

EMOTION-BASED MEDIA PLAYBACK SYSTEM FOR AUTISM

Submitted in partial fulfillment of the requirements for the award of a
Bachelor of Technology in Biomedical Engineering

By,

M.HEPZIBAH SUSAN(39240018)

AISHWARYA.J(39240003)



**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 | 12B Status by UGC | Approved by AICTE
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APRIL - 2023



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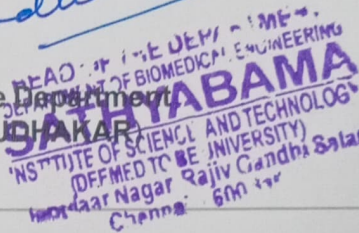
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **M. HEPZIBAH SUSAN (39240018)**, **AISHWARYA.J (39240003)** who have done the project work as a team who carried out the project entitled "**EMOTION-BASED MEDIA PLAYBACK SYSTEM FOR AUTISM**" under our supervision from **October 2022** to **April 2023**.

Internal Guide
(MS. SINDU DIVAKARAN)

Head of the Department
(Dr. T. SUCHAKAR)



Submitted for Viva-voce Examination held on 18.04.2023.

Internal Examiner

External Examiner

DECLARATION

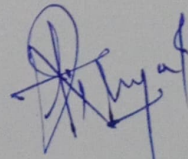
We, **M. HEPZIBAH SUSAN (39240018)** and **AISHWARYA.J (39240003)** hereby declare that the Project Report entitled "**EMOTION-BASED MEDIA PLAYBACK SYSTEM FOR AUTISM**" done by us under the guidance of **Ms. Sindu Divakaran**, Assistant Professor, Department of Biomedical Engineering at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Biomedical Engineering.

DATE: 18/04/2023

PLACE: Chennai

M. Hepzibah Susan

1.M.HEPZIBAH SUSAN



2.AISHWARYA.J

SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to the **Board of Management of SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

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

We would like to express our sincere and deep sense of gratitude to our Project Guide **Ms. Sindu Divakaran, Assistant Professor, Department of Biomedical Engineering** for her valuable guidance, suggestions, and constant encouragement paving the way for the successful completion of our project work.

We wish to express our 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.

We would also like to express our gratitude towards our parents for supporting us in the successful completion of our project.

ABSTRACT

Nowadays Autism children find it difficult to interact socially with people's emotions and make themselves isolated. This project proposes Emotion detection for autism spectrum disorder children (ASD). It is self-posessed of python libraries Open CV, and the Haar-cascade method to predict faces prediction. Conversely, most existing methods rely on the detection of facial expressions of people in social media platforms such as Snapchat uses facial recognition technology, and also detecting facial emotions from their Facial expressions in the image. And for better involvement of the children's social behavior, here a face is captured in real-time and emotions are predicted by Facial expression recognition (FER). This proposed system helps to improve Autism children's behavior as they often observe their facial expressions and predict the facial emotion. If the Predicted facial Emotion is happy, then we will play some Interesting Audio to them using AT mega Microcontroller and DF mini-Player, which will keep them relaxed and will help them to learn interactively. Along With that we have designed and built a stress sensor based on Galvanic Skin Response (GSR), to find their stress level and monitor it via over the Internet Using NodeMCU (ESP8266-12E Microcontroller unit).

KEYWORDS: Autism Spectrum Disorder (ASDs), OpenCV, Learning, Facial Expression Recognition (FER), Stress Detection Using Galvanic Skin Response sensor.

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LIST OF ABBREVIATIONS

ABBREVIATION	EXPANSION
ABA	Applied Behaviour Analysis
ASDs	Autism spectrum disorders
CRTs	Cathode ray tubes
DIP	Dual inline package
FER	Facial expression recognition
GSR	Galvanic Skin Response
IDE	Integrated Development Environment
IoT	Internet of Things
LCDs	Liquid crystal displays
MCU	Microcontroller unit
ML	Machine Learning
MMC	Multimedia Cards
SDMI	Secure Digital Music Initiative
UML	Unified Modeling Language

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CHAPTER 1

INTRODUCTION

Emotions are mental states caused by neurophysiological changes that are related with varied ideas, sensations, behavioral responses, and a level of pleasure or dissatisfaction. Emotions are an important part of the experiences of both language teachers and language learners; however, their role has often been marginalized as a result of the focus on cognitive rather than affective dimensions of language learning within the discipline of Second Language Acquisition. (Jack C. Richards, 2020). Emotions are frequently linked to mood, temperament, personality, disposition, or creativity. Sixteen faces reflecting human sentiments - colored engraving by J. Pass, 1821, after Charles Le Brun. Emotion research has risen during the last two decades, with various fields participating, including psychology, medicine, history, sociology of emotions, and computer technology. Many attempts to explain the genesis, function, and other elements of emotions have fueled intense research on the subject.(Wafa Mellouk et al.,2020) Charles Darwin was the first to speculate on the evolutionary origins and potential functions of emotion. Current research fields include the neuroscience of emotion, which uses technologies such as PET and fMRI scans to explore the affective picture processes in the brain. Emotions(Fig 1.1) can be defined as "a happy or negative experience that is associated with a certain pattern of physiological activity" from a mechanistic standpoint. Emotions are complicated, involving many distinct components such as subjective experience, cognitive processes, expressive behavior, psychophysiological changes, and instrumental action. Academics once attempted to associate emotion with one of the components: William James with subjective experience, behaviorists' with instrumental behaviour, psychophysiolgists with physiological changes, and so on. Emotion is now said to include all of the components. The many components of emotion are classified differently based on the academic discipline. In psychology and philosophy, emotion is often defined as a subjective, aware experience characterised primarily by psychophysiological manifestations, bodily reactions, and mental states. Sociology uses a multi-component explanation of emotion.

behaviours, and the evaluation of circumstances and surroundings. Cognitive processes, such as reasoning and decision-making, are frequently seen to be distinct from emotional processes, resulting in a distinction between "thinking" and "feeling." Nevertheless, not all emotion theories accept this distinction.

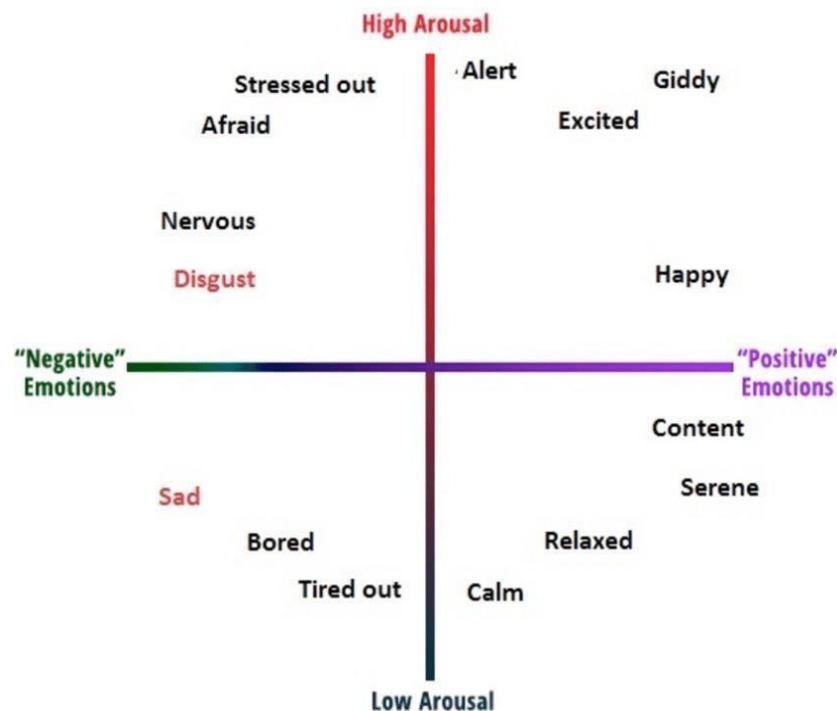


Fig 1.1. Dimensions of emotions

1.1. AUTISM SPECTRUM DISORDER

Autism spectrum disorders can cause some individuals to act out of the ordinary. Autism (Fig 1.2) is a neurodevelopmental disease that lasts a lifetime and is distinguished by behavioral, social, and communication abnormalities. People with autism disorders may experience difficulties interacting with their surroundings as a result of these characteristics. These traits are formed very early in development or at birth. Although the exact neurobiological signaling pathways have not yet been identified, it is clear that autism spectrum disorders reflect how specific parts of the developing brain function. Autism spectrum disorders are characterized by areas of equal intensity with distinct

deficit patterns. A child's ability to acquire social skills, self-care skills, and community participation is often impaired throughout life. Autism spectrum disorders are often accompanied by speech and intellectual disabilities. Therefore, when establishing educational programs, it is important to consider the demands typically associated with autistic disorders and the needs associated with potential disabilities. Currently, the main treatment for autism spectrum disorders is education, directly for children and indirectly for parents and teachers. This overview article aims to explain how autism develops, how it is treated, and how different means of communication can be used. Autism indeed affects brain development, causing problems in behavior, communication, and social interaction. It's a neurological disorder. Although there is currently no approved cure for autism, children have made great strides with early treatment and productive educational efforts (Aysha Faraj AL Dawodi et al., 2020). ASD is usually discovered and clinically identified by the age of 3-4 years. Autism is characterized by three symptoms: communication in spoken and non-spoken language human involvement due to difficulties in recognizing and communicating one's emotions and related adaptation. Restricted or repetitive movement patterns associated with the following conditions may have difficulty learning new material and participating in classroom activities if the disease is not treated and diagnosed early. It typically starts in infancy and lasts into puberty and maturity. While some of her ASD sufferers can live independently, others face significant challenges and require ongoing support and care. Although some people with autism spectrum disorders also have intellectual disabilities, most have average or above-average IQs (Holly Hodges et al., 2020). By enhancing communication, promoting a new language environment. Autism spectrum disorders cause delays in speech and language development independence, and fostering social relationships, assistive skills such as reasoning and appropriate communication may benefit people with autism. Difficulty understanding other people's emotions or expressing themselves, with limited speech and language skills (eg, children with autism). It uses the term much later than its siblings. Peering, or communicating without words. Repeating words or phrases Giving irrelevant answers to questions. Disturbed by minor routine changes (e.g., getting a new toothbrush). Having obsessive hobbies (such as collecting rare books). There is a high level of interest in less congested trains. He or she may flap his arms, rock his body, or

spin in place. Use and play with items in unique ways. By spinning in circles or standing in line. Strange reactions to sounds, breathing, taste, sight, and touch of objects.

