

EMOTIONAL BASED MEDIA PLAYBACK SYSTEM FOR AUTISM

Submitted in partial fulfillment of the requirements for the award of
Master of Technology Degree in Medical Instrumentation

By

SHINY BLESHINA.S (40440008)



DEPARTMENT OF BIOMEDICAL ENGINEERING

SCHOOL OF BIO AND CHEMICAL ENGINEERING

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MAY -2022



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE

www.sathyabama.ac.in

DEPARTMENT OF BIOMEDICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **SHINY BLESINA.S** (Reg. No. **40440008**) who carried out the project entitled "**Emotional based media playback system for autism**" under our supervision from **November 2021 to May 2022**.

Dr.T.SUDHAKAR,M.Sc.,Ph.D.,

Guide

Dr.T.SUDHAKAR,M.Sc.,Ph.D.,

Head of the Department

Submitted for Viva voce Examination held on **11-05-2022**

Internal Examiner

Dr.J.PREMKUMAR

External Examiner

DECLARATION

I **SHINY BLESHINA.S** (Reg. No. **40440008**) hereby declare that the Project Report entitled “**Emotional based media playback system for autism**” done by me under the guidance of **Dr.T.SUDHAKAR**, M.Sc.,Ph.D., Department of Biomedical Engineering is submitted in partial fulfillment of the requirements for the award of **Master of Technology** degree in **Medical Instrumentation**.



DATE : 02-05-2022

PLACE: Chennai

SIGNATUTRE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to **Board of Management of SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to **Dr.T.Sudhakar, M.Sc.,Ph.D., Head of the Department, Department of Biomedical Engineering** for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr.T.Sudhakar, M.Sc.,Ph.D., Head of the Department, Department of Biomedical Engineering** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all **Teaching and Non-teaching** staff members of the **Department of Biomedical Engineering** who were helpful in many ways for the completion of the project.

ABSTRACT

Emotion plays a vital role in determining the thoughts, behaviour and feeling of a human. Autism children find it difficult to interact socially with people's emotions and make themselves isolated. Many autistic children find difficulty in learning. Basically, children with autism are interested in music activities and respond to that. This project proposes Emotion detection for Autism spectrum disorder children (ASD) by using CNN and physiological signal and music plays based upon their mood. Here we capture real time image using webcam and by using convolutional neural network the facial emotion can be predicted and concurrently GSR sensor is directly connected to the user for measuring their sweat gland activity, if both the predicted facial Emotion and GSR sensor is happy, then it will play some Interesting Audio to them using AT mega Microcontroller and mini-Player, which will keep them relaxed and will help them to learn interactively. This proposed system helps to improve Autism children behaviour and their attention towards learning.

Keywords- Autism Spectrum Disorder (ASD), Facial Expression Recognition (FER), Galvanic Skin Response sensor.

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
	ABSTRACT	I
	LIST OF FIGURES	vi
	LIST OF ABBREVIATIONS	v
01.	INTRODUCTION	1
	1.1 AUTISM SPECTRUM DISORDER	1
	1.2 AUTISM AND MUSIC	2
	1.3 FACIAL EMOTION RECOGNITION	2
	1.4 FACE DETECTION	5
	1.4.1 HAAR CASCADES	6
	1.4.2 FEATURE EXTRACTION	7
	1.5 FACIAL EXPRESSION	9
	1.5.1 KERAS AND TENSERFLOW	10
	1.5.2 CNN	11
	1.6 GSR IN EMOTION DETECTION	12
02.	LITERATURE REVIEW	13
	2.1 GENERAL	13
	2.2 LITERATURE REVIEW	13
	2.3 SUMMARY	16
03.	AIM AND SCOPE	17
	3.1 AIM	17
	3.2 EXISTING SYSTEM	17
	3.3 PROPOSED SYSTEM	17

	3.3.1 ADVANTAGES OF PROPOSED SYSTEM	18
	3.4 SCOPE OF STUDY	18
04.	MATERIALS AND METHODS	19
	4.1 HARDWARE COMPONENTS	19
	4.1.1 ARDUINO MEGA 2560	19
	4.1.2 DF MINI PLAYER	20
	4.1.3 GSR SENSOR	21
	4.1.4 NODE MCU-ESP8266	22
	4.1.5 LIQUID CRYSTAL DISPLAY	23
	4.2 SOFTWARE USED	24
	4.2.1 ARDUINO IDE	24
	4.2.1 PHYTHON IDLE	25
	4.3.3 THINGS SPEAK	26
	4.3 PYTHON CODE	27
	4.4 BLOCK DIAGRAM	31
	4.5 METHODOLOGY	32
05.	RESULTS AND DISCUSSION	33
	5.1 RESULTS	33
	5.2 DISCUSSION	38
06.	SUMMARY AND CONCLUSION	39
	6.1 SUMMARY AND CONCLUSION	39
	6.2 FUTURE WORK	39
	REFERENCE	40
	APPENDICES	43

LIST OF FIGURES

FIGURE NO	TITLE	PAGE NO
1.1	MEASUREMENT OF FACIAL FEATURES	4
1.2	DIFFERENCE OF FACE DETECTION AND RECOGNITION	7
1.3	FEATURE EXTRACTION OF FACE MODEL	7
1.4	NON-HUMAN FACE(CAT)	8
1.5	MONKEY SIMILAR TO HUMAN FACE	9
1.6	LAYERS OF CNN	11
4.1	ARDUINO UNO	20
4.2	DF PLAYER	21
4.3	GSR SENSOR	22
4.4	NODE MCU-ESP8266	23
4.5	LIQUID CRYTAL DISPLAY	24
4.6	ARDUINO IDE	25
4.7	THING SPEAK	31
4.8	BLOCK DIAGRAM	32
4.9	METHODOLOGY FLOW DIAGRAM	33
5.1	EMOTIONS FROM DIFFERENT AUTISM CHILDREN	35
5.2	PROPOSED HARDWARE MODEL	36
5.3	OUTPUT ON LCD	37
5.4	OUTPUT OBTAINED ON THING SPEAK	
5.5	DATA DOWNLOADED IN EXCEL SHEET	

LIST OF ABBREVIATIONS

ABBREVIATIONS	FULL FORM OF ABBREVIATIONS
ASD	AUTISM SPECTRUM DISORDER
CNN	CONVOLUTIONAL NEURAL NETWORK
DNN	DEEP LEARNING NETWORK
FEA	FACIAL EXPRESSION ANALYSIS
AI	ARTIFICIAL INTELLIGENCE
FER	FACIAL EMOTION RECOGNITION
PIP	PHYTHON PACKAGE INDEX
GSR	GALVANIC SKIN RESPONSE
LCD	LIQUID CRYSTAL DISPLAY
IDLE	INTEGRATED DEVELOPMENT AND LEARNING ENVIRONMENT

CHAPTER I

INTRODUCTION

1.1 AUTISM SPECTRUM DISORDER

Autism spectrum disorders (ASD) are lifelong, neurobiological developmental disorders that are characterized by impairments in social interaction, communication, and by restricted and stereotypical behaviors. The term ASD will be used to refer to autistic disorder, Asperger syndrome, and Pervasive Developmental Disorder not Otherwise Specified (PDD-NOS). Prevalence estimates of ASD have been considered to be around 1% , but are rapidly increasing. This increase in prevalence of ASD has been attributed to broader ASD diagnostic criteria, lower age at diagnosis, greater public awareness, and environmental components (e.g., toxic chemicals and gene mutations) (Fombonne, 2009; Matson & Kozlowski, 2011). In order to create a homogenous group this thesis is focused on a sample of high functioning children with ASD (HFASD). This should confine our insights to the consequences of this disorder on children's functioning without other confounding variables such as intelligence impacting on this relation.

Although not officially classified, emotional impairments are part of the characteristics of ASD (Begeer et al., 2008), which are presented in difficulties with coping with changes and new situations, and participating in social activities (Gomot & Wicker, 2012; Orsmond, Krauss, & Seltzer, 2004). More and more research shows that impaired emotion regulation is often the underlying cause for these difficulties (Laurent & Rubin, 2004). Emotion regulation refers to the processes that influence when we have certain emotions, how we experience emotions, and how we express these (Gross & Thompson, 2007).

Neurotypical children are able to recognize basic facial expressions such as happy and sad from as early as 3 to 4 months of age and they are able to respond and reciprocate the emotions of others by only 7 months. One of the main diagnostic characteristics of Autism spectrum disorder (ASD) is difficulty in recognizing and

understanding emotions. Even though autistic children have difficulties to interpret emotions, there many studies showings that children and adults with autism can learn how to recognize and interpret emotions and research has shown that structured activities can positively impact autistic children's competence in identifying the feelings of others.

1.2 AUTSIM AND MUSIC

The positive impact of music on social skills has been demonstrated beyond ASD. Typically developing children are more likely to play with another following a shared musical experience and joint musical interactions can enhance emotional empathy, prosociality and bonding in children. More recently, neuroimaging studies have shown that participating in musical activities engages a multimodal network of brain regions involved in hearing, movement, emotion, pleasure and memory, thus allowing transfer of music-related therapeutic effects to non-musical domains through structural and functional brain change. However, a direct link between effects of music interventions and changes in the brain is yet to be demonstrated in autism and was our aim here.

Music is a great connector for Autism children which will keep them relaxed. Music provides non-threatening, safe and enjoyable medium to explore developmental, communication skills. Music improves the development of speech and language skills and can used to communicate with others.

1.3 FACIAL EMOTION RECOGNITION

Emotion recognition is one of the many facial recognition technologies that have developed and grown through the years. Currently, facial emotion recognition software is used to allow a certain program to examine and process the expressions on a human's face. Using advanced image dispensation, this software functions like a human brain that makes it capable of recognizing emotions too. It is AI or "Artificial Intelligence" that detects and studies different facial expressions to use them with additional information presented to them. This is useful for a variety of purposes, including investigations and interviews, and allows authorities to detect the emotions of a person

with just the use of technology. Emotion recognition can detect and recognize different facial expressions using Facial Expression Analysis.

Emotion detection is a latest technique which we used to detect facial emotions by different methods like image processing, physiological signal etc., Detecting these emotions are a challenging factor a small difference in face may result upto different emotions. But, there is a fact that focusing on specific areas of face like raising eyebrows and changes in mouth and face may result for perfect emotions, but still there is a question how to extract all these facial gestures. Studies in machine learning algorithm shows very useful in pattern recognition and classification hence that can be used for emotion detection.

