some countries and moderate in maximum countries & the average turns out to be 15% of people or can be represented as one in every seven persons is suffering from mental or substance use disorder [7].

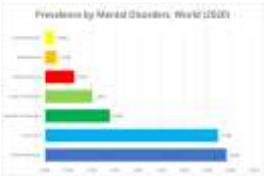

Fig 5: Prevalence by mental disorders, World (2020)

It is observed that anxiety disorders & depression are the highest occurring disorders affecting almost 4% of the population. However, deaths due to mental health and disorders as substance use disorders is negligible only disorders like eating disorders are directly responsible for deaths which occur by malnutrition and other health issues [7]. Anxiety disorders can be observed in various form like obsessive compulsive disorder, phobic disorder or post-traumatic disorder.

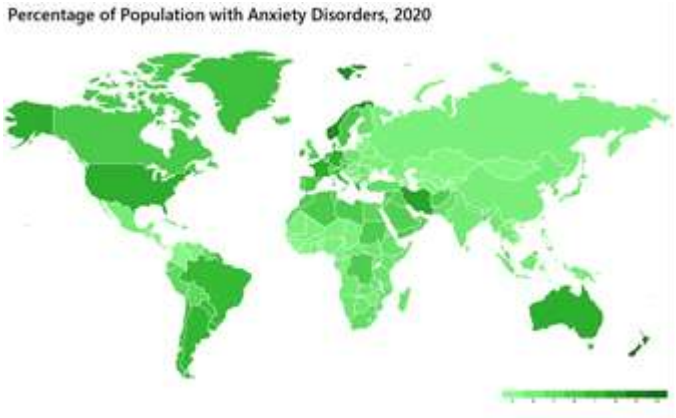

Fig 6: Percentage of population with anxiety disorders, 2020

Hence, observing the insights of most occurring anxiety disorders over different sub-continents around the world with percentage varying from 4% to 7%. Almost 288 million people are suffering from anxiety disorder which ranks it to the top in the table of mental health or neurodevelopmental disorder. As it is also concluded that 66% of this huge number are females [7]. Depressive disorders are also occurring very severely with some specific types involving in it like disaggregation to mild, dysthymia also known as persistent depression and major depressive disorder.

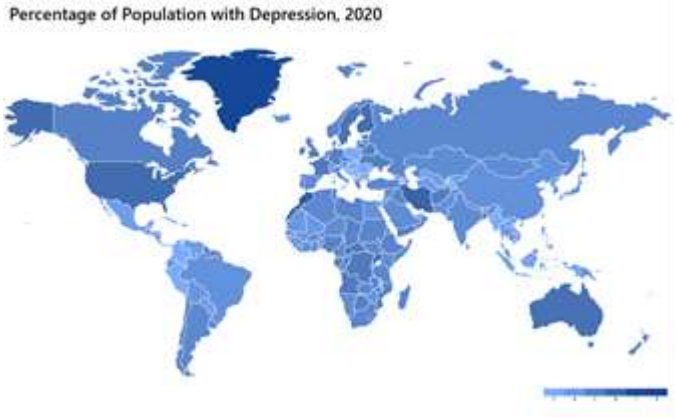

Fig 7: Percentage of population with depression, 2020

The depressive disorder affected population varies between 2% to 6% globally. Hence, it is also important to notice that older people are more likely to be affected by this disorder [7].

Fig 8: Number of people with depression, 2020

Hence, to get better insights about the above representation it is really important to consider the population of various countries as a small percentage may turn out a number in millions. The above representation infers that most of the countries have the depression disorders related cases around 5 to 20 million where as some are exceeding 60 million.

Acceptability of Concept

A robot can play a versatile character in children's daily routine but social adaptation of such robot is highly influenced by its closeness to human like or any other favourable character. Since many prefer robots are suitable to be assigned as Butler rather than a Friend or Guardian [4]. Hence, robots holds a great potential to perform as a play buddy, teacher or can be quoted as a 'Nanny' but there is always strong emotions are related to children so some level of scepticism is experienced when the robot replaces the roles performed by the parents/guardians. So, finally it's well understood that a robot can help parents as aid/companion but can't adopt the roles of them just for the sake of social acceptability [5]. Moreover, it is important to understand that it's always better that the upbringing of a child is done by parents/guardians and their personal involvement is always encouraged. Summoning a child completely to a robot is too much of a risk and there is no space for negligence & error in such jobs.

Goals

BEST's primary objective is to provide a better environment for children by being an always reliable support to them. BEST aspires to build a better understanding & relation between child & parent/guardian. It emphasizes on issues which children might encounter and it is quite difficult for them to express directly to someone other than a friend or someone too close who can fit into their mind set. It encourages child to be more expressive about his/her thoughts & feelings along with it allows parents/guardians to be more involved around their child. The compatibility & easy engagement with environment as a regular toy hosts the system allows children to carry it anywhere with them which helps BEST to stay close to child and be more involved with child to develop a meaningful relationship.