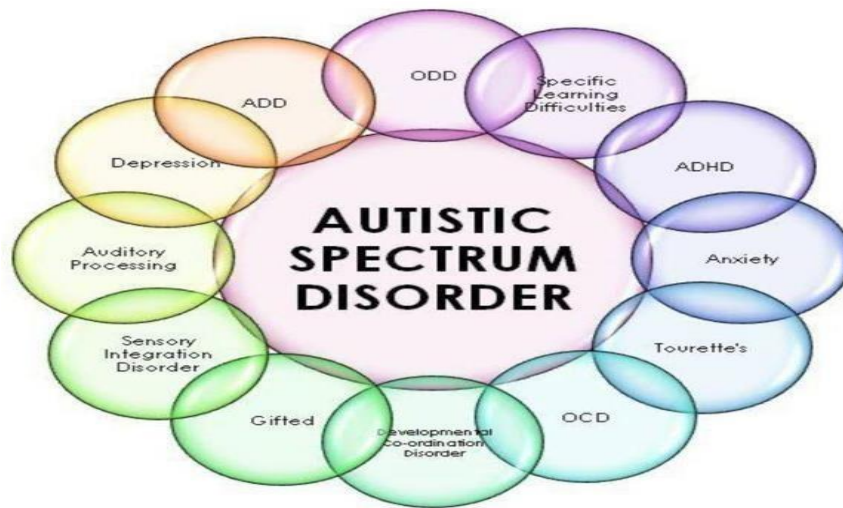


Fig 1.2.Spectrum of autism

1.2. CAUSES OF AUTISM SPECTRUM DISORDER:

Although there is evidence that genes and the environment are important factors, scientists are still unaware of the specific origin of ASD. Genes that may increase the risk of ASD are slowly being discovered by researchers. People with certain genetic disorders, such as tuberous sclerosis and fragile X syndrome, Down syndrome, and Rett syndrome, develop ASD more likely to develop. Many scientists look at how genes combine with family medical problems, parental age and other demographics, and environmental conditions such as difficulties during childbirth and pregnancy. There is currently no scientific evidence between vaccines and autism spectrum disorders (ASD). There are many different causes for autism spectrum disorder (ASD), and its clinical manifestation is typically linked to significant disability over the course of the lifespan. (Lonnie zwaigenbaum et al.,2018). Premature birth and older parental age are two other major risk indicatorsfor ASD . This is related to the hypothesis concluded that older gametes are more likely to carry mutations that may proceed to further obstetric consequences such as preterm birth . There is no doubt that certain illnesses during childbirth, for example, rubella, raisethe chance of Autism spectrum. Nevertheless, there is not much proof that viral illnessescommon present day, such as the flu during pregnancy, significantly

increase the risk of ASD. Signals can be subdued due to genetic influences of the environment, as is the case in certain mouse strains . If so, the evidence must come from studies that combinesophisticated genomic analysis with large-scale epidemiology. May change human risk. Additionally, there is evidence that the risk of ASD increases with shorter and longer intervals between pregnancies (Schieve LA et al.,2018) . Studies show that premature babies are more likely to suffer from autism and various neurodevelopmental disorders. Previous epidemiological analyses have found that obstetric considerations such as uterine bleeding, C-Section, low infant birth weight, premature birth, and childbirth are responsible. Low Apgar scores were some of the indicators more related to autism. Olderparents are more likely to have children with ASD . Early findings have important implications for social workers and other mental health professionals about how they seeand act on the challenges faced by people with ASD.

1.3. TYPES OF AUTISM SPECTRUM DISORDER

There are three types of autism spectrum disorders (Fig 1.3):

Autistic Disorder(Manuela Albernaz Monteiro et al.,.2020) - This is commonly referred to as "classic" autism. That is what most people envision when they hear the term "autism." Autistic people typically have major language deficits, social and communication difficulties, and unique habits and interests.Many autistic persons also have intellectual disabilities.Asperger's Syndrome-Asperger syndrome is characterised by milder signs of autistic disorder. They may have social difficulties as well as unique actions and hobbies.(Seyed Alireza Hosseini et al.,.2023)They do not, however, often have linguistic or intellectual disabilities. Not Otherwise Specified.Pervasive Developmental Disorder-This is also known as "atypical autism" or PDD-NOS.Individuals with atypical autism may fulfil some of the criteria for autistic disorder or Asperger syndrome but not all. Pervasive Developmental Disorder – Not Otherwise Specific.This is also known as "atypical autism" or PDD-NOS. Individuals with atypical autism may fulfil some of the criteria for autistic disorder or Asperger syndrome but not all. These folks often have fewer and milder symptoms than autistic persons. The symptoms may just create social and communication difficulties



Fig 1.3. Types of Autism spectrum disorder

People can accurately identify a standard face and understand face expression during a single glance. However, children with autism spectrum disorder (ASD) often have problems communicating and socializing (Sarah Afiqah Mohd Zabidi et al.,2020). It is difficult for them to interact with their parents, teachers and other kids. The common thread are the differences in social skills, communication, and behavior compared with people who aren't on the spectrum .Also, they do not express their emotion and also, they are unaware of others' feelings too. An innovative system to recognize facial expressions from human faces that is captured in real-time from which children with ASD can learn others' emotions. In this project a web application is produced which captures the human face in real time and predict the emotion of the person and can be stored in the database of the system. Children with ASD often tend to spend time by themselves, so we can integrate the system as a web application which the children can use using tablets for better involvement. The implementation process undergoes face detection, age and gender prediction and emotion recognition using python models and libraries. When the user captures the image of the person's face, it then detects the face using haar cascade classifiers which do haar feature selection for feature extraction. Then a gender python library generates the threshold value for age and gender. Facial Expression Recognition (FER) (Michael Revina et al.,2021) predicts the emotion percentage for each standard six emotion and shows the highest percentage of them. As the child observes the expressions often, it will make human faces familiar and also the child might try to imitate the expressions by learning from it. While there is no cure for autism, this application will

make a huge difference in their lives. This will help them to improve their behaviors and skills. Face recognition comes under the domain of Computer Vision which is an approach to identify and recognize images. Currently, they are being applied to various applications to solve real-world problems in many fields such as industries, manufacturing, healthcare, etc., for public security, marketing, banking, etc. Social media platforms have advanced algorithms capable to perform various functionalities in facial recognition to attract a wider user base. The main objective of this system is to capture an image in real-time and then recognize whether it is a human face using the Computer Vision technique. After detecting the human faces from an image, and observe the facial expressions using Deep Neural Network and If the Predicted facial Emotion is happy, then we will play some Interesting Audio to them using ATmega Microcontroller, which will keep them relax and will help them to learn. Along With that we have designed and built a stress detector using Galvanic Skin Response (GSR). For this objective, we have to calculate the different conductance of the skin when a person is under stress or when not using Galvanic Skin Response (GSR) device and storing the data on the IoT Based Cloud platform (Uzma Hasan et al., 2020) for further Evaluation.

CHAPTER 2

LITERATURE SURVEY

Aysha Faraj AL Dawodi, Sarah Faisal Alzahrani, Reema Abdulkareem Almumtin et al developed an online learning platform to encourage social interaction in autistic children, using UML and ASP.NET. It provides educational games to help them feel more comfortable and relaxed doing activities.

Sarah Afiqah Mohd Zabidi Hazlina ,Md Yusof Sukreen Hana ,Herman Shahrul Naim Sidek describes about the development of an Arduino-based game designed to facilitate learning in ASD children. It is equipped with common components such as touch sensor, MP3 player and LEDs to increase replicability. Research was done based on the Early Intervention module to develop a game that could help improve cognitive skill of ASD children.

Uzma Hasan(B), Md. Fourkanul Islam, Muhammad Nazrul Islam et al aims to design and develop a gaming application for autistic children to improve their cognitive skills. It uses the Internet of Things (IoT) and ABA techniques to develop three games including a puzzle game, an object finding game and a road crossing game. The cognitive development (in terms of gaming scores) of a child over the time can be stored and analyzed using this application.