➤ *Analysis of techniques for facial emotion recognition*

Facial recognition was initially done by Ekman and Friesen who categorized human emotions into six categories; happiness, fear, sadness, disgust, surprise and anger. Movement of facial muscles allows the variations in cheeks, nasio-labial, eyes, brows and mouth. These movements result in representation of different emotions via facial expressions. Figure 1.1 details various measurements of the key facial features which help to determine the emotion. Movement of facial muscles due to emotions result in variations of facial feature changes.. Detection of facial feature changes results in identifying the corresponding emotion from the images

Emotion	Facial Expression
Anger	Lowered and burrowed eyebrows,Intense gaze, Raised chin
Happy	Raised corners of mouth into a smile
Surprise	Dropped jaw,Raised brows,Wide eyes
Fear	Open mouth,Wide eyes,Furrowed brows
Sad	Furrowed brows,Lip corner depressor
Anxiey	Biting of the lips

Fig 1.1 Measurements of facial features

One of the main challenges in emotion recognition as in most computer vision tasks is to deal with the complexity of real-world scenarios. This includes large variations of illumination, appearance of subjects and sensor properties, among many other parameters. With the success of deep-learning methods (Krizhevsky et al., 2012; Bahdanau et al., 2014) that learn hierarchical representations from data, the demand for large-scale data sets (Deng et al., 2009) is increased. One very important challenge is to explore these techniques in detail for emotion recognition tasks where the amount of annotated close-to-real-world data is limited compared to object recognition tasks. Another aspect to study is how to benefit from complementary information from different modalities, such as the visual and auditory streams of videos. From the artificial

intelligence perspective, it would be interesting to see if building an integrated system, such as a neural network architecture that can be trained as one system from input to predictions, is feasible.

1.4 FACE DETECTION

Face detection is one of the fundamental applications used in face recognition technology. Facebook, Amazon, Google and other tech companies have different implementations of it. Before they can recognize a face, their software must be able to detect it first. Amazon has developed a system of real time face detection and recognition using cameras. Facebook uses it mostly on photos that their users upload in order to suggest tagging friends.

Requirements:

- Any operating system that will support OpenCV and Python (Windows, Linux, MacOS)
- Python
- OpenCV-Python
- Haar Cascades Data File
- i5 or higher core processor (CPU)/ 2.1 GHz or higher
- Photo images for testing

In this project, I applied face detection to some photos I took using OpenCV with Python. OpenCV is an open source software library that allows developers to access routines in API (Application Programming Interface) used for computer vision applications. The version I used was developed for Python called OpenCV-Python.

To install, make sure you have PIP (Python Package Index) installed with Python and run from the command line (Windows command prompt or Linux/MacOS terminal):pip

install opencv-python. This will install the main modules on your system for use with OpenCV.

Face detection is a type of application classified under “computer vision” technology. It is the process in which algorithms are developed and trained to properly locate faces or objects (in object detection, a related system), in images. These can be in real time from a video camera or from photographs. An example where this technology is used are in airport security systems. In order to recognize a face, the camera software must first detect it and identify the features before making an identification. Likewise, when Facebook makes tagging suggestions to identify people in photos it must first locate the face. On social media apps like Snapchat, face detection is required to augment reality which allows users to virtually wear dog face masks using fancy filters. Another use of face detection is in smartphone face ID security.

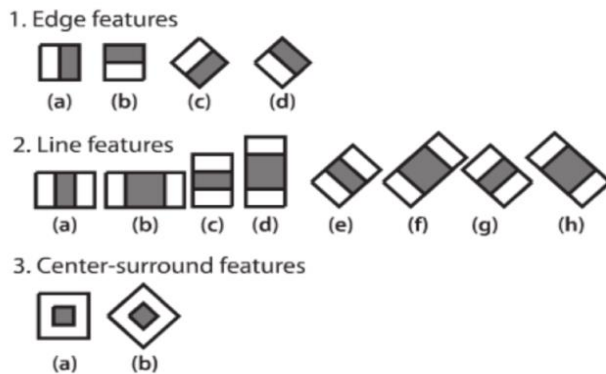
In this project, I implemented a system for locating faces in digital images. These are in JPEG format only. Before we continue, we must differentiate between face recognition and face detection. They are not the same, but one depends on the other. In this case face recognition needs face detection for making an identification to “recognize” a face. I will only cover face detection.

Face detection uses *classifiers*, which are algorithms that detects what is either a face(1) or not a face(0) in an image. Classifiers have been trained to detect faces using thousands to millions of images in order to get more accuracy. OpenCV uses two types of classifiers, LBP (Local Binary Pattern) and Haar Cascades. I will be using the latter classifier.

1.4.1 Haar Cascades

A sequence of rescaled “square-shaped” functions which together form a wavelet family or basis. It is based on the Haar Wavelet technique to analyze pixels in the image into squares by function. This uses machine learning techniques to get a high degree of accuracy from what is called “training data”. This uses “integral image” concepts to compute the “features” detected. Haar Cascades use the **Adaboost** learning algorithm

which selects a small number of important features from a large set to give an efficient result of classifiers.



Face Detection determines the locations and sizes of human faces in arbitrary (digital) images.

In **Face Recognition**, the use of Face Detection comes first to determine and isolate a face before it can be recognized.

Fig 1.2 Difference of face detection and recognition

Figure 1.2 This is a brief illustration of Features Extraction and the difference between Face Detection and Face Recognition. Face detection is about locating, while face recognition is about identifying.

1.4.2 Feature Extraction

Haar Cascades use machine learning techniques in which a function is trained from a lot of positive and negative images. This process in the algorithm is feature extraction.

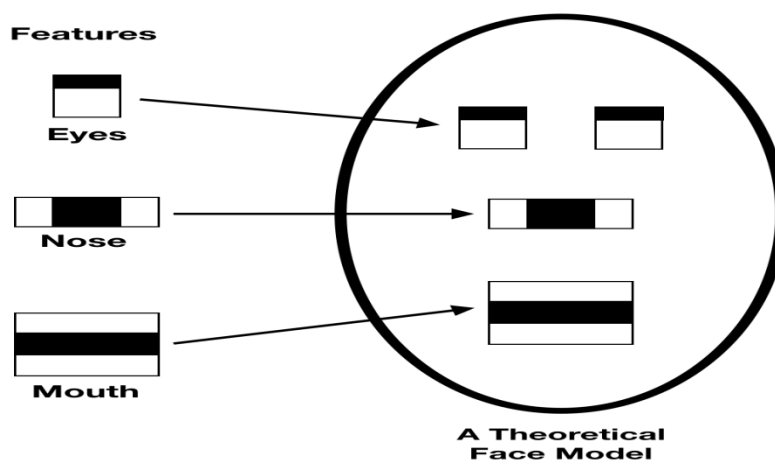


Fig 1.3 Feature Extraction of Face model

In feature extraction, the algorithm uses training data to best identify features that it can consider a face.

➤ *Running OpenCV*

For this project I prepared a directory where I dumped all the files needed. You will need to put in this directory the following:

- face_detection.py (the name I gave to the Python program that contains code. This name can be changed.)
- haarcascade_frontalface_default.xml (Haar Cascade training data)
- photos

➤ *Non-Human faces Vs Human faces*

The first non-human face I tested was from the cat photo. Now I tried using various parameters, but the algorithm had failed to detect the face using the values I entered. Perhaps there is a combination of values in the parameter I have not used that would have detected the face, but for now I am leaving this as unsuccessful. The features were there for the eyes and mouth, but I am assuming this is not readily detectable as a face because the training data from the Haar Cascades classifier may not have enough information. The data was mostly human faces after all the training data used in this project is an XML file called: haarcascade_frontalface_default.xml



Fig 1.4 Non-Human face(Cat)

Now here is the interesting part. I tested a monkey's face and I was able to get a detection.

Parameters:

scaleFactor=1.1,
minNeighbors=1,
minSize=(30, 30),

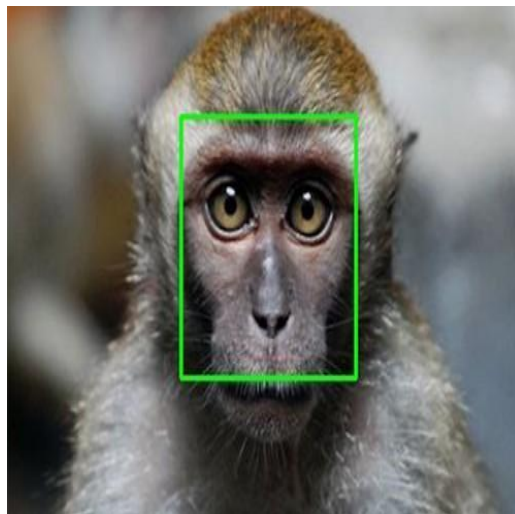


Fig 1.5 Monkey similar to human face

Since the monkey is a member of the primate family to which humans belong, the similarities may be the reason why it would be more accurately detected. Certainly more tests can be done with non-human faces to see how it compares with the training data. A more appropriate way to detect animal faces is with a classifier trained using animal photos.

1.5 FACIAL EXPRESSION

For finding out the facial emotions here we used pre trained dataset emotion detection.h5 which is a keras trained model

The major dependencies include:

- 1) TensorFlow: Python Library used for Machine Learning
- 2) FacialExpressionModel: Python Package used for Detect Facial Expression.
- 3) AudioPlayer: Python Library used for Play MP3 Files
- 4) Numpy: Python Library used for Mathematical Functions
- 5) OpenCV: Python Library for Computer Vision.

Explanation:

The main concept used to predict the Emotion of Autism children's and Play Music's based on their Emotions. The flow of the project is as follows:

- First using read the image from Camera by using OpenCV
- Then, the **haar cascade** method is used to detect faces in each frame of the webcam feed.
- The region of image containing the face is resized to **48x48** and is passed as input to the CNN.
- The emotion with maximum score is displayed on the screen.
- Based on the Emotion Audio Will be played.

1.5.1 Keras and TensorFlow

TensorFlow is a free and open-source software library for machine learning. It can be used across a range of tasks but has a particular focus on training and inference of deep neural networks. TensorFlow is a symbolic math library based on dataflow and differentiable programming. It is an end-to-end open-source platform for machine learning. It has a comprehensive, flexible ecosystem of tools, libraries and community resources that lets researchers push the state-of-the-art in ML and developers easily build and deploy ML powered applications.

