

REAL TIME FACE MASK DETECTION TO PREVENT VIRAL RESPIRATORY INFECTION

A Project Report Phase – II

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in Electronics and Communication Engineering

by

SIDDHANT KUMAR SINGH (39130428)

SINDRI REVANTH (39130430)



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

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

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

APRIL - 2023



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with "A" grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119
www.sathyabama.ac.in

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of SIDDHANT KUMAR SINGH (39130428) and SINDRI REVANTH (39130430) who carried out the project entitled "**REAL TIME FACE MASK DETECTION TO PREVENT VIRAL RESPIRATORY INFECTION**" under my supervision from November 2022 to April 2023.

Internal Guide

Dr. K. SRILATHA, M.E., Ph.D.,

Head of the Department

Dr. T. RAVI, M.E., Ph.D.,

Submitted for Viva-voce Examination held on 20-04-2023

Internal Examiner

External Examiner

DECLARATION

We SIDDHANT KUMAR SINGH (39130428) and SINDRI REVANTH (39130430) hereby declare that the Project Report entitled “ REAL TIME FACE MASK DETECTION TO PREVENT VIRAL RESPIRATORY INFECTION ” done by us under the guidance of Dr. K. SRILATHA, M.E., Ph.D., Associate Professor Department of Electronics and Communication Engineering submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

DATE: 20-04-2023

PLACE: Chennai

SIGNATURE OF THE CANDIDATES

1. 
2. 

ACKNOWLEDGEMENT

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

We convey our thanks to **Dr. N. M. NANDHITHA, M.E., Ph.D.**, Professor & Dean, School of Electrical and Electronics and **Dr. T. RAVI, M.E., Ph.D.**, Professor & Head, Department of Electronics and Communication Engineering for providing us necessary support and details at the right time during the progressive reviews.

We would like to express my sincere and deep sense of gratitude to our Project Guide **Dr. K. SRILATHA, M.E., Ph.D.**, Associate Professor Department of Electronics and Communication for her valuable guidance, suggestions and constant encouragement paved 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 Electronics and Communication Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

The COVID-19 pandemic disrupted people's livelihoods and hindered global trade and transportation. During the COVID-19 pandemic, the World Health Organization mandated that masks be worn to protect against this deadly virus. Protecting one's face with a mask has become the standard. Many public service providers will encourage clients to wear masks properly in the foreseeable future. On the other hand, monitoring the individuals while standing alone in one location is exhausting.

This project offers a solution based on deep learning for identifying masks worn over faces in public places to minimize the coronavirus community transmission. The main contribution of the proposed work is the development of a real-time system for determining whether the person on a webcam is wearing a mask or not. The ensemble method makes it easier to achieve high accuracy and makes considerable strides toward enhancing detection speed. In addition, the implementation of transfer learning on pretrained models and stringent testing on an objective dataset led to the development of a highly dependable and inexpensive solution.

The findings provide validity to the application's potential for use in real world settings, contributing to the reduction in pandemic transmission. Compared to the existing methodologies, the proposed method delivers improved accuracy, specificity, precision, recall, and measure performance in three-class outputs. These metrics include accuracy, specificity, precision, and recall. An appropriate balance is kept between the number of necessary parameters and the time needed

TABLE OF CONTENTS

CHAPTER No.	TITLE	PAGE No.
	ABSTRACT	v
	LIST OF FIGURES	ix
	LIST OF TABLES	x
1	INTRODUCTION	1
2	LITERATURE SURVEY	3
	2.1 Objectives	5
3	EXISTING METHODS	6
	3.1 Embedded System	6
	3.1.1 System	6
	3.1.2 Characteristics of Embedded System	6
	3.2 Existing System	6
4	PROPOSED METHOD	12
	4.1 Proposed System	12
	4.1.1 Advantages of proposed system	12
	4.1.2 Hardware Requirements in Proposed System	12
	4.1.3 Software Requirements in Proposed System	12
	4.2 Arduino Micro-Controller	13
	4.2.1 Arduino UNO	15
	4.2.2 Applications of Arduino	17