Mehdi Hosseinzadeh, Jalil Koohpayehzadeh, Ahmed Omar Bali et al develops an assistive technologies and the Internet of Things (IoT) that can help to eliminate the lack of verbal and nonverbal communication. This provides a systematic review of ASD approaches in the context of IoT devices, with evaluation metrics such as accuracy and sensitivity.

Nigmatullina , V Ju Dadakina ,Kazan uses a comparative analysis of scientific studies devoted to the issues of modern characteristics and effectiveness of modern technologies and models of complex support for children with autism, as well as quantitative and qualitative assessment of the quality of pre-school education of childrenwith autism

Emma J Glasson , Sarah MacDermott et al has implemented statewide guidelines for the assessment of ASD, developed an open forum for clinicians to discuss issues, and supported a statewideregister of newly diagnosed cases, leading to improved consistency and cohesiveness.

Okan Arslan, Fethi A. Inan ,Hyunchang moon,Yusuf Murat Ozdemir et al examined the use of technology in ASD education by conducting a systematic literature review using the Web of Science database. 100 studies were reviewed to investigate the type and purpose of technology use, the types of technology used for skill development, and instructional delivery tool skills.

Sven Strick Roth , Dietmar Zoerner , Tobias Moebert et al proposes a game concept to integrate learning content with a playful narrative to promote motivation and attention for socio-emotional training in autistic people. To increase attention, game-based learning concepts can be used to promote motivation and attention for socio-emotional training.

Jose Maria Garcia-Garcia, Victor MR Penichet, Maria D Lozano et al aims to help children with ASD improve their ability to understand and detect emotions, a novel software application has been developed. It incorporates emotion recognition technologies to support novel interaction mechanisms based on TUIs and facial expressions. Evaluation results are positive and support the validity of the proposal.

Ahmed Hassan, Niels Pinkwart, Muhammad Shafi developed games that can improve social behaviour in individuals with ASD, but need larger sample and clinical validation.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

- This proposed system helps to improve Autism children's behavior as they often observe their facial expressions and predict the facial emotion.
- Face recognition comes under the domain of Computer Vision which is an approach to identifying and recognizing images.
- Currently, they are being applied to various applications to solve real-world problems in many fields such as industries, manufacturing, healthcare, for public security, marketing, banking, etc.
- 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.

3.2 SCOPE

- The main objective of this system is to capture an image in real-time and then recognize whether it is a human face using the Computer Vision technique.
- After detecting the human faces from an image, and observe the facial expressions using Deep Neural Network.
- If the Predicted facial Emotion is happy, then we will play some Interesting Audio to them using AT mega Microcontroller and DF mini-Player, which will keep them relaxed and will help them to learn.
- Along With that we have designed and built a stress detector using Galvanic Skin Response (GSR). For this objective, we have to calculate the different conductance of the skin when a person is under stress or when not using Galvanic Skin Response (GSR) device. These Stress levels of Autism People can be monitored in real-time using IoT mobile Application this will be helpful to easily monitor them by their family members, doctors/ care-taker.

CHAPTER 4

MATERIALS AND METHODS

4.1. HARDWARE USED

4.1.1. ARDUINO

Arduino (Fig 4.1.) is a single-board open-source microcontroller (Leo Louis.,2018) to make using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open-source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a boot loader that executes on the microcontroller.

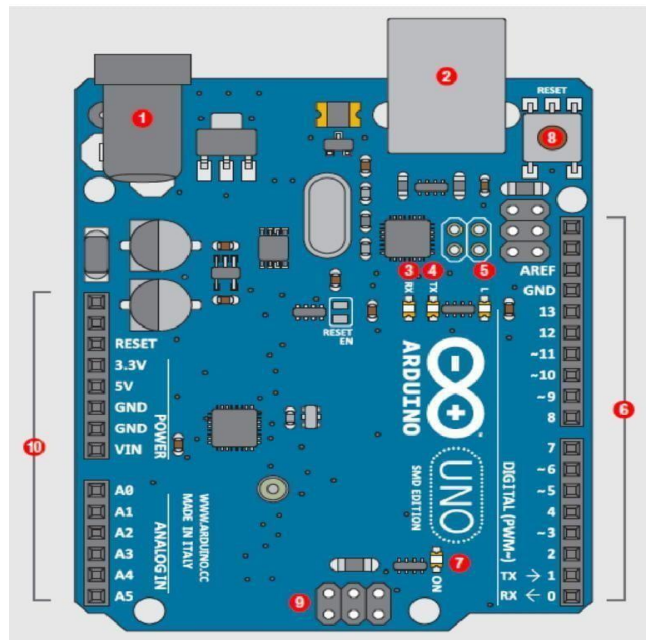


Fig 4.1. Arduino

1. Power In (Barrel Jack)-Can be used with either a 9V or 12V wall-wart or battery.
2. Power In (USB Port)-Provides power and communication with your board when plugged into your computer via USB.

3. LED (RX: Receiving)-This shows when the Arduino is receiving data (such as when being programmed).
4. LED (TX: Transmitting)-This shows when your Arduino is transmitting data (such as when running a program).
5. LED Pin 13: Troubleshooting) - This LED is incorporated into your sketch to show to show if your program is running properly.
6. Pins (ARef, Ground, Digital, Rx, Tx)-These various pins can be used for inputs, outputs, power, and ground.
7. LED (indicates arduino is ON)-This is a simple power indicator LED.
8. Reset Button-This is a way to manually reset your Arduino, which makes your code restart
9. ICSP Pins (uploading Code without Bootloader)-This is for “in-Circuit serial Programming “, used if you want to bypass the boot loader.
10. Pins (Analog In, Power In,Ground, Power Out, Reset)-These various pins can be used for inputs, outputs, power, and ground.

4.1.2. LIQUID CRYSTAL DISPLAY

Liquid crystal displays (LCDs) (Fig 4.2.) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. LCDs are made up of a spatial array of pixels, with each pixel having a pair of electrodes and polarizing filters sandwiching a column of liquid crystal (LC) material. (Hallum LE et al.,.2021)

An LCD consists of two glass panels, with the liquid crystal material sandwiched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed. Polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. One each polarisers are pasted outside the two glass panels. These polarisers would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light

rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent.



Fig 4.2. Liquid crystal display

When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters. The LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD's don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics.

4.1.3. DF MINI PLAYER

The DF Player Mini MP3 Player (Fig 4.3.) For Arduino is a small and low-cost MP3 module with a 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 microcontrollers such as Arduino, ESP32, Raspberry Pi and any microcontrollers with UART.

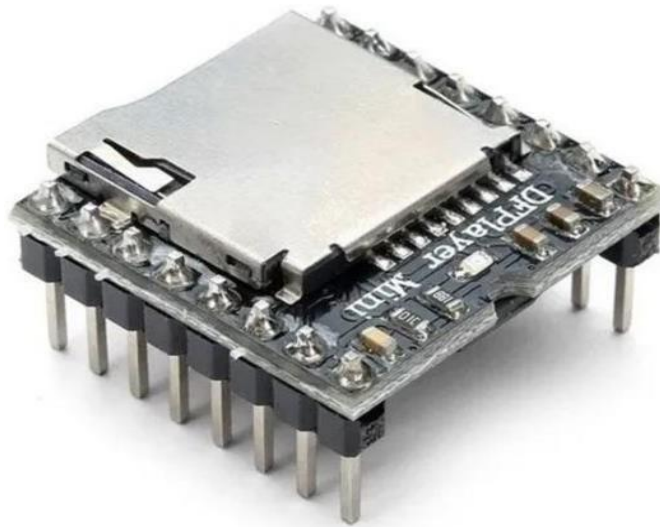


Fig 4.3.DF mini player

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 continues to play-audio data is sorted by folder, supports up to 100 folders, every folder can hold up to 255 songs-30 level adjustable volume, 6 -level EQ adjustable. The DF Player (MP3 module) is used to insert the micro-SD card (memory card) in accordance with the downloaded songs on it (Emmanuel G. Dada et al.,.2018).

Application: Car navigation voice broadcast, Road transport inspectors, toll stations voice

prompt,Railway station, bus safety inspection voice prompt, Electricity, communications, financial business hall voice prompts, Vehicle into and out of the channel verify that the voice prompts, The public security border control channel voice prompts,Multi-channel voice alarm or equipment operating guide voice, The electric tourist car safe driving voice notices, Electromechanical equipment failure alarm, Fire alarm voice prompts; The automatic broadcast equipment, regular broadcast.

4.1.4. SD CARD

The standard was introduced in August 1999 by joint efforts between SanDisk, Panasonic (Matsushita) and Toshiba as an improvement over MultiMediaCards (MMCs), and has become the industry standard. The three companies formed SD-3C, LLC, a company that licenses and enforces intellectual property rights associated with SD memory cards and SD host and ancillary products.The companies also formed the SD Association (SDA), a non-profit organization, in January 2000 to promote and create SD Card standards.SDA today has about 1,000 member companies. The SDA uses several trademarked logos owned and licensed by SD-3C to enforce compliance with its specifications and assure users of compatibility.