Keras is an open-source software library that provides a Python interface for artificial neural networks. Keras acts as an interface for the TensorFlow library. Up until version 2.3, Keras supported multiple backends, including TensorFlow, Microsoft Cognitive Toolkit, Theano, and PlaidML. Keras is an API designed for human beings, not machines. Keras follows best practices for reducing cognitive load: it offers consistent & simple APIs, it minimizes the number of user actions required for common use cases, and it provides clear & actionable error messages. It also has extensive documentation and developer guides.

1.5.2 Convolutional neural network

In the past few decades, Deep Learning has proved to be a very powerful tool because of its ability to handle large amounts of data. The interest to use hidden layers has surpassed traditional techniques, especially in pattern recognition. One of the most popular deep neural networks is Convolutional Neural Networks

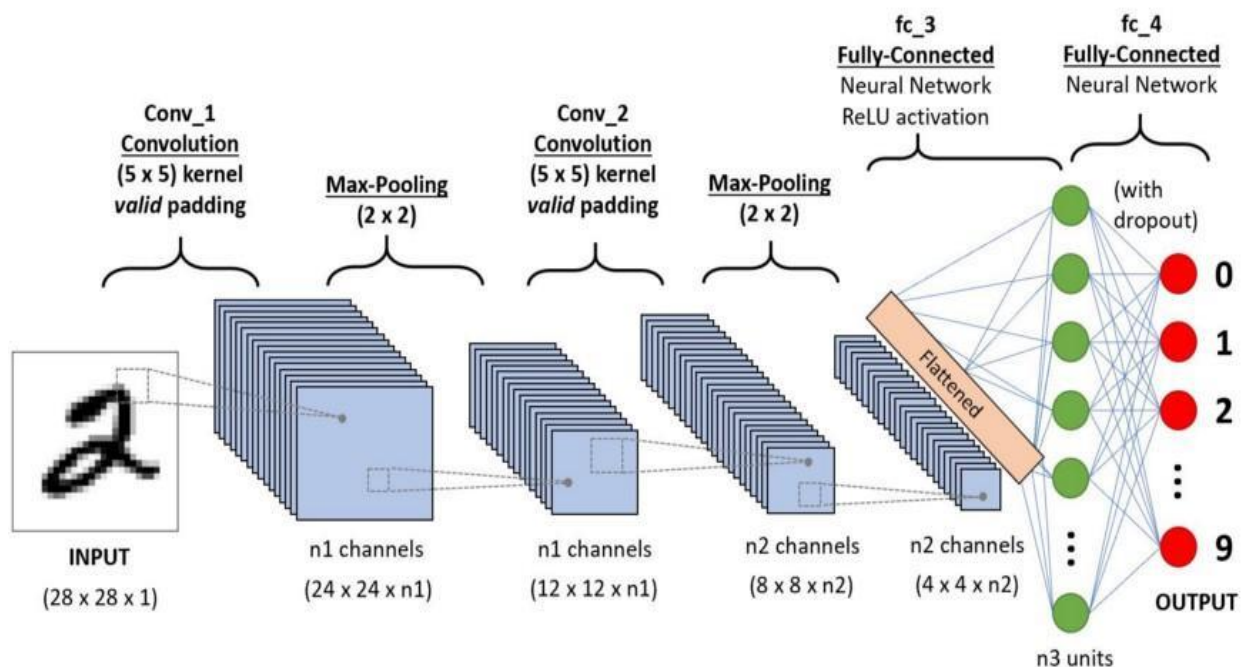


Fig 1.6 Layers of CNN

Convolutional neural networks are composed of multiple layers of artificial neurons. Artificial neurons, a rough imitation of their biological counterparts, are

mathematical functions that calculate the weighted sum of multiple inputs and outputs an activation value. When you input an image in a ConvNet, each layer generates several activation functions that are passed on to the next layer.

The first layer usually extracts basic features such as horizontal or diagonal edges. This output is passed on to the next layer which detects more complex features such as corners or combinational edges. As we move deeper into the network it can identify even more complex features such as objects, faces, etc.

Pooling layer

Similar to the Convolutional Layer, the Pooling layer is responsible for reducing the spatial size of the Convolved Feature. This is to **decrease the computational power required to process the data** by reducing the dimensions. There are two types of pooling average pooling and max pooling. I've only had experience with Max Pooling so far I haven't faced any difficulties.

1.6 GSR IN EMOTION DETECTION

The galvanic skin response (GSR), also known as electrodermal activity (EDA) or skin conductance (SC), is a continuous measurement of electrical parameters of human skin. Most often, skin conduction is used as the main parameter in this technique. Electrical parameters of the skin are not under conscious human control. Sweat reaction causes a variation of the amount of salt in the human skin and this leads to the change of electrical resistance of the skin. When sweat glands become more active, they secrete moisture towards the skin surface. That changes the balance of positive and negative ions and affects the electrical currents' flow property on the skin.

GSR signal amplitude is associated with stress, excitement, engagement, frustration, and anger, and the obtained measurement results correlate with the self-reported evaluation of arousal. Attention-grabbing stimuli and attention-demanding tasks lead to the simultaneous increase of the frequency and magnitude of GSR. So, GSR allows not only to recognize emotions, but also to automatically detect decision making process.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Previous works are focused on eliciting results from unimodal systems. Machines used to predict emotion by only facial expressions [1] or only vocal sounds [2]. After a while, multimodal systems that use more than one features to predict emotion has more effective and gives more accurate results. So that, the combination of features such as audio-visual expressions, EEG, body gestures have been used since. More than one intelligent machine and neural networks are used to implement the emotion recognition system. Multimodal recognition method has proven more effective than unimodal systems

2.2 LITERATURE REVIEW

A.Yao,*et al.* used a well-designed Convolutional Neural Network (CNN) architecture regarding the video based emotion recognition. They proposed the method named as HOLONET has three critical considerations in network design. To reduce redundant filters and enhance the non-saturated non-linearity in the lower convolutional layers, they used modified Concatenated Rectified Linear Unit (CReLU) instead of ReLU. To enjoy the accuracy gain from considerably increased network depth and maintain efficiency, they combine residual structure and CReLU to construct the middle layers. To broaden network width and introduce multi-scale feature extraction property, the topper layers are designed as a variant of the inception-residual structure. This method more realistic than other methods here. It's focused on adaptability in real-time scenario than accuracy and theoretical performance. Though its accuracy is also impressive but only this method is applicable only in the video based emotion recognition. Other types of data rather than video, this method can't produce results

Yahia Said, Mohammad Barr reviewed that face-sensitive convolutional neural network can be used to detect faces on large scale images then analyzing face landmarks to predict expressions for emotion recognition. The FS-CNN is composed form two stages,

patch cropping, and convolutional neural networks. The first stage is used to detect faces in high-resolution images and crop the face for further processing. The second stage is a convolutional neural network used to predict facial expression based on landmarks analytics, it was applied on pyramid images to process scale invariance.

Dandil *et al.* proposed a facial emotion classifier based on a Convolutional Neural Network. The proposed CNN is composed of three convolution layers, 1 max-pooling layer after the first convolution layer, 2 average pooling layers after the second and the third convolution layers, 2 fully convolution layers, and a softmax layer. To detect faces in images, the ViolaJones face detection algorithm was used. To train and evaluate the proposed method, they build a dataset with 3600 images, and 240 images were used as testing data. The evaluation of the proposed method achieves a maximum accuracy of 72%.

Jumaini *et al.* proposed two configurations for emotion recognition by exploring the face detection task. The first one was a simple CNN model with 3 convolution layers, 3 pooling layers, and 2 fully connected layers. The second one was a combination of the Histogram of Oriented Gradient (HOG) and the CNN model of the first configuration. Both methods were trained and evaluated on the FER 2013 dataset. The evaluation of the proposed methods proves that the simple CNN achieves better accuracy than the combination of HOG+ CNN

Liu *et al.* uses the fer2013 dataset and two layer CNN to classify different facial emotions. They have also compared it with 4 different existing models and the proposed model yields a test accuracy of 49.8%. S Suresh *et al* proposed a sign language recognition system that classifies 6 different sign languages using a Deep Neural Network (DNN). Two models with different optimizers (Adam and SGD) are compared and the model with Adam optimizer is found to have more accuracy.

K. Bouaziz *et al* . has demonstrated an analytics workflow that integrates the tools

and techniques of image recognition. The proposed model classifies different handwriting with CNN architecture.

F.Zhou *et al* used a deep convolutional neural network model to detect ship in motion for PolSAR images. The model uses a faster region based CNN (Faster-RCNN) method to recognizeships with different sizes. The model is validated using NASA/JPL AIRSAR dataset.

Sarah Afiqah Mohd Zabidi *et al.* developed of a system designed to facilitate learning in ASD children.This Arduino-based game is equipped with common components such as touch sensor.MP3 player and LEDs to increase replicability.A research was done based on the Early intervention module to develop a game that could help improve cognitive skill of ASD children.Early intervention for children with ASD has proven to be effective in reucing ASDs symptom.

It is reported by Estes et al. that early intervention during the ages of 0 to 6 can reduce its impact and improve the child's development. Some examples of intervention approaches for ASD children are Applied Behaviour Analysis (ABA)

Feng-Tso Sun *et al.* explained that the physiological responses caused by mental stress can be masked by variations due to physical activity. We present an activity-aware mental stress detection scheme. Electrocardiogram (ECG), galvanic skin response (GSR), and accelerometer data were gathered from 20 participants across three activities: sitting, standing, and walking. For each activity, we gathered baseline physiological measurements and measurements while users were subjected to mental stressors. The activity information derived from the accelerometer enabled us to achieve 92.4% accuracy of mental stress classification for 10-fold cross validation and 80.9% accuracy for between-subjects classification.

2.3 SUMMARY

Every reviewed papers explain emotion detection for the normal people here,we used this for autism children because they are in need of emotions classification.Autism children are not in aware of their own emotions and also others,they couldn't response to peoples by their emotions. Due to this reason autism children not able to concentrate in their studies.Even though autistic children have difficulties to interpret emotions, there many studies showings that children and adults with autism can learn how to recognize and interpret emotions and research has shown that structured activities can positively impact autistic children's competence in identifying the feelings of others.Other paper explains that relationship between autism children and music. Music has been identified as a strength in people with Autism Spectrum Disorder . Music therapy helps individuals with ASD identify and appropriately express their emotions. Because music is processed in both hemispheres of the brain, it can stimulate cognitive functioning and may be used for remediation of some speech/language skills.