4.3	Adjustable Infrared Sensor	19
4.3.1	Features of Infrared Sensor	20
4.3.2	Connections of Wire	20
4.3.3	Applications of Infrared sensor	21
4.3.4	Working of IR sensor	22
4.4	MG995 Servo Motor	23
4.4.1	Using Servo Motor	23
4.4.2	Applications of Servo Motor	24
4.4.3	MG995 Features	25
4.5	ESP32 CAM WiFi Module	26
4.5.1	Features of ESP32 Cam	26
4.5.2	Specifications of ESP32 Cam	27
4.5.3	Package Includes in ESP32	28
4.6	LCD Display 16×2	29
4.6.1	LCD 16×2 Pin Configuration	30
4.6.2	Features of LCD 16×2	31
4.6.3	16×2 LCD I2C	31
4.6.4	Features of LCD I2C	31
4.6.5	Registers of LCD	31
4.6.6	Command Register	32
4.6.7	Data Register	32
4.7	LM2596 Adjustable DC-DC Converter Module	34
4.7.1	Features of LM2596 Converter	34
4.7.2	Packages Includes of LM2596 Converter	34
4.8	CH340G USB to TTL Serial Converter	36
4.8.1	Features CH340G USB to TTL serial converter	37
4.8.2	Supports	37
4.8.3	Package Includes of CH340G	38

4.9	Software Requirements	38
4.9.1	Arduino Software IDE	38
4.9.2	Writing Sketchs	39
4.9.3	Programmer	41
4.9.4	Burn Boot Loader	42
4.9.4	Help	42
4.10	Embedded C	43
4.10.1	Embedded System Programming	44
4.11	Basic Image Processing Concepts Used	44
4.11.1	Types	45
4.11.2	Modules	47
4.12	Importing Libraries	47
4.13	Dataset	49
5.	RESULTS AND DISCUSSION	50
6.	CONCLUSION AND FUTURE SCOPE	53
	REFERENCES	54

LIST OF FIGURES

FIGURE No.	FIGURE NAME	PAGE No.
4.1	Hardware Block Diagram of Proposed System	13
4.2	Arduino UNO	46
4.3	Arduino UNO Pin Diagram	19
4.4	IR Sensor	23
4.5	MG995 Servo Motor	26
4.6	ESP32 Cam	29
4.7	LCD Pin Diagram	30
4.8	DC-DC Converter Motor	36
4.9	CH340G USB to TTL Converter	38
4.10	arduino IDE	39
4.11	Embedded C	43
4.12	Flow Chart of Proposed System	46
4.13	Software Block Diagram of Proposed System	48
5.1	Final Developed Model of Proposed System	50
5.2	Arduino Interface of the Final Result	51
5.3	Uploading the ESP32 Camera module	52
5.4	Detecting the Face Mask	52

LIST OF TABLES

TABLE No.	TABLE NAME	PAGE No.
4.1	Technical Specifications Of Arduino	17
4.2	Specifications of IR Sensors	21
4.3	Pin Description of Servo Motor	25
4.4	Specifications of Cam	28
4.5	Command Codes of LCD	33
4.6	Specifications of LM2595 Converter	35
4.7	Specifications of Serial Converter	37
4.8	About Arduino IDE	41

CHAPTER-1

INTRODUCTION

The project supports people wearing masks in public locations to prevent COVID-19 transmission is advancing rapidly. Disease spread can be delayed by physically separating sick persons from others, taking additional precautions, and minimizing the probability of transmission per interaction. A mask minimizes transmissibility per encounter in laboratory and clinical settings by limiting the transmission of contaminated respiratory particles. When public mask-wearing is widespread, it effectively reduces virus spread. Recently, researchers at the University of Edinburgh published a study to better understand the COVID-19 pandemic response measures. Wearing a face mask or other covering over the nose and mouth was proven to significantly minimize the risk of coronavirus spread by avoiding the forward distance traveled by an individual's exhaled air. Face mask detection is determining whether or not someone is wearing a mask.