Fig 4.4.SD card

In 1999, SanDisk, Panasonic (Matsushita), and Toshiba agreed to develop and market the Secure Digital (SD) Memory Card (Fig 4.4). Music files are read from flash-based storage (SD Card), which can only hold 128mb, decoded via a decoder chip, and played via a high-end audio DAC.(Emmanuel G. Dada et al .,2018)The card was derived from the MultiMediaCard (MMC) and provided digital rights management based on the Secure Digital Music Initiative (SDMI) standard and for the time, a high memory density.It was designed to compete with the Memory Stick, a DRM product that Sony had released the year before. Developers predicted that DRM would induce wide use by music suppliers concerned about piracy.The trademarked "SD" logo was originally developed for the Super Density Disc, which was the unsuccessful Toshiba entry in the DVD format war. For this reason the D within the logo resembles an optical disc.

4.1.5. GALVANIC SKIN RESPONSE

GSR sensor (Fig 4.5) stands for galvanic skin response sensor and it is a method of measuring the electrical conductance of the skin (Daghan Dogan et al.,2019). 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. Note: This device is not a medical device.Features: Detects conductance of skin, Finger Straps for electrodes For all Grove users (especially beginners), Technical Details: Dimensions 24mm x 20mm x 9.80mm, WeightG.W 29g, Battery Exclude Input Voltage 5V/3.3V, Sensitivity adjustable via a potentiometer. The data measured from the designed device was evaluated for the patient's position, GSR, the respiration rate, the blood oxygen content, and the heart rate The designed device might provide for monitoring and recording data with led display, serial port, microSD card or internet of things. (Mehmet Ali Dincer et al ., 2021).

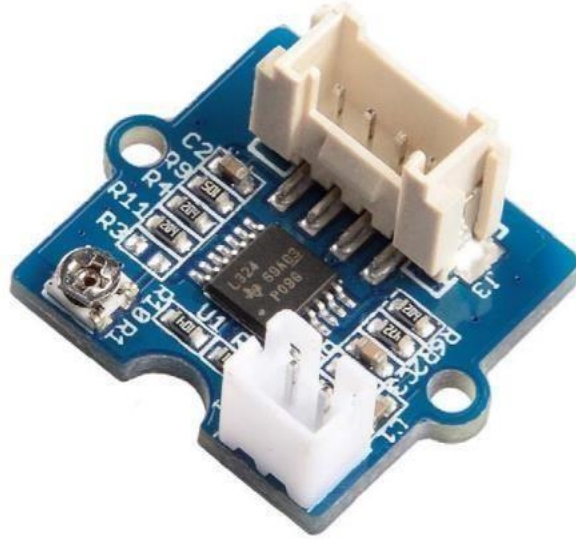


Fig 4.5. Galvanic skin response

4.1.6. NODEMCU

NodeMCU (Fig 4.6) is an open-source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit) Strictly speaking, the term "NodeMCU" refers to the firmware rather than the associated development kits. Both the firmware and prototyping board designs are open source. The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented. The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications (see related projects). NodeMCU is an open source and LUA programming language based firmware developed for ESP8266 wifi chip (Yogendra Singh Parihar , 2019).

There are two available versions of NodeMCU as version 0.9 & 1.0 where the version 0.9 contains ESP-12 and version 1.0 contains ESP-12E where E stands for "Enhanced".

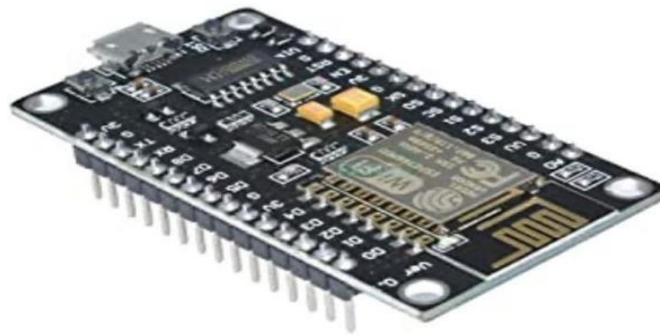


Fig 4.6. Nodemcu

4.1.7. SPEAKER

A loudspeaker (Fig 4.7) (commonly referred to as a speaker or speaker driver) is an electroacoustic transducer that converts an electrical audio signal into a corresponding sound. A speaker system, also often simply referred to as a "speaker" or "loudspeaker", comprises one or more such speaker drivers, an enclosure, and electrical connections possibly including a crossover network. The speaker driver can be viewed as a linear motor attached to a diaphragm which couples that motor's movement to motion of air, that is, sound. An audio signal, typically from a microphone, recording, or radio broadcast, is amplified electronically to a power level capable of driving that motor in order to reproduce the sound corresponding to the original unamplified electronic signal. This is thus the opposite function to the microphone; indeed the dynamic speaker driver, by far the most common type, is a linear motor in the same basic configuration as the dynamic microphone which uses such a motor in reverse, as a generator. The dynamic speaker was invented in 1925 by Edward W. Kellogg and Chester W. Rice issued as US Patent 1,707,570. Apr 2, 1929. When the electrical current from an audio signal passes through its voice coil—a coil of wire capable of moving axially in a cylindrical gap containing a

concentrated magnetic field produced by a permanent magnet—the coil is forced to move rapidly back and forth due to Faraday's law of induction; this attaches to a diaphragm or speaker cone (as it is usually conically shaped for sturdiness) in contact with air, thus creating sound waves. In addition to dynamic speakers, several other technologies are possible for creating sound from an electrical signal, a few of which are in commercial use. A speech production task was performed by pairs of speakers in which they alternately read aloud a written story divided into a sequence of short reading turns (Vincent Aubanel et al., 2020)



Fig 4.7.speaker

In order for a speaker to efficiently produce sound, especially at lower frequencies, the speaker driver must be baffled so that the sound emanating from its rear does not cancel out the (intended) sound from the front; this generally takes the form of a speaker enclosure or speaker cabinet, an often rectangular box made of wood, but sometimes metal or plastic. The enclosure's design plays an important acoustic role thus determining the resulting sound quality. Most high fidelity speaker systems (picture at right) include two or more sorts of speaker drivers, each specialized in one part of the audible frequency range. The smaller drivers capable of reproducing the highest audio frequencies are called tweeters, those for middle frequencies are called mid-range drivers and those for low frequencies are called woofers. Sometimes the reproduction of the very lowest frequencies (20--50 Hz) is augmented by a so-called subwoofer often in its own (large) enclosure. In a two-way or three-way speaker system (one with drivers covering two or three different frequency ranges) there is a small amount of passive electronics called a

crossover network which helps direct components of the electronic signal to the speaker drivers best capable of reproducing those frequencies.

4.2. SOFTWARE USED

4.2.1 ARDUINO IDE

Arduino Integrated Development Environment (IDE) Learn how the Arduino IDE works, such as compiling ,uploading sketches, file management, installing dependencies and user friendly platform(. The Arduino Integrated Development Environment – or Arduino Software (IDE) – contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Arduino IDE can program Arduino microcontroller. Arduino IDE is a tool to write a program for Arduino boards. Arduino IDE is open-source software that can be downloaded and installed on the computer is free. Arduino IDE provides many ready-to-use libraries (Alisher Shakirovich Ismailov.,2022).Writing Sketches:Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs,create, open, and save sketches, and open the serial monitor.NB: Versions of the Arduino Software (IDE) prior to 1.0 saved sketches with the extension .pde. It is possible to open these files with version 1.0, you will be prompted to save the sketch with the .ino extension on save.

IDE VERIFY File: Verify Checks your code for errors compiling it.

IDE UPLOAD File: Upload Compiles your code and uploads it to the configured board. See uploading below for details. Note: If you are using an external programmer with your

board, you can hold down the " shift" Key on your computer when using this icon. The text will change to " Upload using Programmer" IDE NEW File: New Creates a new sketch.

4.2.2. PYTHON IDLE

IDLE is Python's Integrated Development and Learning Environment. IDLE has the following features: coded in 100% pure Python, using the tkinter GUI toolkit cross-platform: works mostly the same on Windows, Unix, and macOS Python shell window (interactive interpreter) with colorizing of code input, output, and error messages multi-window text editor with multiple undo, Python colorizing, smart indent, call tips, auto completion, and other features search within any window, replace within editor windows, and search through multiple files (grep). A Python Integrated Development Environment (IDE) gives every one of the fundamental apparatuses required for software development with Python language. For researchers, an IDE is basically a software application that packs all the common developer tools into an exclusive user-friendly Graphical User interface. (AL. Sayeth Saabith et al., 2021). debugger with persistent breakpoints, stepping, and viewing of global and local name spaces configuration, browsers, and other dialogs Menus IDLE has two main window types, the Shell window and the Editor window. It is possible to have multiple editor windows simultaneously. On Windows and Linux, each has its own top menu. Each menu documented below indicates which window type it is associated with. Output windows, such as used for Edit => Find in Files, are a subtype of editor window. They currently have the same top menu but a different default title and context menu. On macOS, there is one application menu. It dynamically changes according to the window currently selected. It has an IDLE menu, and some entries described below are moved around to conform to Apple guidelines. File menu (Shell and Editor) New File: Create a new file editing window. Open... Open an existing file with an Open dialog. Open Module... Open an existing module (searches sys.path). Recent Files: Open a list of recent files. Click one to open it. Module Browser: Show functions, classes, and methods in the current Editor file in a tree structure. In the shell,

open a module first. Path Browser: Show sys.path directories, modules, functions, classes and methods in a tree structure. Save: Save the current window to the associated file, if there is one. Windows that have been changed since being opened or last saved have a * before and after the window title. If there is no associated file, do Save As instead. Save As... Save the current window with a Save As dialog. The file saved becomes the new associated file for the window. (If your file manager is set to hide extensions, the current extension will be omitted in the file name box. If the new filename has no '.', '.py' and '.txt' will be added for Python and text files, except that on macOS Aqua, '.py' is added for all files.)