Functionality

A. Encourages Interaction

BEST system tries to invoke a conversation with child whenever it detects his/her presence. This kind of action is required to imitate a simple human gesture termed as greeting. So, a simple greeting message is delivered by BEST system to invoke a conversation as sometimes the child won't promptly prefer to communicate.

B. Understands Emotion

BEST system detects emotion using facial expressions and based on current ongoing conversation. Understanding emotion helps the parents/guardians to understand the situation better and helps them

to react accordingly. Remote monitoring of child's emotion is something which is very useful to decide when child needs special attention.

C. Assists Communication

BEST acts as a helping agent between parents & child to establish a communication whenever physical presence is not possible. It all depends on parents/guardians whether they want to maintain anonymity or they can reveal that they are going to be communication through the toy.

Design

Fig 9: B.E.S.T design

A. Design Goals

- Compact - BEST can fit inside any toy which sizes more than 8'' in height and width.
- Independent System - BEST is just like any other toy but with some extra features which helps it become a better companion.

B. Prototype Components

- Raspberry Pi, it allows the system to be operational on its own without much involvement of external agents.
- Raspberry Pi Camera, to detect facial expression to determine the emotion.
- Microphone, to accept the speech delivered by the child.
- Speaker, to deliver a voice output which is being sent by the parent/guardian.
- Power Bank, to keep the system up and running all the time.

C. Companion Application

This application will be used by parent/guardian to communicate to BEST system in the form of text messages which will be delivered by the toy & it will provide the text feedback from the BEST system which it receives from the child in form of speech input.

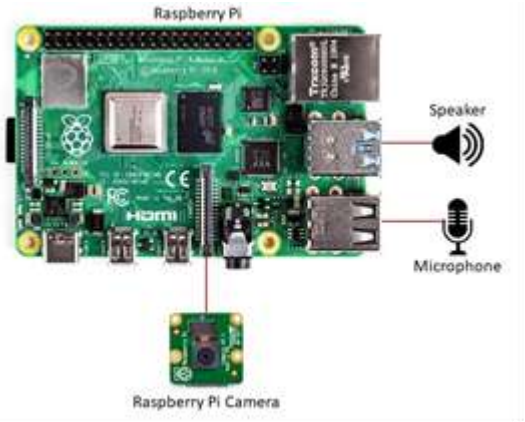

Fig 10: B.E.S.T system

2. Materials And Methods

Emotion Detection

Fig 11: Emotion detection flow chart

By using OpenCV & Haar Cascade Classifier to detect the face & then passing cropped face to the emotion detection model, we obtained real time emotion analysis.

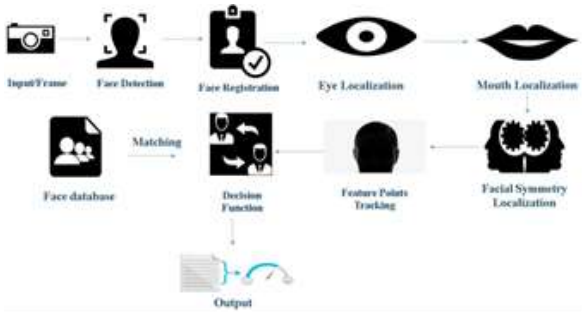

Fig 12: Haar cascade classifier

Fig 13: Emotion detection model

The emotions are being classified into 7 segments i.e. angry, disgusted, fearful, happy, neutral, sad, surprised after the face detected by the Haar Cascade and the cropped face image being parsed by model trained for Emotion Detection.

D. Speech Sentiment Analysis

Fig 14: Speech sentiment analysis flow chart

NLP for Sentimental Analysis of the conversation to detect whether the child needs so special supervision of parent or not. Syntax analysis & semantic analysis are crucial part of NLP as grammatical structure of sentence and how each word is contributing to the context.

Some steps to clean the data obtained and organize the processed text, such as: tokenization, part of speech tagging, stemming and lemmatization, stop word removal.

E. Assists Communication

Fig. 15 B.E.S.T system flow chart

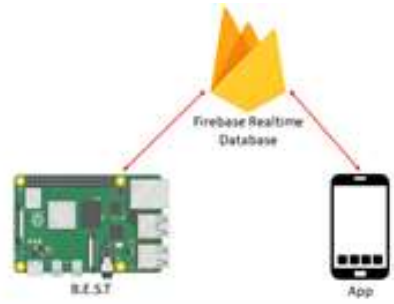

Fig 16: B.E.S.T system communication

Dataset & Model

By using FER-2013 dataset for Facial Emotion Recognition which segments the emotion into 7 segments as angry, disgusted, fearful, happy, neutral. sad, surprised. This dataset contains 28709 training images & 7178 test images which sums up as total of 35887 images.