In computer vision and pattern recognition, face detection is a crucial component. The face is recognized using various machine learning techniques . The existing systems have several flaws, including high feature complexity and low detection accuracy. Face identification approaches based on deep convolutional neural networks (CNNs) have been popular In Increasing detection performance. Even though many academicians have worked hard to develop fast face detection and recognition algorithms, there is a significant difference between 'detection of the face under mask' and 'detection of mask over face'. In practice, it is difficult to spot mask abuse. The key challenge is the dataset limitation. Mask-wearing status datasets are often minimal and merely identify the presence of masks. There is very little study on detecting masks over the face in the literature. The proposed method intends to create a technique that can accurately detect masks over the face in public places (such as airports, train stations, crowded markets, and bus stops) to prevent coronavirus transmission, thus contributing to public health. Furthermore, detecting faces with or without a mask in public is difficult due to the little data available for detecting masks on human faces, making the model difficult to train. As a result, the concept of transfer learning is utilized to transfer learned kernels from networks trained on a large dataset for similar face detection

In this pandemic situation, there is a need to monitor the people wearing masks to control the spread of COVID-19. It is necessary to alert the people to wear masks properly in public places by comparing the captured image with the datasets. If CCTV cameras record videos, the faces appear small, hazy, and low-resolution. Because people do not always stare straight at the camera, the facial angles change. These real world videos differ significantly from those obtained by webcams or selfie cameras, making face mask recognition in practice much more difficult. Residual blocks were integrated into the depth-wise separable convolution layer developed by MobileNetV2. Residual networks enable deep network training by creating the network using residual models. Residual network ResNet50V2 is one of the fastest object detection techniques for face detection using CNN. InceptionResNetV2 is a convolutional neural architecture based on the Inception family of architectures that includes residual connections (which replace the filter concatenation stage in the Inception).

Efficient Net examines neural network scaling, thereby simultaneously scaling the network's width, resolution, and depth. The objective was to create a face detector using ResNet50V2 to improve the efficiency of identifying faces with better accuracy and speed. The system's goal was to reduce manual labor by identifying people through video analysis and determining whether or not they are wearing masks. A heuristic evaluation with numerous users was conducted to examine usability, concluding that the implemented system is more user-friendly, faster, and more efficient than existing solutions. A unified approach of ResNet50V2 combines many features and classifiers, where all features can be used to identify the mask through video detection. ResNet50V2 can identify multiple objects in a single frame or image, providing better accuracy since many persons can be in a single frame. ResNet50V2 correctly identifies and warns the user with better accuracy compared to ResNet101V2. The object recognition algorithm performs better only when the images are captured, and it takes more time to process the image and produce the output. Comparatively, ResNet50V2 gives the result by detecting the object in the video stream. The proposed method is faster, more efficient, and more accurate.

CHAPTER-2

LITERATURE SURVEY

Pranaad Munjal, et.al.,(2020). Everyone has learned the value of wearing a mask since the Covid-19 epidemic. Excessive acute breathing syndrome (SARS-COV-2) is a contagious virus that may be spread via contact with infected people and by respiratory tract droplets from sneezing. It may be transmitted by direct contact with an inflammatory person or an infected surface. The World Health Organization and local authorities have issued a joint statement urging the public to use face masks as part of a comprehensive strategy to contain the virus. From the perspective of technological progress, deep learning and computer vision have shown to be an effective means of recognition via picture processing. This system is a real-time program for identifying genuine users from those who have assumed their identities. It was coupled with a card containing about 4000 images with width and height dimensions of 224x224 and executed a flatness accuracy of 98%. In this project, this variant was taught to differentiate between good and unnice variants of the same kind, and a nice variant was selected. Airports, trains, universities, offices, and other public venues may all benefit from its use. See whether COVID-19 recommendations were implemented.

Hiten Goyal, et.al.,(2020) people's daily lives are more affected when instability spreads quickly around the world. One strategy for combating the pandemic might include mandating the use of face masks in public spaces. This need can only be satisfied by using computerized and green face detecting systems. This piece introduces a static and stationary video face identification model that "codecs" and "informs" the images. This version has been trained and tested using the Kaggle dataset. Over 4000 photographs make up the 98% accurate data collection. The proposed version outperforms DenseNet-121, MobileNet-V2, VGG-19, and Inception-V3 in terms of computational accuracy and efficiency. Many commercial and public establishments, as well as institutions of higher learning, hospitals, banks, and airports, might benefit from the utilization of this work's photographic capabilities.