Save Copy As... Save the current window to different file without changing the associated file. (See Save As note above about filename extensions.) Print Window: Print the current window to the default printer.

Close Window: Close the current window (if an unsaved editor, ask to save; if an unsaved Shell, ask to quit execution). Calling exit () or close () in the Shell window also closes Shell. If this is the only window, also exit IDLE. Exit IDLE: Close all windows and quit IDLE (ask to save unsaved edit windows).

4.2.3. THINGSPEAK IoT PLATFORM

ThingSpeak is a platform that provides various services exclusively targeted for building IoT applications. It offers capabilities for real-time data collection, visualization of collected data in the form of charts, and the ability to create plugins and apps for collaborating with web services, social networks, and other APIs. We will discuss each of these features in detail below. The core element of ThingSpeak is a 'ThingSpeak Channel'. A channel is used to store the data that is sent to ThingSpeak and comprises of the following elements: 8 fields for storing data of any type: These fields can be used to store data from sensors or embedded devices. 3 location fields: These fields can be used to store latitude, longitude, and elevation, which are useful for tracking a moving device. 1 status field: This field allows for a short message to describe the data stored in the channel. To use ThingSpeak, you need to sign up and create a channel. Once you have a channel, you can send data to it, allow ThingSpeak to process it, and retrieve the same data when needed. Indeed, an IoT service plays a crucial role in an IoT system, and ThingSpeak is a

prominent application platform that offers a wide range of features. At the core of ThingSpeak is a channel that serves as a repository for storing and processing data collected from IoT devices, often referred to as 'things'. Along with data storage, ThingSpeak provides various apps for seamless integration with web services, APIs, and social networks. It also offers the flexibility to create custom applications as plugins, which expands its capabilities for IoT application development.

ThingSpeak presents extensive possibilities for exploring the integration of the Internet of Things (IoT) into various domains. With its comprehensive features and functionalities, ThingSpeak empowers developers and users to harness the potential of IoT for building innovative and sophisticated applications.

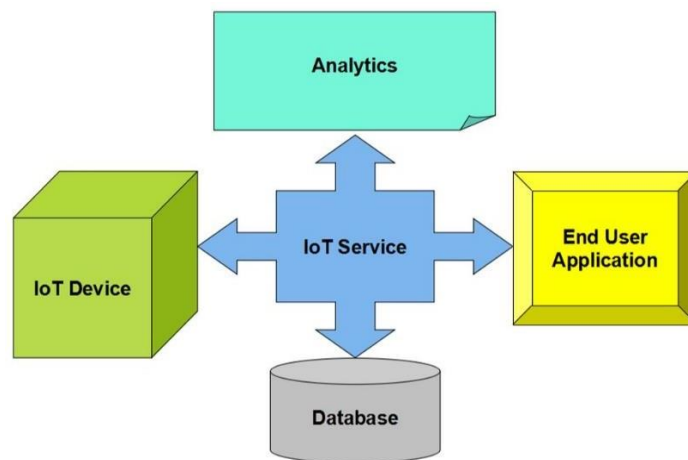


Fig 4.8.IoT service

The above diagram(Fig4.8) illustrates where an IoT service fits in an IoT ecosystem. The Internet of Things(IoT) is a system of 'connected things'. The things generally comprise of an embedded operating system and an ability to communicate with the internet or with the neighboring things. One of the key elements of a generic IoT system that bridges the various 'things' is an IoT service. One such IoT application platform that offers a wide variety of analysis, monitoring and counteraction capabilities is 'ThingSpeak'. An open-source Internet of Things called ThingSpeak is used as a platform to retrieve and display the collected data. (Mohd Amirul Asyraf Razali et al., 2020).

4.3. METHODOLOGY

- When the emotion is detected.(Fig 4.9.) by the camera, the image is processed by Python code and stored on a PC. Via a cable, it is connected to the Arduino and Node MCU boards.
- Face recognition comes under the domain of Computer Vision which is an approach to identify and recognize images.
- Currently, they are being applied to various applications to solve real-world problems in many fields such as industries, manufacturing, healthcare, etc., for public security, marketing, banking, etc.
- Social media platforms have advanced algorithms capable to perform various functionalities in facial recognition to attract a wider user base.
- The main objective of this system is to capture an image in real-time and then recognize whether it is a human face using the Computer Vision technique.
- After detecting the human faces from an image, and observe the facial expressions using Deep Neural Network and If the Predicted facial Emotion is happy, then we will play some Interesting Audio to them using AT mega Microcontroller, which will keep them relax and will help them to learn.
- Along With that we have designed and built a stress detector using Galvanic Skin Response(GSR).For this objective, we have to calculate the different conductance of the skin when a person is under stress or when not using Galvanic Skin Response (GSR) device and storing the data in the IoT Based Cloud platform for further Evaluation.