Most of the researches presented that emotional recognition can be easily done by neural networks,while comparing to other techniques.In human,emotions can be easily described by facial expressions,voices and changes in body can be monitored by physiological signals like ECG,EEG,GSR etc.,The real time image can be monitored by using webcam and by using haar cascade algorithm human face can be detected this is the first step in detecting human face and followed by that Convolutional neural network is used to identify facial emotions.Many reviewed papers shows that using CNN we get better accuracy.Few researchers using only image processing or physiological signal for emotion detection,but here we used both image processing and physiological signal for the better accuracy.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

- To play music for autism children by detecting their emotions
- To detecting their real time emotions and send data to the arduino board
- To measuring their emotions by using GSR sensor

3.2 EXISTING SYSTEM

It has been seen that using a Convolutional Neural Network model to recognize human emotion from images. Many sources explain how emotion detection can be done for normal person. There are many researches undergo for emotional recognition with different machine learning techniques using physiological signals, image processing etc., Many reviewed papers shows that low accuracy rate for the face reaction classification.

3.3 PROPOSED SYSTEM

In our proposed system, real time emotions can be detected by machine learning techniques and songs will play as per their mood along with that stress can be monitored by using GSR. This system will the great effort for the autism children for their learning abilities and also for controlling their anger while being in stress. For performing the emotion detection **Deep convolutional neural network** is trained using **python** will be used. For building the model, adding the convolution layers, compiling and fitting the model, **Keras** which runs on top of **tensorflow**, is used as the deep learning library

3.3.1 Advantages of proposed system

- This system mostly use for the ASD childrens to recognize their own emotions which displayed on the system.
- This is great effort for Austim for their learning without any distractions.
- Real time emotion prediction is a and playing a music according to their mood.
- This makes the ASD children to relieve from their stress and to learn interactively.

3.4 SCOPE OF THE STUDY

In this study, how autism children face an challenges in recognizing their own emotions as well others and how these emotions make issues in their day to day life for their learning abilities. Here,we studied how music play a vital role in ASD childrens life and their response towards music. In present, there are lot of researches going through for emotion detection by using different neural network techniques and also different methods like image processing, live image detection, changes in body by physiological signal(EEG,ECG,GSR).Here we used CNN technique for live image detection and emotion processing also we used GSR sensor for measuring emotion changes by sweat gland activity.All these data get transferred to arduino board and then to DF mini player ,we fetch songs by SD card .Analyzing all these data ,music played according to their emotion.

CHAPTER 4

MATERIALS AND METHODS

4.1 HARDWARE COMPONENTS:

4.1.1 Arduino MEGA 2560

Arduino is a single-board microcontroller which renders incorporating electronics in multidisciplinary activities fully available. The hardware is a basic open source hardware board based on an 8-bit Atmel AVR or a 32-bit Atmel ARM microcontroller. On the microcontroller, the device consists of a common programming language compiler and a boot loader. Arduino is an open-source prototype framework of simple hardware and software. It is made up of a programmable circuit board (also known as a microcontroller) and ready-to-use software labelled as Arduino IDE (Integrated Development Environment), which is used to write and transfer programming code to the physical device.

- *Specification*
 - Microcontroller: ATmega328
 - Operational Voltage: 5V
 - Input Voltage: 7-12V
 - Input Voltage: 6 - 20V (range)
 - 14 Digital I/O Pins of which 6 provide PWM output
 - Input Pins (analog): 6
 - DC Current: 40mA per I/O Pin
 - DC Current: 50mA for 3.3V for each Pin
 - Flash Memory: 32 KB (ATmega328)

- SRAM: 2 KB (ATmega328)

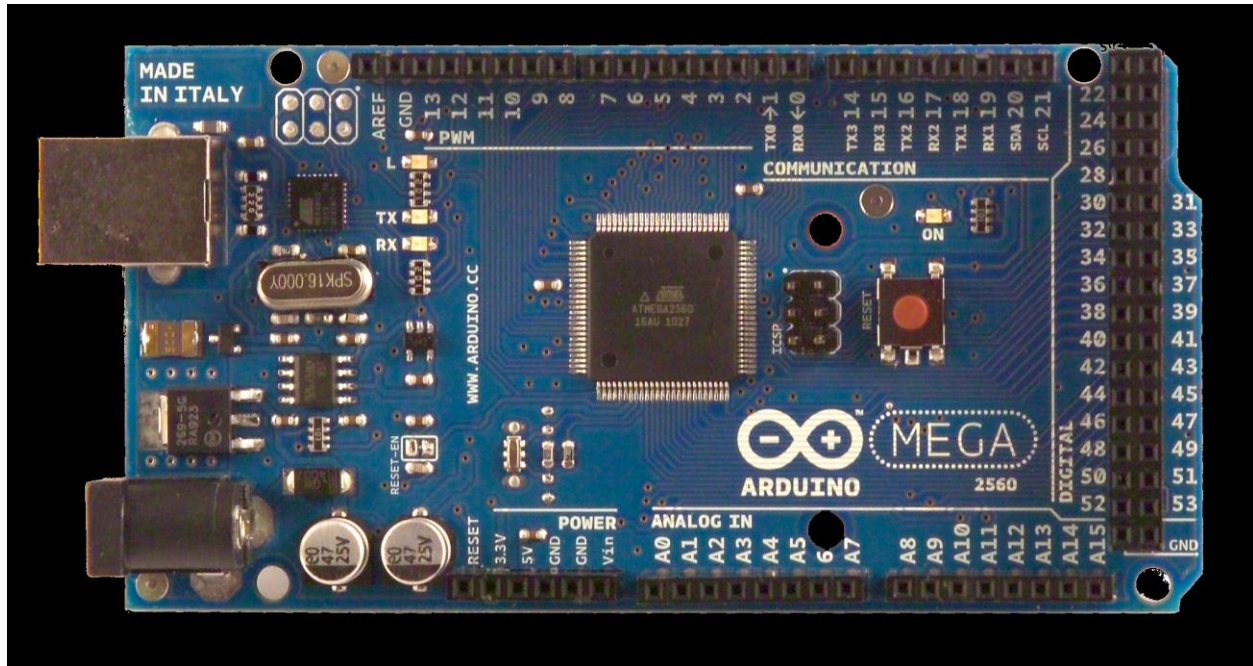


Fig 4.1 Arduino MEGA 2560

4.1.2 DF mini player

The DF Player Mini is a small and low price MP3 module with an simplified output directly to the speaker. The module can be used as a stand alone module with attached battery, speaker and push buttons or used in combination with an Arduino UNO or any other with RX/TX capabilities.

- *Specification*
 - supported sampling rates (kHz): 8/11.025/12/16/22.05/24/32/44.1/48
 - 24 -bit DAC output, support for dynamic range 90dB , SNR support 85dB
 - fully supports FAT16 , FAT32 file system, maximum support 32G of the TF card, support 32G of U disk, 64M bytes NORFLASH
 - a variety of control modes, I/O control mode, serial mode, AD button control mode
 - advertising sound waiting function, the music can be suspended. when advertising is over in the music continue to play

- audio data sorted by folder, supports up to 100 folders, every folder can hold up to 255 songs
- 30 level adjustable volume, 6 -level EQ adjustable

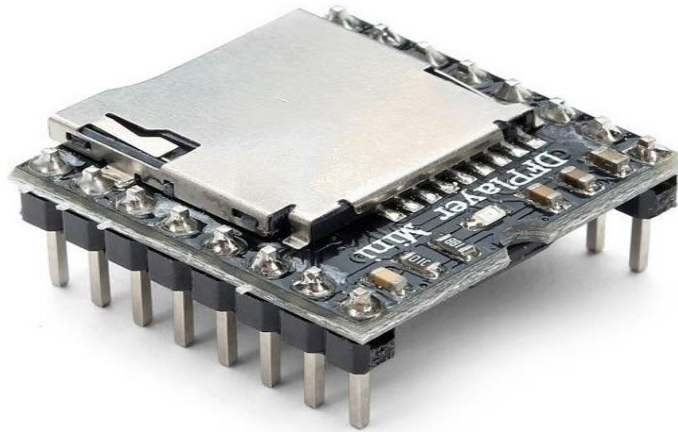


Fig 4.2 DF Player

4.1.3 GSR Sensor

GSR stands for galvanic skin response and it is a method of measuring the electrical conductance of the skin. Strong emotions can cause stimulus to your sympathetic nervous system, resulting more sweat being secreted by the sweat glands. Grove - GSR allows you to spot such strong emotions by simply attaching two electrodes to two fingers on one hand. It is an interesting gear to create emotion related projects like sleep quality monitor.

Features

- Detects conductance of skin
- Finger Straps for electrodes For all Grove users (especially beginners),



Fig 4.3 GSR sensor

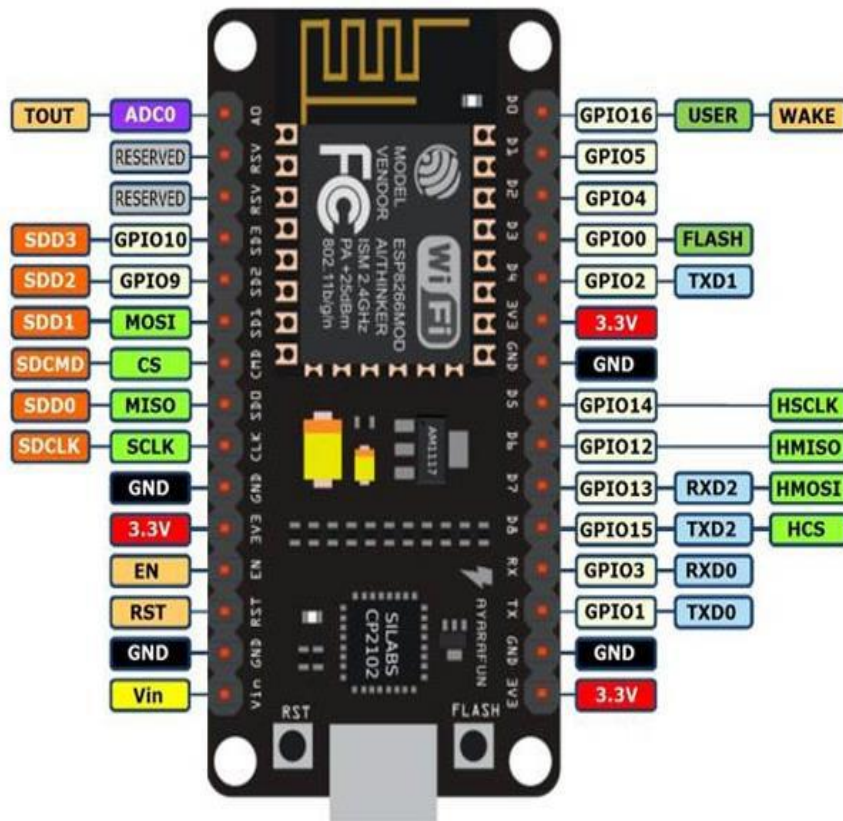
4.1.4 Node MCU-ESP8266

The ESP8266 is designed by Espressif Systems microcontroller. The ESP8266 itself is a free Wi-Fi network solution which can also operate self-contained application as a connection from existing micro controllers to Wi-Fi. This module has a USB connector and an extensive selection of pin-outs. You can attach Node MCU devices to a laptop with a micro USB cable and flash it easily; much like Arduino It is also breadboard compatible.