Table 1: Dataset Contents

Emotion	*Train Images*	*Test Images*	*Total Images*
Angry	3995	958	4953
Disgusted	436	111	547
Fearful	4097	1024	5121
Happy	7215	1774	8989
Neutral	4965	1233	6198
Sad	4830	1247	6077
Surprised	3171	831	4002

By training the model in a 4-layered CNN for 50 epochs following result is achieved.

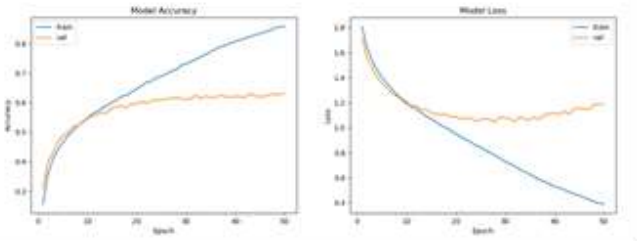

Fig 17: Graph of model accuracy & loss

3. Results and Discussion

Fig 18: Emotion detection result

4. Conclusion

By Inclusion of a screen for more interactive activities like storytelling, learning good habits, etc. which will allow children to spend more time with toy & system can take over many more roles easily. Addition of some safety features for children like GPS location & SOS features.

References:

[1] National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention.

[2] Lindsay Arnold, "EmobieTM: A Robot Companion for children with Anxiety", IEEE 2016.

[3] Hsuan-Kuan Huang, Hung-Hsiu Yu and Yea-Shuan Huang, "A Companion Robot with Facial Expressions and Face Recognition", IEEE 2010.

[4] Kerstin Dautenhahn, Sarah Woods, Christina Kaouri, Michael L. Walters, Kheng Lee Koay, Iain Werry, "What is a Robot Companion – Friend, Assistant or Butler?".

[5] Wafa Johal, Carole Adam, Humbert Fiorino, Sylvie Pesty, “Acceptability of a companion robot for children in daily life situations”, CogInfoCom 2014, 5th IEEE International Conference on Cognitive Infocommunications, November 5-7, 2014, Vietri sul Mare, Italy.
[6] Bahar Irfan, Aditi Ramachandran, Samuel Spaulding, Dylan F. Glas, Iolanda Leite and Kheng Lee Koay, “Personalization in Long-Term Human-Robot Interaction”, IEEE 2019.
[7] Global Burden of Disease Study 2019 (GBD 2019) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2020.
[8] Why Early Childhood Matter, Brain Development, firstthingsfirst.org [Online Resource].
[9] Child Development, Brain Development of Children, adam-mila.com [Online Resource].

[10] Sudhan Murugan Bhagavathi, Anitha Thavasimuthu, Aruna Murugesan, Charlyn Pushpa Latha George Rajendran, A Vijay, Raja Laxmi, Rajendran Thavasimuthu, Weather forecasting and prediction using hybrid C5.0 machine learning algorithm International Journal of Communication Systems, Vol. 34, Issue. 10, Pp. e4805, 2021.
PM Surendra, S Manimurugan, A New Modified Recurrent Extreme Learning with PSO Machine Based on Feature Fusion with CNN Deep Features for Breast Cancer Detection, Journal of Computational Science and Intelligent Technologies, Vol. 1, Issue. 3, Pp. 15-21, 2020.
[11] PK Sadineni, Comparative Study on Query Processing and Indexing Techniques in Big Data, 2020 3rd International Conference on Intelligent Sustainable Systems (ICISS), pp. 933-939, 2020.
[12] AH Omar Baabood, Prajoona Valsalan, Tariq Ahmed Barham Baomar, IoT Based Health Monitoring System, Journal of Critical Reviews , Vol. 7, Issue. 4, pp. 739-743, 2020.
[13] Sajay KR, Suvanam Sasidhar Babu, Vijayalakshmi Yellepeddi, Enhancing The Security Of Cloud Data Using Hybrid Encryption Algorithm, Journal of Ambient Intelligence and Humanized Computing, 2019. https://doi.org/10.1007/s12652-019-01403-1
[14] Bindhia K Francis, Suvanam Sasidhar Babu, Predicting academic performance of students using a hybrid data mining approach, Journal of Medical Systems, 43:162, 2019. https://doi.org/10.1007/s10916-019-1295-4
[15] Vijayalakshmi Y, Manimegalai P, Suvanam Sasidhar Babu, Accurate Approach towards Efficiency of Searching Agents in Digital Libraries using Keywords, Journal of Medical Systems, 43:164, 2019. https://doi.org/10.1007/s10916-019-1294-5
[16] Teena Jose, Dr. Suvanam Sasidhar Babu – Detecting Spammers on Social Network Through Clustering Technique, Journal of Ambient Intelligence and Humanized Computing, pp.1-15, 2019. https://doi.org/10.1007/s12652-019-01541-6