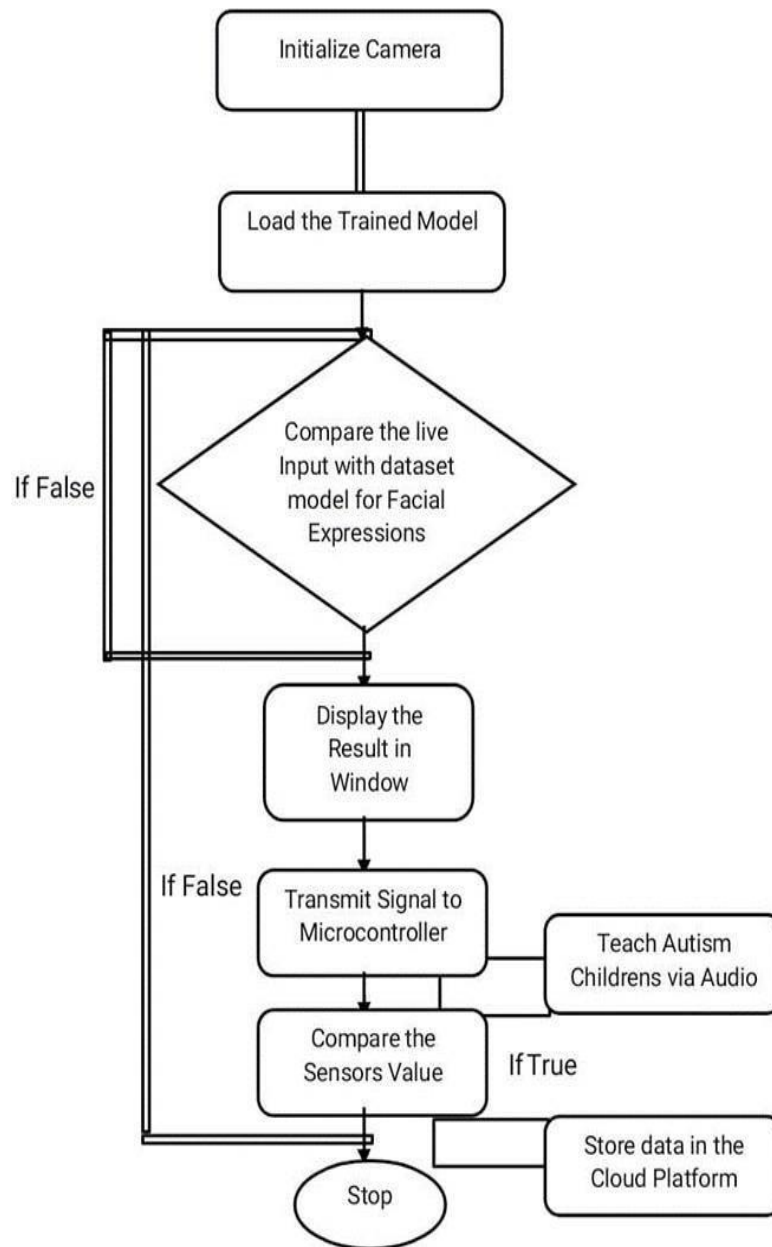


Fig 4.9. Flow chart of the prototype

4.3.1. BLOCK DIAGRAM OF THE PROTOTYPE

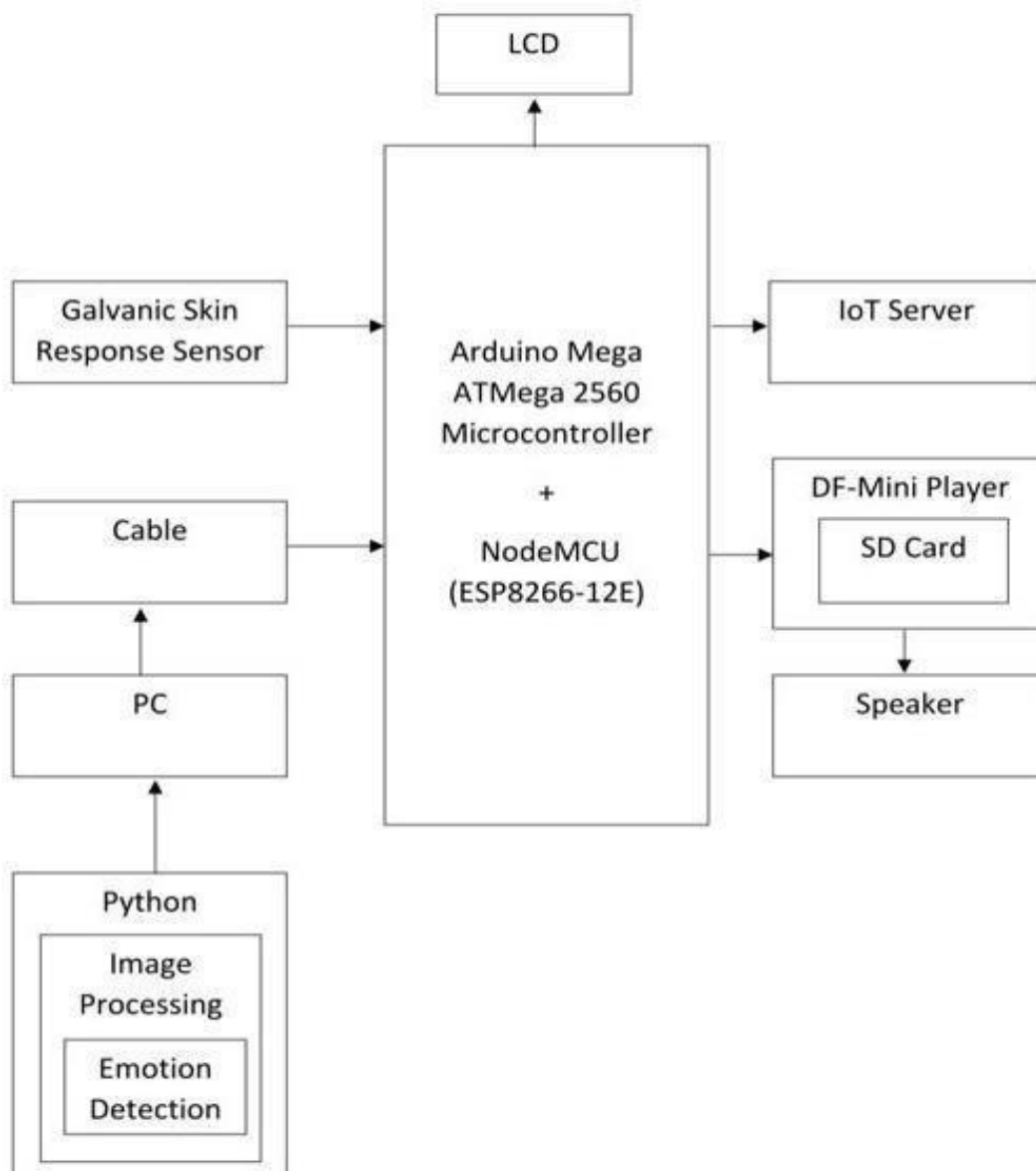


Fig 4.10. Block diagram of the prototype

- After the camera recognises an emotion, python code is used to process the image and it is then saved on a computer (Fig 4.10.) It is linked to the Node MCU and Arduino boards by a cable.
- A GSR sensor is used to detect the conductance of the skin (if the conductance value is greater than 80, it is considered sad, and if the conductance value is below 80, it is considered happy), and the sensor is held using the thumb and index finger.
- If the emotion is detected as happy, the audio stored for happy will be played in the speaker (such as rhymes), and if the emotion is detected as sad, the audio stored for sad will be played in the speaker (such as clapping sounds to motivate the kid).
- The output is displayed on the LCD (the GSR value and the type of emotion: happy, sad, or neutral).
- The output is stored in the IoT server for future use (we use ThinkSpeak software), and doctors can monitor patients with the details stored in the IoT server.
- Advantages-Cost Efficient, Multi-Parameter Monitoring with Facial Expression and GSR values, Easy Learning
- Disadvantages-The main disadvantage of this system is teacher needs to take care of only one child at a time and sometimes this system is not effective.

4.4. ALGORITHM

Emotion Recognition Introduction: In This Python program we the major dependencies include:

- 1) Facial Expression Model: Python Package used for Detect Facial Expression.
- 2) Audio Player: Python Library used for Play MP3 Files
- 3) NumPy: Python Library used for Mathematical Functions
- 4) OpenCV: Python Library for Computer Vision

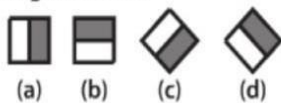
Explanation

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:

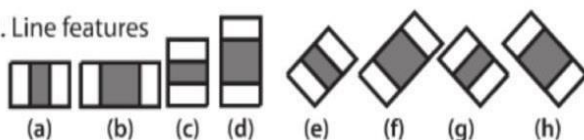
- First using read the image from Camera by using OpenCV
- Then, the haar cascade method is used to detect faces in each frame of the webcam feed.
- The region of image containing the face is resized to 48x48 and is passed as input to the CNN.
- The emotion with maximum score is displayed on the screen.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

Haar Cascade (Fig 4.11) -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 Ad boost learning algorithm which selects a small number of important features from a large set to give an efficient result of classifiers. 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.

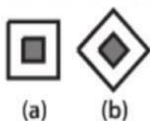
1. Edge features



2. Line features



3. Center-surround features



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.4.11.Haar Cascades

Feature Extraction (Fig 4.12) -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.

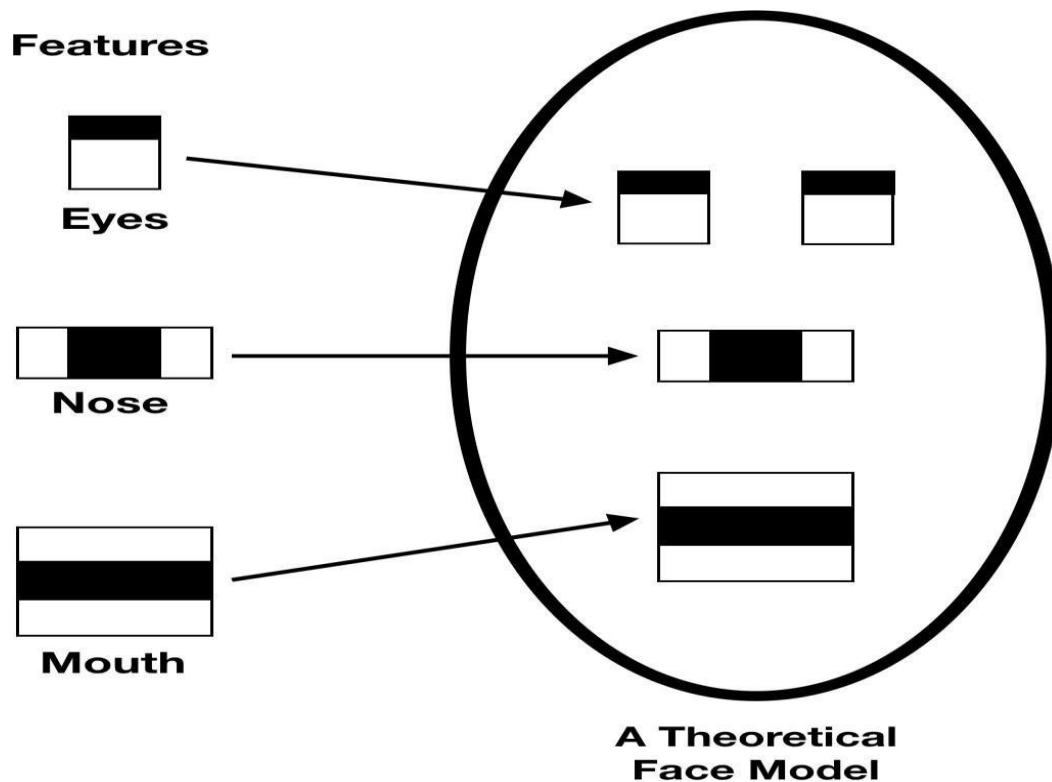


Fig.4.12. Feature extraction

In feature extraction, the algorithm uses training data to best identify features that it can consider a face. The training data used in this project is an XML file called: `haarcascade_frontalface_default.xml`.

Running OpenCV- As part of this project, a directory is created to store all the necessary files. Must ensure that the following files are placed in this directory:

- face_detection.py (the Python programme containing the code). Note that the name of this file can be changed as desired.
 - haarcascade_frontalface_default.xml (Haar Cascade training data, used for face detection)
 - photos (a directory that contains the photos to be processed or used in the project).
- Make sure all these files are located in the designated directory for the project to function properly.