➤ *Specification*

- Voltage: 3.3V.
- Wi-Fi Direct (P2P), soft-AP.
- Consumption of current: 10uA~170mA.
- Attachable flash memory: 16MB max (512K normal).
- Integrated TCP/IP protocol stack.
- Processor: Ten silica L106 32-bit.

- Speed of the processor: 80~160MHz.



the LCD is off, the light rays are rotated by the two polarisers and the liquid crystal, so that the light rays come out of the LCD without any direction, and thus the LCD becomes translucent. If appropriate voltage is applied to the electrodes, the molecules of liquid crystal will be oriented in a certain direction. The light rays going through the LCD would be rotated by the polarisers, which would activate/highlight the desired characters.

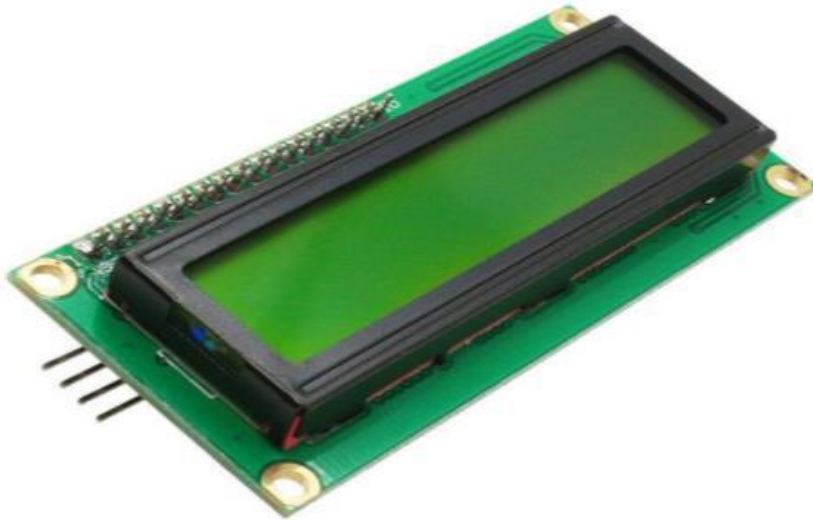


Fig 4.5 Liquid Crystal Display

4.2 SOFTWARE USED:

4.2.1 Arduino IDE

A cross platform framework (for Windows, macOS and Linux) written with functions C and C++ is an Arduino Integrated Development Environment (IDE). It is used for writing and uploading Arduino compatible applications, but also for other developer boards with the support of third-party core systems.

The IDE source code is released under the GNU General Public License, version 2. The Arduino IDE uses special code structuring guidelines to support the languages C and C++. The Arduino IDE supplies a wiring project software library that provides a number of common input and output procedures. User-written code only needs two simple functions to start the sketch and the main program loop, which are compiled and connected into an executable cyclic executive program with the GNU tool

chain, which is also included with the IDE distribution. The Arduino IDE uses the software to translate the source codes to a text file in hexadecimal that is loaded into the Arduino board by a loader program in the circuitry of the board.

➤ *Initial Setup*

If the Arduino IDE has been opened, here is what it looks like. It opens in a blank sketch where you can start programming right away. First, we need to customize the board and port settings to enable us to upload code. Connect your Arduino board to your PC with a USB cable.



Fig 4.6 Arduino IDE

4.2.2 Python IDLE

Python is an open source and cross-platform programming language, that has become increasingly popular over the last ten years. It was first released in 1991. Latest version is 3.7.0. CPython is the reference implementation of the Python programming language. Written in C, CPython is the default and most widely-used implementation of the language. Python is a multi-purpose programming languages (due to its many extensions), examples are scientific computing and calculations, simulations, web development (using, e.g., the Django Web framework), etc.

Some important Python Packages for Science and Numerical Computations are:

- *NumPy* - NumPy is the fundamental package for scientific computing with Python
- *SciPy* - SciPy is a free and open-source Python library used for scientific computing and technical computing. SciPy contains modules for optimization, linear algebra, integration, interpolation, special functions, FFT, signal and image processing, ODE solvers and other tasks common in science and engineering.
- *Matplotlib* - Matplotlib is a Python 2D plotting library. [10]
- *Pandas* - Pandas Python Data Analysis Library [11]

These packages need to be downloaded and installed separately, or you choose to use, e.g., a distribution package like Anaconda, where you typically get the packages you need for scientific computing. With Anaconda you typically get the same features as with MATLAB.

The programming language is maintained and available, which includes the Python programming language interpreter, and a basic code editor, or an integrated development environment, called IDLE.

4.2.3 Thing Speak

According to the programmers, "Thing Speak is an open access IoT program and API for storing and retrieving data from things over the Internet or a Local Area Network using the HTTP protocol. Thing Speak allows the development of sensor monitoring apps, location tracking applications, and a social network of objects with status updates.

➤ Features

- Configure devices to share data through common IoT protocols through Thing Speak
- Real-time display of the sensor data



Fig 4.7 Thing Speak

4.3 PYTHON CODE

```
import cv2
import tensorflow
from Models.model import FacialExpressionModel
import numpy as np
import time
import serial

rgb = cv2.VideoCapture(0)
facec = cv2.CascadeClassifier('Models/haarcascade_frontalface_default.xml')
font = cv2.FONT_HERSHEY_SIMPLEX
found = set()

arduinoData = serial.Serial('COM6', 115200)
```

```
readdat=""
```

```
def getSerial():
```

```
    global DaTa_r
```

```
    global temp_Stat
```

```
    global stat
```

```
    if(arduinoData.in_waiting >0):
```

```
        line = arduinoData.readline()
```

```
        readdat=line.decode()
```

```
        print(readdat)
```

```
        if(readdat == "Ready\r\n"):
```

```
            print("Device online")
```

```
    else:
```

```
        readdat=""
```

```
def __get_data__():
```

```
    """
```

```
    __get_data__: Gets data from the VideoCapture object and classifies them  
    to a face or no face.
```

```
    returns: tuple (faces in image, frame read, grayscale frame)
```

```
    """
```

```
    __, fr = rgb.read()
```

```
    fr=cv2.flip(fr,1)
```

```
    gray = cv2.cvtColor(fr, cv2.COLOR_BGR2GRAY)
```

```

faces = facec.detectMultiScale(gray, 1.3, 5)

return faces, fr, gray

def start_app(cnn):
    skip_frame = 10
    data = []
    flag = False
    ix = 0
    count_h=0
    count_s=0
    count_n=0
    count_h_max=5
    count_s_max=5
    while True:
        ix += 1
        getSerial()
        faces, fr, gray_fr = __get_data__()
        for (x, y, w, h) in faces:
            fc = gray_fr[y:y+h, x:x+w]

            roi = cv2.resize(fc, (48, 48))
            pred = cnn.predict_emotion(roi[np.newaxis, :, :, np.newaxis])

            cv2.putText(fr, pred, (x, y), font, 1, (255, 255, 0), 2)
            cv2.rectangle(fr,(x,y),(x+w,y+h),(255,0,0),2)
            if(str(pred)=='Happy' ):
                count_h+=1
                count_s=0
                count_n=0
                print("Happy ",count_h)

```

```

        if(count_h>=5 and count_h >= count_h_max):
            count_h=0
            count_h_max=20
            arduinoData.write('Happy'.encode())
            print('Happy send')

    elif(str(pred)=='Sad' ):
        count_s+=1
        count_h=0
        count_n=0
        print("Sad ",count_s)
        if(count_s>=5 and count_s >= count_s_max):
            count_s_max=20
            count_s=0
            arduinoData.write('Sad'.encode())
            print('Sad send')
    else:
        count_n+=1
        count_s=0
        count_h_max=5
        count_s_max=5
        count_h=0
        if(count_n>=20):
            count_n=0
            arduinoData.write('Neutral'.encode())

        if cv2.waitKey(30) == 27:
            break
        cv2.imshow('Autism', fr)
        cv2.destroyAllWindows()
if __name__ == '__main__':

```

```

model          =      FacialExpressionModel("Models/face_model.json",
"Models/face_model.h5")
start_app(model)