Shabana Habib¹, et.al.,(2021) That's what Sheroz Khan gives us. The COVID-19 epidemic has caused a substantial number of fatalities and great financial

troubles for the world's population since December 2019. The COVID-19 virus transmits from person to person by the mucus that infected persons cough or sneeze out of their mouths and nostrils. Wearing a mask in public is one of the best strategies, according to the World Health Organization (WHO), to reduce and stop the transmission of COVID-19. Early detection of face masks is crucial to halting the spread of COVID-19. For this aim, a number of deep learning based architectures have been built, including VGG16, VGG19, InceptionV3, ResNet-CI, ResNet-L, Efficient Net, MobileNetV1, and MobileNetV2. From the results of these experiments, we suggest a face mask recognition method that is both quick and accurate and can be applied to localized devices. Our proposed version is based on the architecture of MobileNetV2, which first collects major features from the input data and then sends them to autoencoder to create more abstract representations up to the classification level. The proposed model also makes extensive use of data augmentation methods (such as rotation, turn, Gaussian fade, sharpening, carving, skew, and clipping) to expand the pool of potential models. We evaluate the performance of our proposed model on three publicly accessible datasets and show that it regularly outperforms existing state-of-the-art approaches.

Pingchao Mao, et al., (2021). As the year 2019 ended, many cases of pneumonia caused by "Covid-19" were discovered in a few Wuhan hospitals. The "Covid-19" virus causes a contagious respiratory infection that may be transferred by direct physical contact in addition to the air.. Before the corona virus may cause contamination, it must spread in a very restricted region where it comes into touch with the mucosa. In order to protect the population from the newly emerged coronavirus, it is crucial to use scientifically validated mask usage. In terms of healthiness Workers in the medical field can safeguard the populace's health and save lives. The patient must spray the droplets and shield them from the medical staff to prevent inhaling. An instantaneous masks detection approach is proposed here, with a variant for type detection. The real version's check performance is superior to that of the convolutional neural network employed. In order to find Hence, this project is useful in the struggle to contain the spread of the virus and in the pursuit of a world free of infection.

2.1 OBJECTIVES

- **It proposes a system on face mask detection.**
 - In this system, ARDUINO MEGA (ATmega2560) microcontroller is used which acts as brain of the system, because the entire system program instruction stored in it.
 - The IR sensor is used here for determining the arrival and departure of people so that opening and closing of gate can be operate automatically using servo motor.
- **To find whether the person is wearing the mask or not**
 - Here ESP32 CAM Wifi + Bluetooth Development Board with OV2640 Camera module is used.

CHAPTER-3

EXISTING METHODS

3.1 EMBEDDED SYSTEMS

Embedded System is a system composed of hardware, application software and real time operating system. It can be small independent system or large combinational system.

3.1.1 SYSTEM

System is a way of working, organizing or performing one or many tasks according to a fixed set of rules, program or plan.

It is an arrangement in which all the unit combined to perform a work together by following certain set of rules in real time computation. It can also be defined as a way of working, organizing or doing one or many tasks according to a fixed plan.

An Embedded System is a system that has software embedded into computer hardware, which makes a system dedicated for a variety of application or specific part of an application or product or part of a larger system.

3.1.2 CHARACTERISTICS OF EMBEDDED SYSTEM

- An embedded system is software embedded into computer hardware that makes a system dedicated to be used for variety of application.
- Embedded system generally used for do specific task that provide real-time output on the basis of various characteristics of an embedded system.
- Embedded system may contain a smaller part within a larger device that used for serving the more specific application to perform variety of task using hardware-software intermixing configuration.
- It provides high reliability and real-time computation ability.

3.2 EXISTING SYSTEM

This project exists that the COVID-19 pandemic disrupted people's livelihoods and hindered global trade and transportation. During the COVID-19 pandemic, the World Health Organization mandated that masks be worn to protect against deadly virus.