CHAPTER 5

RESULTS AND DISCUSSION

5.1. RESULTS

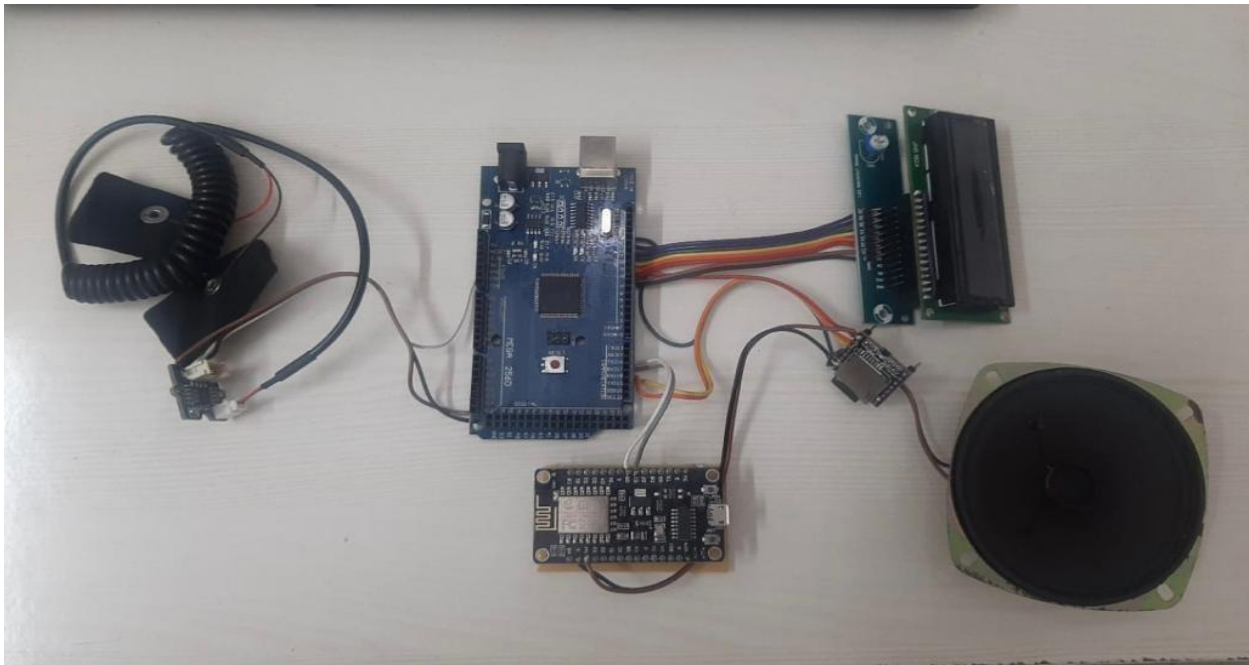


Fig 5.1. Prototype

The primary objective of this system(Fig 5.1.) is to capture real-time images and utilise computer vision techniques to determine if it is a human face. Upon detecting a human face, facial expressions are extracted and analysed using a deep neural network to predict emotions. If happiness is detected, interesting audio will be played through an AT Mega Microcontroller & DF Mini Player to help relax and facilitate learning. Additionally, a stress detector based on galvanic skin response (GSR) has been designed and built. This involves calculating different conductances of the skin during stressful situations. Data is then stored on an IoT-based cloud platform for further evaluation.



Fig 5.2.Emotion- Happy



Fig 5.3. When GSR is less than 80

When the camera detects a facial expression of happiness(Fig 5.2.), it compares it to the Galvanic Skin Response (GSR) value. If the GSR value is below 80(Fig 5.3.) and the detected emotion is happiness, a rhyme will be played, providing an opportunity to educate the child during moments of happiness.



Fig 5.4.Emotion- sad



Fig 5.5. When GSR is greater than 80

When the camera identifies a facial expression of sadness(Fig 5.4.), it compares it to the Galvanic Skin Response (GSR) value. If the GSR value is above 80 (Fig 5.5.) and the identified emotion is sadness, a clapping sound will be played, serving as encouragement for the child.



Fig 5.6. Output obtained in Lcd view

If the system consistently detects a sad emotion in the child, it may be prudent to consider consulting a doctor for further diagnosis and evaluation of the child's emotional well-being. The output is shown in Fig 5.6.

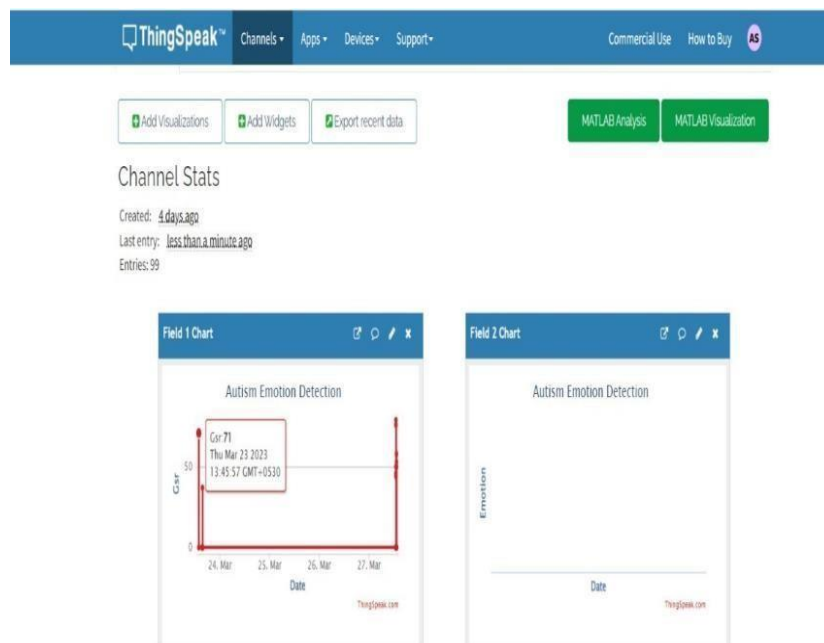


Fig 5.7. Output obtained in Thingspeak

The hospital-side controls determine the access for Parents and other users to examine the data through a mobile app(Fig 5.7.). Two new fields, one for Galvanic Skin Response (GSR) and one for emotion, have been added. Field 1 displays the GSR value along with the day, date, and time. Field 2 in Excel records the emotion states in words. This system is utilized in hospitals for maintaining patient records.

Table 5.1 Data analysis

Subject	GSR value(Ω)	Type of emotion
1	45	Happy
2	48	Neutral
3	55	Happy
4	86	Sad
5	56	Happy
6	90	Sad
7	90	Neutral
8	60	Happy
9	78	Happy
10	88	Sad

The collected data is stored in an Excel sheet as show in above Table 5.1 for analysis. If the emotion is recognised as cheerful and the GSR value is less than 80, rhymes will be played. If the emotion is recognised as being sad and the GSR value is greater than 80, a clapping sound will be played. However, if the emotion is detected as neutral and the GSR value is either above or below 80, no sound will be played. This system can be utilised by doctors to analyse past data for further evaluation.

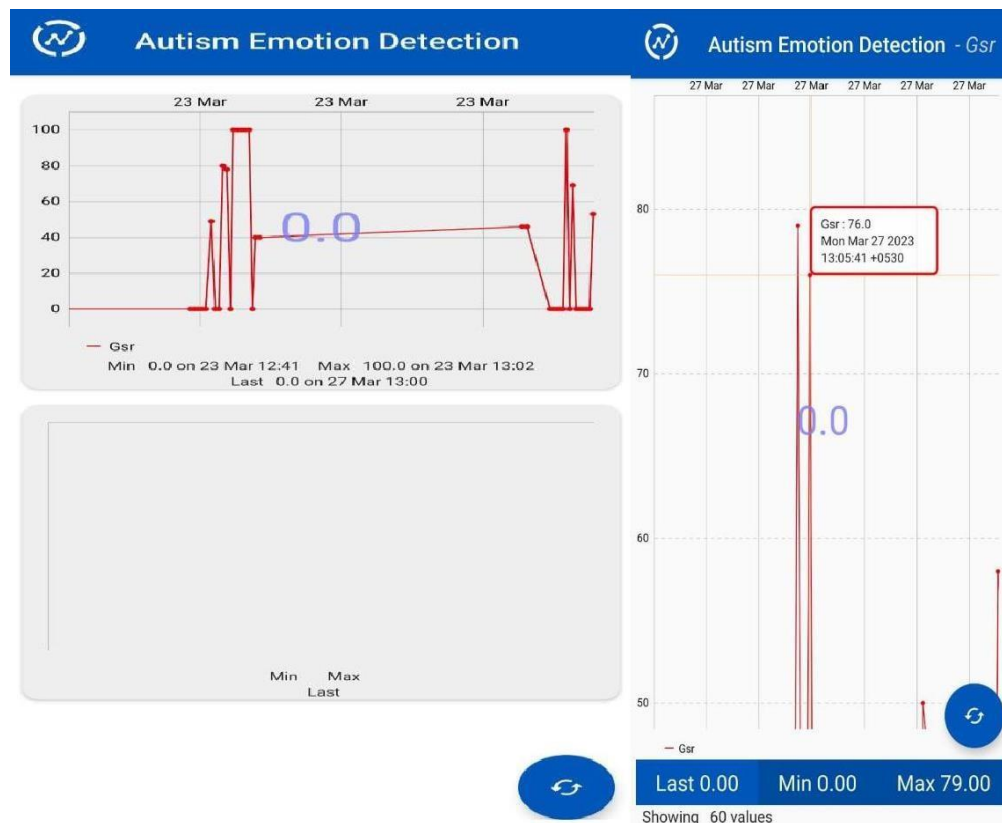


Fig 5.8. Graph shown on mobile app

Clicking on a point on the graph(Fig 5.8.) will trigger the display of the GSR value, date, day, and time for the corresponding data point. This feature allows for easy analysis and interpretation of the data presented on the graph.