```

4.4 BLOCK DIAGRAM

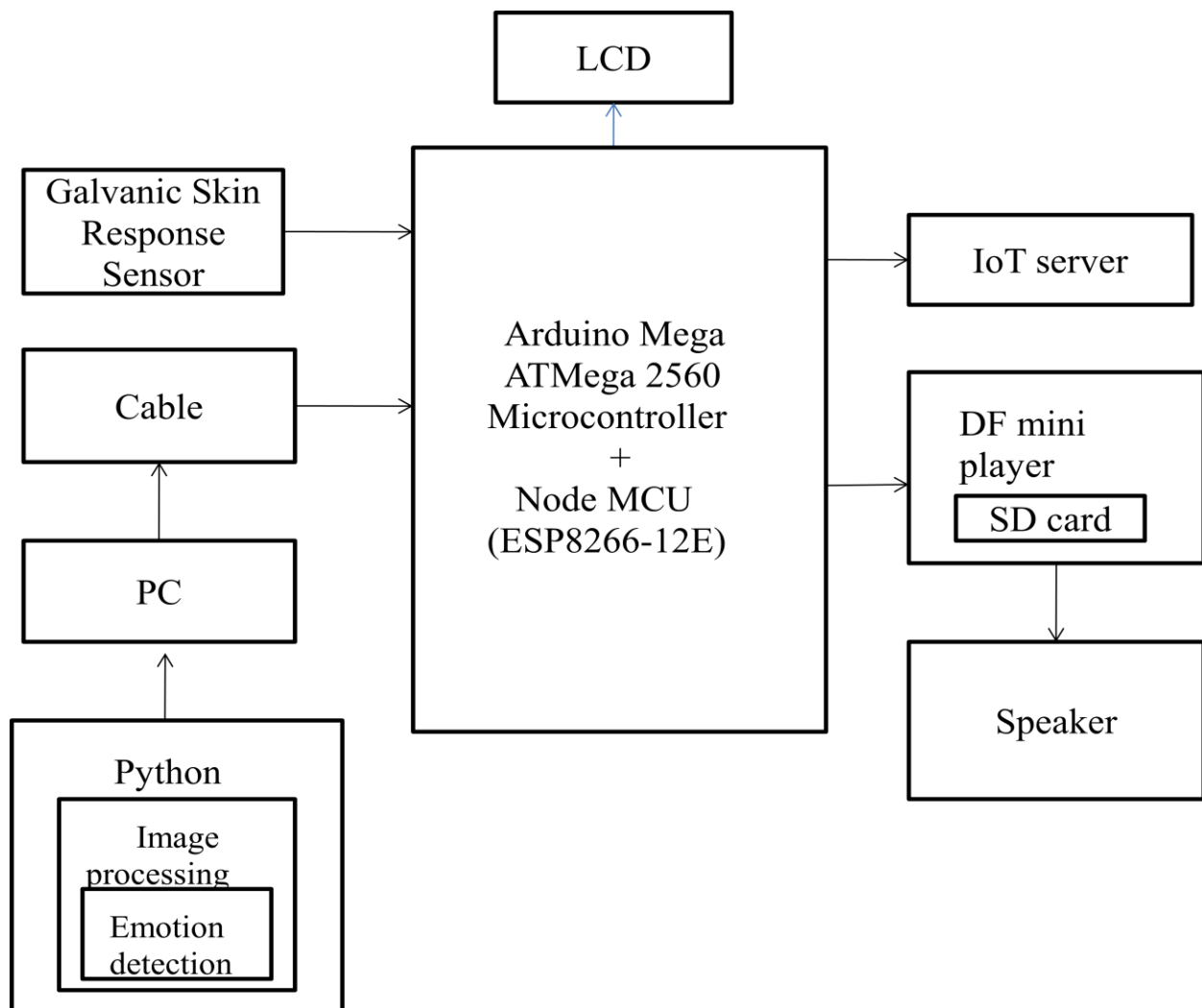


Fig 4.8 Block Diagram

4.5 METHODOLOGY

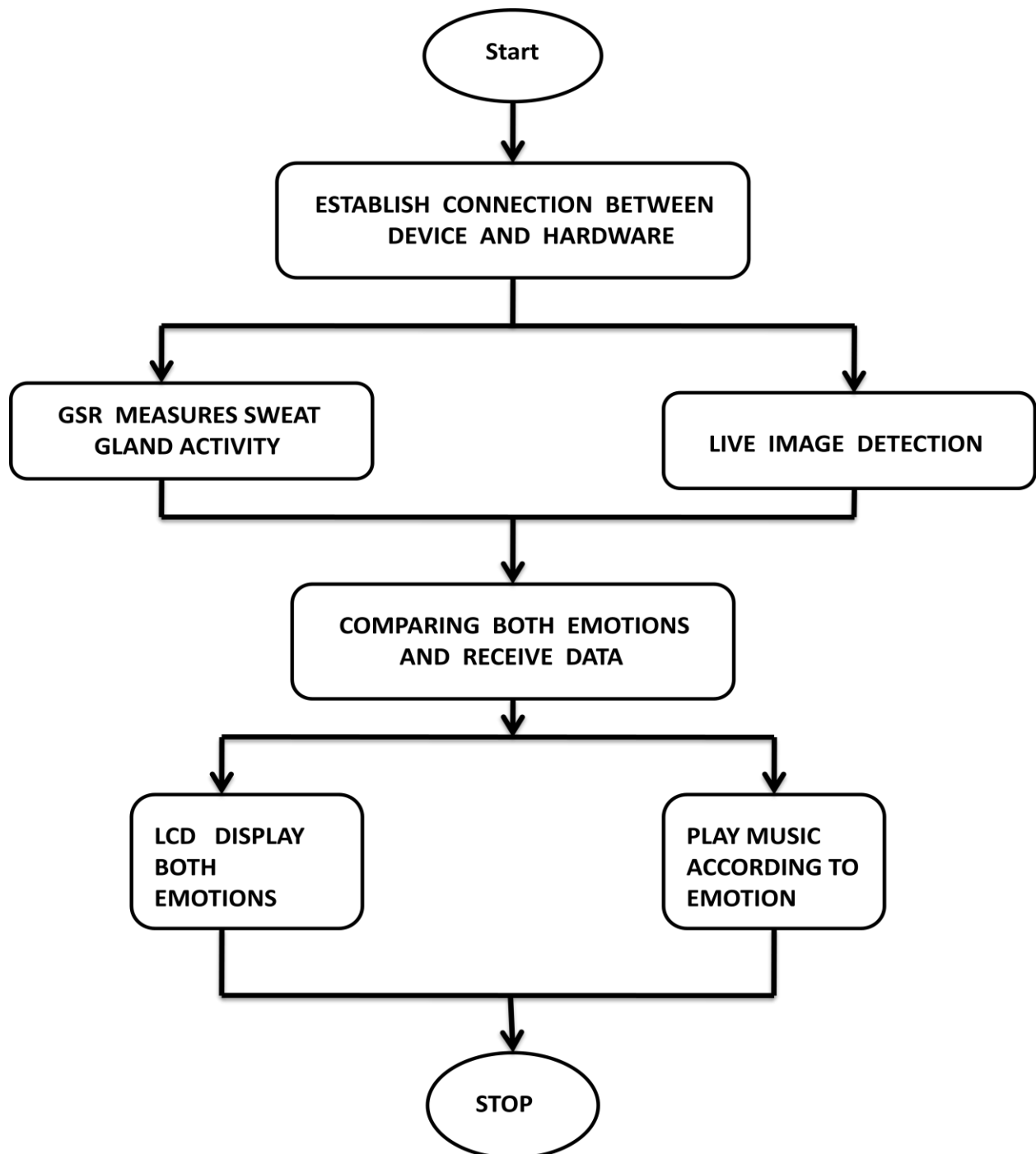


Fig 4.9 Methodology Flow diagram

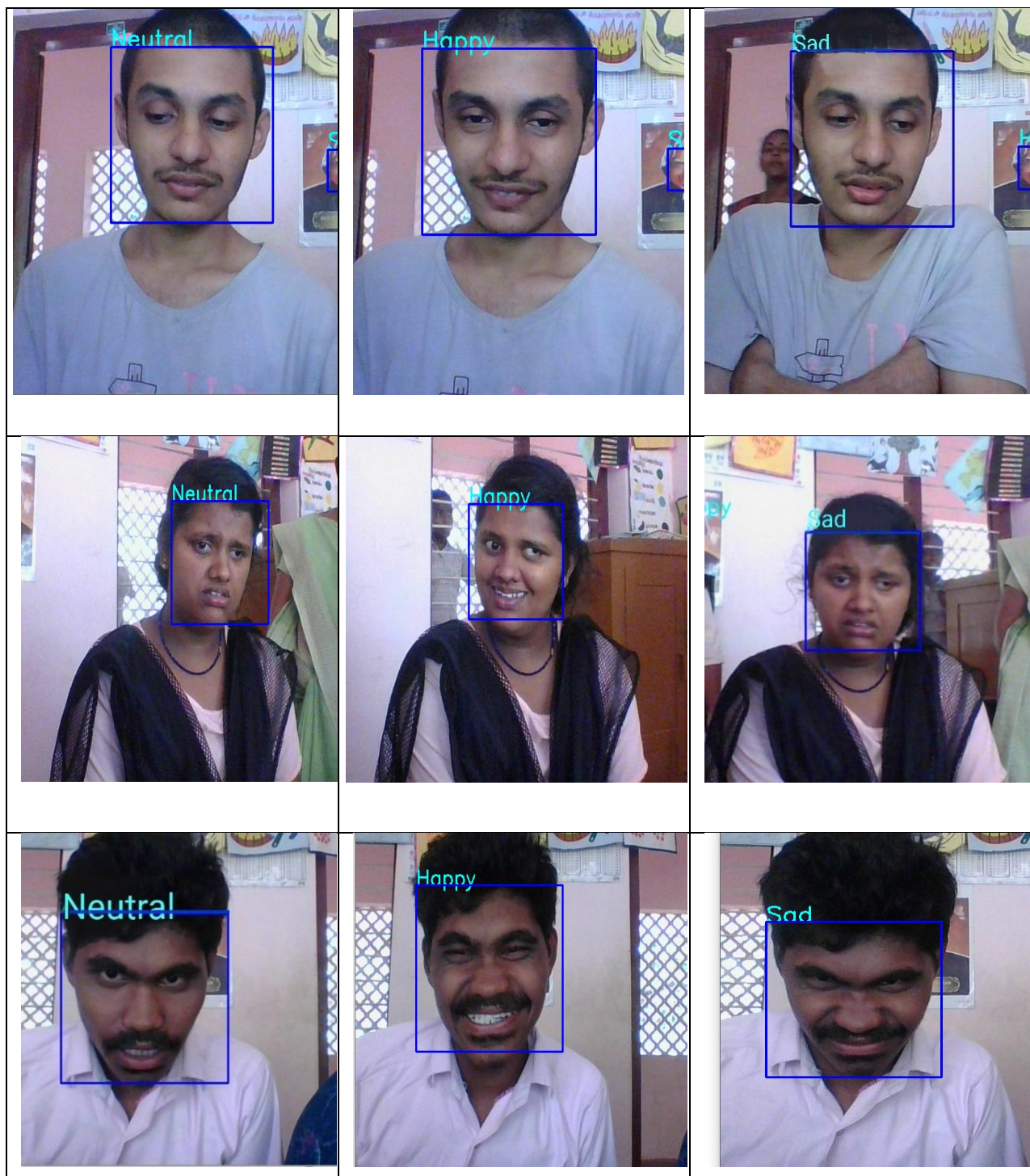
CHAPTER 5

RESULTS AND DISCUSSION

5.1 RESULTS

Here, we tested for Autism children because the facial emotions will be different from normal people and autism children. We got better accuracy in Neutral and Happy while in sad it tends to be different. Here the children pretend to be that emotion so we get some variation in that predicted emotions.