Protecting one's face with a mask has become the standard. Many public service providers will encourage clients to wear masks properly in the foreseeable future. On the other hand, monitoring the individuals while standing alone in one location is exhausting. The outbreak of COVID-19 has taught everyone the importance of face masks in their lives. SARS-COV-2(Severe Acute Respiratory Syndrome) is a communicable virus that is transmitted from a person while speaking, sneezing in the form of respiratory droplets. It spreads by touching an infected surface or by being in contact with an infected person. Healthcare officials from the World Health Organization and local authorities are propelling people to wear face masks as it is one of the comprehensive strategies to overcome the transmission.

There has been a lot of interest in projects with similar purposes. Most researchers utilized CNN from all the approaches mentioned in the literature because of its outstanding performance and capacity to extract valuable characteristics from the image data. Other methods have employed hybrid strategies that use ML methodologies with or without deep learning.

CNN-Based Approaches: Contrary to ML approaches, we do not need to extract the features in CNN-based methods manually. CNN uses convolution and pooling techniques to extract valuable features from the input. We have discussed some popular CNN-based face mask models in the following.

MobileNetV2 was used to classify the face mask and Caffe-based face detector. A small dataset of 4095 images was used. Additionally, the dataset has only two classes, masked and unmasked. Hence, the model trained is not able to detect the incorrectly masked faces (i.e., having his or her mask below the nose). It achieved a decent F1-score of 0.93.

The MAFA or Masked Faces face mask dataset was initially produced. They built a CNN model capable of detecting facial occlusion, including masks. They divided their concept into three key components: the proposal module, the embedding module, and the verification module. The initial module combines two

CNNS and this deadly virus. Protecting one's face with a mask has become the standard. Many public service providers will encourage clients to wear masks properly in the foreseeable future. On the other hand, monitoring the individuals while standing alone in one location is exhausting. The outbreak of COVID-19 has taught everyone the importance of face masks in their lives. SARS-COV-2(Severe Acute Respiratory Syndrome) is a communicable virus that is transmitted from a person while speaking, sneezing in the form of respiratory droplets. It spreads by touching an infected surface or by being in contact with an infected person. Healthcare officials from the World Health Organization and local authorities are propelling people to wear face masks as it is one of the comprehensive strategies to overcome the transmission.

There has been a lot of interest in projects with similar purposes. Most researchers utilized CNN from all the approaches mentioned in the literature because of its outstanding performance and capacity to extract valuable characteristics from the image data. Other methods have employed hybrid strategies that use ML methodologies with or without deep learning.

CNN-Based Approaches: Contrary to ML approaches, we do not need to extract the features in CNN-based methods manually. CNN uses convolution and pooling techniques to extract valuable features from the input. We have discussed some popular CNN-based face mask models in the following.

MobileNetV2 was used to classify the face mask and Caffe-based face detector. A small dataset of 4095 images was used. Additionally, the dataset has only two classes, masked and unmasked. Hence, the model trained is not able to detect the incorrectly masked faces (i.e., having his or her mask below the nose). It achieved a decent F1-score of 0.93.

The MAFA or Masked Faces face mask dataset was initially produced. They built a CNN model capable of detecting facial occlusion, including masks. They divided their concept into three key components: the proposal module, the embedding module, and the verification module. The initial module combines two CNNs and

retrieves facial image characteristics. The second module focuses on detecting facial landmarks that are not obscured by occlusion. The LLE algorithm is implemented at this stage. In the final module, classification and regression tasks are carried out using a CNN to determine if an item is a face and to scale the position of missing facial signals. Identifying side-facing faces degraded the model's performance, and the dataset contains more occluded than masked faces. Therefore, training with this dataset is not always viable for face mask identification alone. The performance was determined by calculating the precision of each parameter and averaging the precision of various parameters. Recorded precision averaged 74.6%.

A dataset known as “MASKED FACE DATASET” was proposed and three CNN architectures were cascaded for face mask detection. The dataset only consists of 200 images. To overcome the problem of overfitting, they used the concept of transfer learning and fine-tuned the model with the WiderFace dataset [14]. The first CNN consists of five layers and is used to scale the input image. The second and third layers consist of seven layers each. The advantage of using three cascaded CNN is that each false detection is eliminated, thus making a prediction stronger. However, using three CNN makes it computationally expensive. The model achieved an accuracy of 86.6% and recall of an 87.8% on their proposed dataset.