5.2.DISCUSSION

A revolutionary technology that recognises facial expressions from human faces in real time, allowing children with ASD to learn about the feelings of others. In this project, a web application is created that records the human face in real time and predicts the person's age, gender, and mood, which are then recorded in the system's database. Children with ASD frequently spend time alone; therefore, we can incorporate the system as a web application that the children may utilise on tablets for further interaction. Face identification, age and gender prediction, and emotion recognition are all performed using Python models and modules during the implementation process.

5.2.1. EXPERIMENTAL TEST STABILISING TOUCH SENSOR AND DF PLAYER VERSUS GSR SENSOR AND DF MINI PLAYER.

A copper plate was used as a touch sensor. In the physical arrangement, a medium- to high-value (100 kilo- to 50 mega-Ohm) resistor is connected between the send and receive (sensor) pins. The sensor terminal is the receive pin. A wire attached to this pin and terminated with a copper plate produces an excellent sensor. The DF Player is critical to this system since it acts as a user guide. During the testing, it was discovered that the speaker's volume was far too loud. To restrict the current entering the DF Player, a 1K ohm resistor was attached to one of the component's pins (the TX pin). The presence of human body contact at the sensor If the sensor is made of exposed metal, the transmit pin may never be able to effect a change in the receive (sensor) pin, causing the sensor to time out. Because there is only one source of charge, through the resistor, the greater the resistance value, the further away the sensor can detect touch. As a result, expanding the area for charge storage by boosting the capacitance of the finger would take longer to fill, and so the sensor could feel touch from a greater distance. As a result, an 1M resistor was chosen for this device. GSR stands for galvanic skin response, and it is a method of measuring the electrical conductance of the skin. Strong emotions can cause stimulation of your sympathetic nervous system, resulting in 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.

The module can be used as a stand-alone module with an attached battery, speaker, and push buttons, or used in combination with microcontrollers such as Arduino, ESP32, Raspberry Pi, and any microcontroller with UART.

5.2.2. DATA LOGGING AND DATA EVALUATION PLX-DAQ WAS USED FOR DATA LOGGING.

Its datalogging capability can keep track of the date the game was played, the modes played on that day, the time it took to fill the proper slot, the correct slot filled, and the current score. The data is delivered in real-time from the Arduino to the laptop. The data will then be saved in an Excel file and may be used for further study. The USB jack is used instead of a power supply since the USB connector's original purpose is to power the device, and it must also be linked to a laptop or computer so that the datalogger may receive and save data in an Excel file on the laptop. ThingSpeak is used to collect data in Excel. A spreadsheet for analysis. If the emotion is recognised as happy and the GSR value is less than 80, rhymes will be played. A clapping sound is produced when the emotion is recognised as sad and the GSR value is greater than 80. If the emotion is recognised as neutral and the GSR value is either greater than or less than 80, no sound is played. It will be used by the physicians to analyse previous data. The existing system lacks some features, such as sending the data to the cloud. A few improvements have been made to make the device more helpful. The data is directly sent to the cloud (in computing speak) for easier access. Therapists can view the stored data online, which can help them plan for future treatments.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1. SUMMARY

Face recognition is a subset of Computer Vision, which is a way to Images must be identified and recognized. They are now being used in a variety of applications to tackle real-world problems in a variety of sectors, manufacturing, healthcare, and so on for public safety, marketing, banking, and so forth. Platforms for social media have evolved. To implement this project, you would need to use Python to develop the facial emotion detection algorithm and connect it to the GSR sensor data, which would be collected by an Arduino Mega or Node MCU microcontroller. The threshold values for matching the facial expressions and sweat responses would need to be determined experimentally, and the results could be visualized using an IoT platform like ThingSpeak. Develop a facial emotion detection algorithm using Python Connect the facial emotion detection algorithm to a GSR sensor data collected by an Arduino Mega or Node MCU microcontroller Determine threshold values for matching facial expressions and sweat responses Use the threshold values to trigger appropriate responses, such as playing rhymes or clapping sounds Visualize the results using an IoT platform like ThingSpeak. The primary goal of this system is to record an image in real time and then recognize it. Using the Computer Vision method, determine if it is a human face. After sensing the human Deep Neural Network and If the predicted facial emotion is happiness, we will play some interesting audio to them. Together with that, we created and manufactured a stress detector based on Galvanic Skin Response.(GSR). To achieve this goal, we must compute the varying conductances of the skin while a person moves. is under stress, or when the Galvanic Skin Response (GSR) device is not being used and data is not being stored in the IoT-based Cloud platform for further evaluation.

6.2.CONCLUSION

The proposed project involves creating a facial expression recognition system using Python and incorporating a sound playback feature for kids with autism. The system aims to help children with autism recognize and understand different facial expressions, which can be challenging for them due to their social and communication difficulties. The project has several potential benefits for children with autism, including improving their social skills, engagement, and self-esteem. The use of computer vision and sound playback technology can provide an engaging and interactive learning experience for children with autism, and the use of rewards can help encourage their participation and motivation. The efficiency of the project will depend on the accuracy of the facial expression recognition system, the effectiveness of the clap sound playback system, and the engagement of the child with autism. Proper testing and calibration of the system, along with the use of engaging and interactive features, can help maximize the project efficiency and effectiveness. In the proposed System we have Tested Facial Expression using Convolution Neural Network Prediction and comparing the output with Galvanic Skin Response sensor to analyze the Emotion level of the Kid with ASD (autism spectrum disorder) we were able to predict the Facial Emotion, and compare the values Successfully and providing the system the higher success rate. In Future we can combine Pulse Rate Sensor and Restless Detection along with Non-Invasive Therapy system which will help us to analyzein depth data and providing them with a no-invasive rehabilitation therapy for Immediate relief.

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APPENDIXES

CODE FOR PYTHON

```
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('COM5', 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")

    if(readdat == "Temperature Safe\r\n"):
        #print (")
        temp_Stat=1

    if(readdat == "RST\r\n"):
        #print ('reset')
        temp_Stat=0
        stat=75
    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)
```

CODE FOR ARDUINO MEGA

```
#include<LiquidCrystal.h>
#include "DFRobotDFPlayerMini.h"
#include <Wire.h>
#define splash splash1

#define python Serial
#define ard_node Serial3
#define mp3_serial Serial2

LiquidCrystal lcd(8, 9, 10, 11, 12, 13);

#define gsr A1

String IncomingData = "";

int gsr_r;
int dis_t = 25;
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 <= 36) {
        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, "");
}

}

}

```

CODE FOR NODEMCU

```

#include <ESP8266WiFi.h>
#include <SoftwareSerial.h>
#include "ThingSpeak.h"

```

```

#define RX D6

```

```

#define TX D5
SoftwareSerial ard_node(RX, TX, false, 256);
//SoftwareSerial ard_node;


int a, b;


char ssid1[] = "Project";
char password1[] = "1234567890";


unsigned long channelID = 2077072 ;
const char * writeAPIKey = "XH89CVWRXEL69EUO"; // write API key for your
ThingSpeak Channel
const char* server = "api.thingspeak.com";
String th;


int gsr_r;
String prev_Rec = "Neutral";
int tup = 20;


WiFiClient client;


void setup() {
  // put your setup code here, to run once:
  Serial.begin(115200);
  ard_node.begin (115200);
  // ard_node.begin (115200, SWSERIAL_8N1, RX, TX, false, 256);


  setupWifi();

```

```

    ThingSpeak.begin(client);

}

void setupWifi() {

    Serial.println();
    Serial.println();
    Serial.print(ssid1);
    WiFi.begin(ssid1, password1);
    Serial.print("Connecting to ");

    while (WiFi.status() != WL_CONNECTED)
    {

        if (b <= 0) {
            b = 2;
        }
        delay(800);
        Serial.print(".");

    }

    Serial.println("");
    Serial.println("WiFi connected");
    Serial.println("IP address: ");
    Serial.println(WiFi.localIP());

    delay(1000);
}

```

```

void loop() {

    getArd();

    UpdateServer();

    delay(300);
}

void getArd() {
    String SS = ""; String SSs = "";
    while (ard_node.available() > 0) {

        char S = ard_node.read();
        SS += S;
        // Serial.println(SS);
        delay(10);

    }
    if (SS.length() > 0) {
        Serial.println(SS);
        String gs = getSplitValue(SS , ',', 0);
        String emo = getSplitValue(SS , ',', 1);
        gsr_r = gs.toInt();
        prev_Rec = String(emo);

        ard_node.flush();

    }
}

```

```

}
void UpdateServer() {

    tup++;
    if (tup >= 50) {

        if (client.connect(server, 80)) {
            ThingSpeak.setField(1, String(gsr_r));
            ThingSpeak.setField(2, String(prev_Rec));

            // write to the ThingSpeak channel
            int x = ThingSpeak.writeFields(channelID, writeAPIKey);
            if (x == 200) {
                Serial.println("Channel update successful.");

            }
            else {
                Serial.println("Problem updating channel. HTTP error code " + String(x));

            }
        }
        tup = 0;
    }
}

```