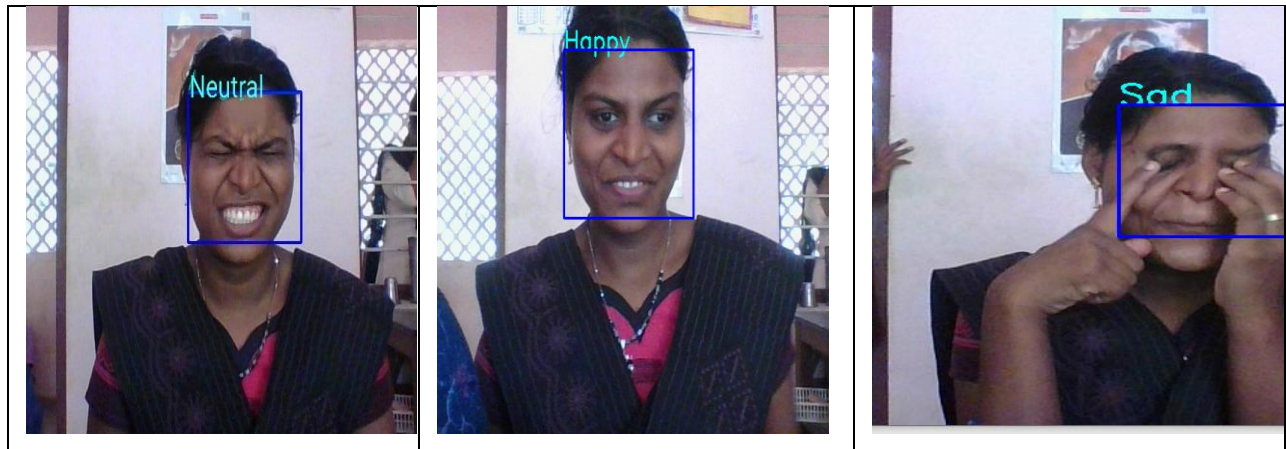


Fig 5.1 Emotions from different Autism children

The above figure shows that different emotions which detected from the Autism children. Here, we detect live emotions from six Autism children and songs have been played according to their emotion.

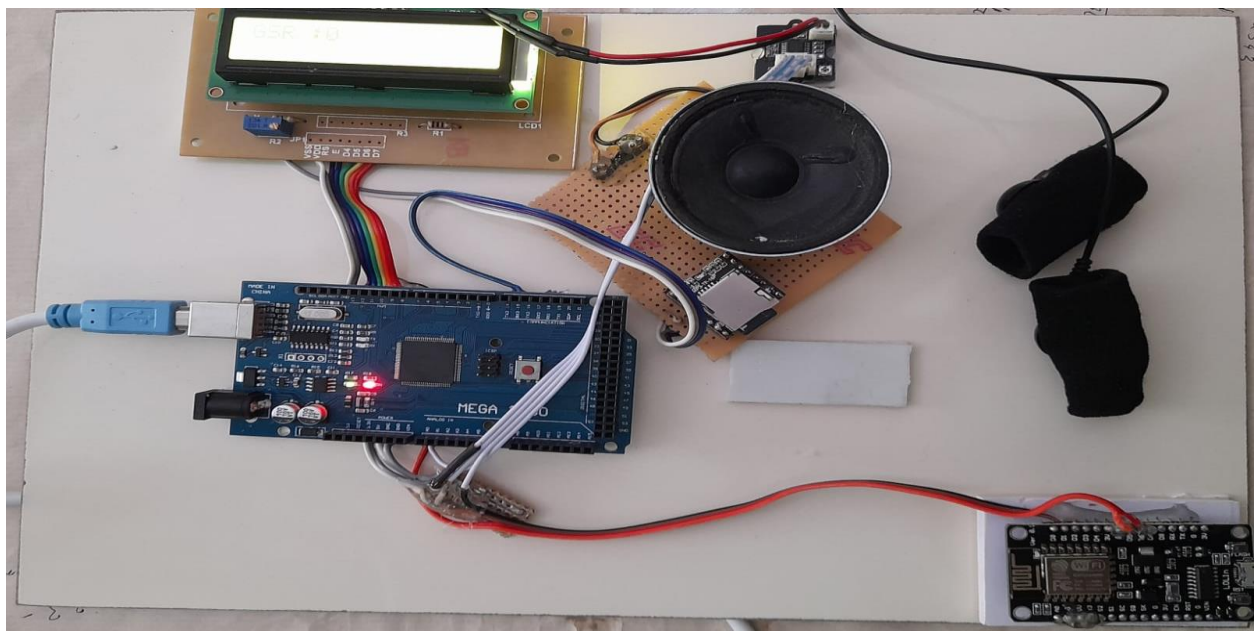


Fig 5.2 Proposed Hardware Model

Figure 5.2 shows the complete hardware of the proposed design. The hardware consists of the Arduino board to which GSR sensor get connected also live image detection data get transferred to arduino board for every second. An LCD is connected to visualize the immediate output of the sensor. Data from the arduino board is sent to Thing speak platform via the Node MCU-ESP8266 module



Fig 5.3 Output on LCD

In figure 5.3, the GSR value and emotion which detected from webcam will be displayed as happy or Sad. Here, the maximum emotion which detected from the webcam will be displayed. Hence, both the emotions get compared if both get same emotion then music will played according to that emotion with their preferences.

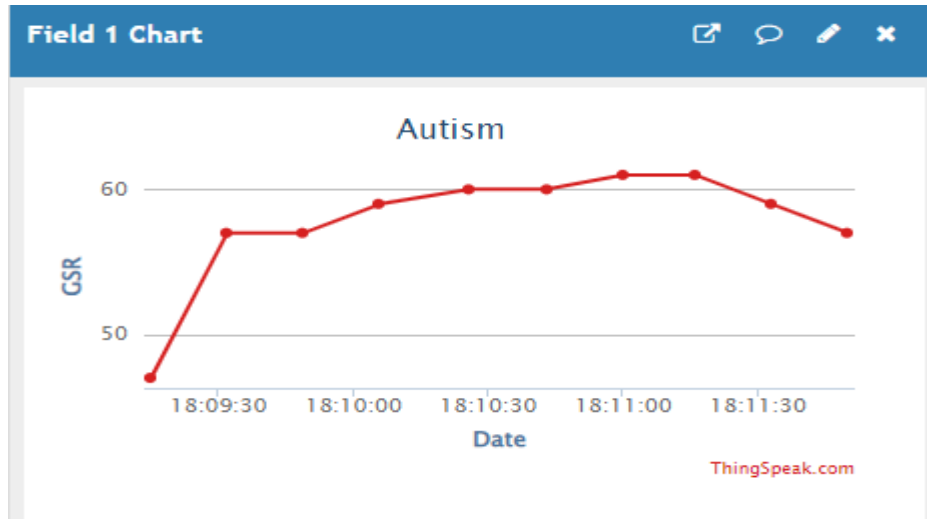


Fig 5.4 Output obtained on Thing speak

feeds (1) - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	created_a_entry_id	field1	field2	latitude	longitude	elevation	status														
1	2022-02-01	1	702 Neutral,																		
2	2022-02-01	2	702 Neutral,																		
3	2022-02-01	3	702 Neutral,																		
4	2022-02-01	4	702 Neutral,																		
5	2022-02-01	5	702 Neutral,																		
6	2022-02-01	6	702 Neutral,																		
7	2022-02-01	7	702 Neutral,																		
8	2022-02-01	8	703 Neutral,																		
9	2022-02-01	9	703 Neutral,																		
10	2022-02-01	10	704 Neutral,																		
11	2022-02-01	11	703 Neutral,																		
12	2022-02-01	12	702 Neutral,																		
13	2022-02-01	13	702 Neutral,																		
14	2022-02-01	14	702 Neutral,																		
15	2022-02-01	15	702 Neutral,																		
16	2022-02-01	16	703 Neutral,																		
17	2022-02-01	17	703 Sad,																		
18	2022-02-01	18	703 Sad,																		
19	2022-02-01	19	703 Sad,																		
20	2022-02-01	20	36 Sad,																		
21	2022-02-01	21	40 Sad,																		
22	2022-02-01	22	25 Sad,																		
23	2022-02-01	23	43 Sad,																		
24	2022-02-01	24	59 Sad,																		

Fig 5.5 Data downloaded in Excel sheet

The graphical output at the Thing Speak cloud is seen in Fig 5.4 and can be used only after logging in to the Thing Speak website with username and password, and the data can be downloaded as the excel form which seen in fig 5.5.

5.2 DISCUSSION

To measure the emotions in real time we used both image processing and physiological signal. For image processing the real time image got captured by webcam and face detection can be done followed by that facial expression can be predicted.

Here, we used haar cascade for human face detection and Convolutional neural network(CNN) for easy emotion prediction and pretrained dataset have been used for better result.

We tested this system for six Autism children in Rejoice School for Autism and the Developmentally Delayed which located in Kanyakumari and predicted their real time emotions and music has played according to their emotions.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY AND CONCLUSION

Autism children find difficult to interact people with their emotions and this is the reason they keep themselves isolated and not to be interested in learning. This work has explored the possibility of embedding conventional therapy modules into assistive technologies. This step is important in helping ASD children learn effectively and to help therapist's workload in order for them to be able to focus more on the child themselves. In addition to that we got tested for Autism children also we added to stored all the data to the cloud and can be downloaded as excel. The data which stored on cloud can be viewed by therapists online and this can help ease therapists or practitioners to make plans for future treatment. The data stored also be improved by automating graph plotting so that the trend for each child's progress can be analyzed easier. Also, we test the comfortability of the children when they connected with GSR, and got to know they are not facing any discomfort. While playing the music the children got interested and listen to that music.

6.2 FUTURE WORK

Our work has been done for only two emotions happy and sad as this is the first step of interfacing emotions into music. Here, we used CNN technique as it is easy when comparing with other. In future various techniques can be used in place of CNN and two or more can be interfaced for time consumption. Also, we used GSR as a physiological signal for comparing image and to the body reactions for better emotion detection. In future different types of physiological signal can be used like ECG, EEG, Photoplethysmogram etc., Interfacing more physiological signal with image processing better result can be obtained.

Here, we used Thing speak website to store all the data into cloud so all data can be viewed by the therapists when they are in need to monitor. In advanced technique it can be make to sent alarm to the respective parents, care takers or therapists when the children got any fear or angry for a prolonged time.

REFERENCES

1. A.Yao, D. Cai, P. Hu, ; HoloNet: towards robust emotion recognition in the wild, Proceedings of the 18th ACM International Conference on Multimodal Interaction 2016.
2. A. Estes, J. Munson, S. J. Rogers, J. Greenson, J. Winter, and G. Dawson, "Long-Term Outcomes of Early Intervention in 6-Year-Old Children With Autism Spectrum Disorder," *Journal of the American Academy of Child & Adolescent Psychiatry*, vol.54,no.7,pp.580-587,2015.
3. Allen, K. D., & Warzak, W. J. The problem of parental non adherence in clinical behavior analysis: Effective treatment is not enough. *Journal of Applied Behavior Analysis*, 33(3), 373–391.2020
4. Albinali, F., Goodwin, M. S., & Intille, S. S. *Recognizing stereotypical motor movements in the laboratory and classroom: A case study with children on the autism spectrum*. Paper presented at the Proceedings of the 11th international conference on Ubiquitous computing; 2020
5. Darrow, C.: The rationale for treating the change in galvanic skin response as a change in conductance. *Psychophysiology* 1, 31–45; 2020
6. Dandil E, Özdemir R Real-time facial emotion classification using deep learning. *Data Sci Appl* 2(1):13–17; 2020
7. Gil Levi,Tal Hassner; Emotion Recognition in the Wild via Convolutional Neural Networks and Mapped Binary Patterns, SC / Information Sciences Institute, the Open University of Israel; 2019.
8. Healey, J.A., Picard, R.W.: Detecting stress during real-world driving tasks using physiological sensors. *IEEE Transactions on Intelligent Transportation Systems* 6(2), 156–166; 2018
9. Jumani SZ, Ali F, Guriro S, Kandhro IA, Khan A, Zaidi A Facial expression recognition with histogram of oriented gradients using CNN. *Indian J Sci Technol* 12:24; 2019
10. KunHan, Dong Yu, Ivan Tashev; Speech Emotion Recognition Using Deep Neural Network and Extreme Learning Machine; Department of Computer

- Science and Engineering, The Ohio State University, Columbus,43210, OH, USA; Microsoft Research, One Microsoft Way, Redmond,98052, WA, USA,2020.
- 11.Khan MA, Javed K, Khan SA, Saba T, Habib U, Khan JA, Abbasi AA Human action recognition using fusion of multiview and deep features: an application to video surveillance.Multimedia Tools Appl 1- 26 ;2020
 - 12.K. Bouaziz, T Ramakrishnan, S. Raghavan, K. Grove, A.A.Omari, Lakshminarayan, “ Character Recognition by Deep Learning: An Enterprise solution.”, IEEE Conference on Big Data. 2021
 - 13.Lu Lingling liu, "Human Face Expression Recognition Based on Deep Learning-Deep Convolutional Neural Network", International Conference on Smart Grid and Electrical Automation (ICSGEA) ;2020
 - 14.Light, J., McNaughton, D., & Caron, J. New and emerging AAC technology supports for children with complex communication needs and their communication partners: State of the science and future research directions. Augmentative and Alternative Communication,35, 26–41 (2019).
 - 15.Lu Feng Zhou, Weiwei Fan, Qiangqiang Sheng and Mingliang Tao, "Ship Detection Based On Deep Convolutional Neural Networks For Polsar Images "International Geoscience and Remote Sensing Symposium 2018
 - 16.S.Suresh, H. T. P Mithun and M. H. Supriya, "Sign Language Recognition System Using Deep Neural Network," 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS), Coimbatore, India,, pp. 614-618. doi: 10.1109/ICACCS.2019.8728411;2019
 - 17.Sarah Afiqah Mohd Zabidi,Shahrul Naim Sidek; Simple touch sensor-based game as ambient assistive device for mild autism spectrum disorder children;IEEE EMBS conference on biomedical engineering and sciences(IECBES)2020
 - 18.Students department of comuter science"EMO Player'Emotional based music player'International Research Journal of Engineering and Technology(IRJET),www,irjet.net Volume:5Issue:04;2018

19. T. A. Slocum, R. Detrich, S. M. Wilczynski, T. D. Spencer, T. Lewis, and K. Wolfe, "The Evidence-Based Practice of Applied Behavior Analysis," *Behav. Anal.*, vol. 37, no. 1, pp. 41–56, 2018
20. Yhia Said, Mohammad Barr; Human emotion recognition based on facial expressions via deep learning on high-resolution images; 2021.
21. Zhang Y-D, Khan SA, Attique M, Rehman A, Seo S ; A resource conscious human action recognition framework using 26-layered deep convolutional neural network. *Multimedia Tools Appl* 1–23 ;2020

APPENDICES

PROGRAM USED FOR ARDUINO BOARD

```
#include<LiquidCrystal.h>
#include "DFRobotDFPlayerMini.h"
#include <Wire.h>
#define splash splash1
#define python Serial
#define ard_node Serial2
#define mp3_serial Serial3
LiquidCrystal lcd(13, 12, 11, 10, 9, 8);
#define gsr A0
String IncomingData = "";
int gsr_r;
int dis_t = 250;
int disp = dis_t ;
DFRobotDFPlayerMini DFPlayer;
String prev_Rec = "Neutral";
void setup() {
    // put your setup code here, to run once:
    Serial.begin(115200);
    ard_node.begin(115200);
    python.begin(115200);
    mp3_serial.begin(9600);
    LcDSet();
    delay(1000);
    splash(0, "Initializing");
    splash(1, "DF-Player");
    if (!DFPlayer.begin(mp3_serial)) { //Use softwareSerial to communicate with mp3.
        Serial.println(F("Unable to begin:"));
    }
```

```

    Serial.println(F("1.Please recheck the connection!"));
Serial.println(F("2.Please insert the SD card!"));
}
Serial.println(F("DFPlayer Mini online."));
DFPlayer.volume(25); //Set volume value. From 0 to 30
DFPlayer.play(2); //Play the first mp3
splash(0, "Initializing");
splash(1, "Python");
python.println("Ready");
lcd.clear();
}
void LcDSet() {
    lcd.begin(16, 2);
    splash(0, "Emotion Based");
    splash(1, "Teaching System");
    delay(3000);
    splash(0, "For Autistic");
    splash(1, "Children's");
    delay(3000);
}
void loop() {
    // put your main code here, to run repeatedly:
    getSensor();
    getPython();
    if (DFPlayer.available()) {
        printDetail(DFPlayer.readType(), DFPlayer.read()); //Print the detail message from
DFPlayer to handle different errors and states.
    }
    disp++;
    // Serial.println(disp);
    if (disp > dis_t) {

```

```

    lcd.setCursor(0, 0);
    lcd.print("GSR :   ");
    lcd.setCursor(5, 0);
    lcd.print(gsr_r);
    ard_node.print(gsr_r);
    ard_node.print(",");
    ard_node.print(prev_Rec);
    ard_node.print(",");
    // Serial.println();
    disp = 0;
}
delay(10);
}

void getPython() {
    if (python.available())
    {
        IncomingData = python.readString();
        delayMicroseconds(5);
    }
    if (IncomingData.length() > 0) {
        python.println(IncomingData);
        splash(1, IncomingData);
        if (IncomingData == "Sad" and prev_Rec != "Sad" and gsr_r > 80)
        {
            prev_Rec = "Sad";
            DFPlayer.play(2);
        }
        else if (IncomingData == "Happy" and prev_Rec != "Happy" and gsr_r < 80)
        {
            prev_Rec = "Happy";
            DFPlayer.play(1);
        }
    }
}

```

```

    }
    else if (IncomingData == "Neutral" and prev_Rec != "Neutral")
    {
        prev_Rec = "Neutral";
        DFPlayer.stop();
    }
    IncomingData = "";
}

}void getSensor() {
    gsr_r = analogRead(gsr);
    gsr_r = map(gsr_r, 0, 1023, 100, 0);
    if (gsr_r < 35) {
        gsr_r = 0;
    }
    if (DFPlayer.available() ) {
        Serial.print(F("Number:"));
        Serial.print(DFPlayer.read());
        Serial.println(F(" Play Finished!"));
        if ( prev_Rec == "Neutral")
        {
            prev_Rec = "Neutral";
            DFPlayer.stop();
        }
        else if (prev_Rec == "Sad" and gsr_r > 80 )
        {
            prev_Rec = "Sad";
            DFPlayer.play(2);
        }
        else if (gsr_r < 80 and prev_Rec == "Happy" )
        {
            prev_Rec = "Happy";

```

```
    DFPlayer.play(1);  
}  
else {  
    DFPlayer.stop();  
    splash(1, "")
```

PROGRAM USED FOR DF PLAYER

```
void printDetail(uint8_t type, int value){  
    switch (type) {  
        case TimeOut:  
            Serial.println(F("Time Out!"));  
            break;  
        case WrongStack:  
            Serial.println(F("Stack Wrong!"));  
            break;  
        case DFPlayerCardInserted:  
            Serial.println(F("Card Inserted!"));  
            break;  
        case DFPlayerCardRemoved:  
            Serial.println(F("Card Removed!"));  
            break;  
        case DFPlayerCardOnline:  
            Serial.println(F("Card Online!"));  
            break;  
        case DFPlayerUSBInserted:  
            Serial.println("USB Inserted!");  
            break;  
        case DFPlayerUSBRemoved:  
            Serial.println("USB Removed!");  
            break;
```

```

case DFPlayerPlayFinished:
    Serial.print(F("Number:"));
    Serial.print(value);
    Serial.println(F(" Play Finished!"));
    break;
case DFPlayerError:
    Serial.print(F("DFPlayerError:"));
    switch (value) {
        case Busy:
            Serial.println(F("Card not found"));
            break;
        case Sleeping:
            Serial.println(F("Sleeping"));
            break;
        case SerialWrongStack:
            Serial.println(F("Get Wrong Stack"));
            break;
        case CheckSumNotMatch:
            Serial.println(F("Check Sum Not Match"));
            break;
        case FileIndexOut:
            Serial.println(F("File Index Out of Bound"));
            break;
        case FileMismatch:
            Serial.println(F("Cannot Find File"));
            break;
        case Advertise:
            Serial.println(F("In Advertise"));
            break;
        default:
            break;
    }

```

Splash

```
void splash1( int row, String txt)
{
    int curs = (17 - txt.length()) / 2;
    lcd.setCursor(0, row);
    lcd.print("-----");

    lcd.setCursor(curs, row);
    lcd.print(txt);
    delay(100);
}

void splash2( int row, String txt)
{
    int curs = (21 - txt.length()) / 2;
    lcd.setCursor(0, row);
    lcd.print("-----");
    lcd.setCursor(curs, row);
    lcd.print(txt);
    delay(70);
}
```