The SRCNet model for face mask detection. The model comprises two networks: a classification network and an image super-resolution (SR) network. The model is capable of adequately classifying incorrect face mask wearing (IFW), correct face mask wearing (CFW), and no face mask wearing (NFW). The model was trained using the MMD or Medical Masked dataset [16] and the MobileNetV2 CNN algorithm was adopted [10]. The design was well organized and effective. However, the dataset used for training was very small and the inference speed was slower than other algorithms. The model achieved an accuracy of 98.07%.

A dataset known as “MASKED FACE DATASET” was proposed and three CNN architectures were cascaded for face mask detection. The dataset only consists of

200 images. To overcome the problem of overfitting, they used the concept of transfer learning and fine-tuned the model with the WiderFace dataset [14]. The first CNN consists of five layers and is used to scale the input image. The second and third layers consist of seven layers each. The advantage of using three cascaded CNN is that each false detection is eliminated, thus making a prediction stronger. However, using three CNN makes it computationally expensive. The model achieved an accuracy of 86.6% and recall of an 87.8% on their proposed dataset.

The SRCNet model for face mask detection. The model comprises two networks: a classification network and an image super-resolution (SR) network. The model is capable of adequately classifying incorrect face mask wearing (IFW), correct face mask wearing (CFW), and no face mask wearing (NFW). The model was trained using the MMD or Medical Masked dataset [16] and the MobileNetV2 CNN algorithm was adopted [10]. The design was well organized and effective. However, the dataset used for training was very small and the inference speed was slower than other algorithms. The model achieved an accuracy of 98.07%.

VGG-16 CNN was used for face mask detection. The dataset they developed consists of 25,000 images, and the model was trained on it. The mask-covered area in an image was first segmented and extracted. The proposed model used the Adam optimizer as an optimization function. Their algorithm was 96% accurate at spotting face masks.

The SSDMNv2 model is proposed in many projects which had happened. They used a similar approach to ours—for face detection, they utilized a single-shot multi-box detector and MobileNetV2 for classification. The classification accuracy was around 92% and the F1-score was 0.93. Our proposed system outperforms it with 98.6% training and 97% testing accuracy and a 0.95 F1-score.

For face detection, YOLOv3 was used. It was trained on celeb and wider face databases. The model was later evaluated on the FDDB database and achieved an accuracy of 93.9%.

VGG-16 CNN was used for face mask detection. The dataset they developed consists of 25,000 images, and the model was trained on it. The mask-covered area in an image was first segmented and extracted. The proposed model used the Adam optimizer as an optimization function. Their algorithm was 96% accurate at spotting face masks.

The SSDMNv2 model is proposed in many projects which had happened. They used a similar approach to ours—for face detection, they utilized a single-shot multi-box detector and MobileNetV2 for classification. The classification accuracy was around 92% and the F1-score was 0.93. Our proposed system outperforms it with 98.6% training and 97% testing accuracy and a 0.95 F1-score.

For face detection, YOLOv3 was used. It was trained on celeb and wider face databases. The model was later evaluated on the Fddb database and achieved an accuracy of 93.9%.

CHAPTER-4

PROPOSED METHOD

4.1 PROPOSED SYSTEM

The real-time face mask detection system is proposed, which is implemented in two phases (training and deployment). the dataset is classified into three classes: face with the correct mask, face with an incorrect mask, and face without a mask.

4.1.1 Advantages of Proposed System

- The system can be operated automatically using sensors.
- Opening and closing of gate without any human participation.
- Mask detection can be notified immediately.

4.1.2 Hardware Requirements in Proposes System

- Arduino Uno
- E18-D80NK IR Sensor
- LCD Display
- Servo Motor
- ESP32 CAM WiFi + Bluetooth
- UART Serial Converter Module

4.1.3 Software Requirements in Proposed System

- Embedded C
- Arduino IDE

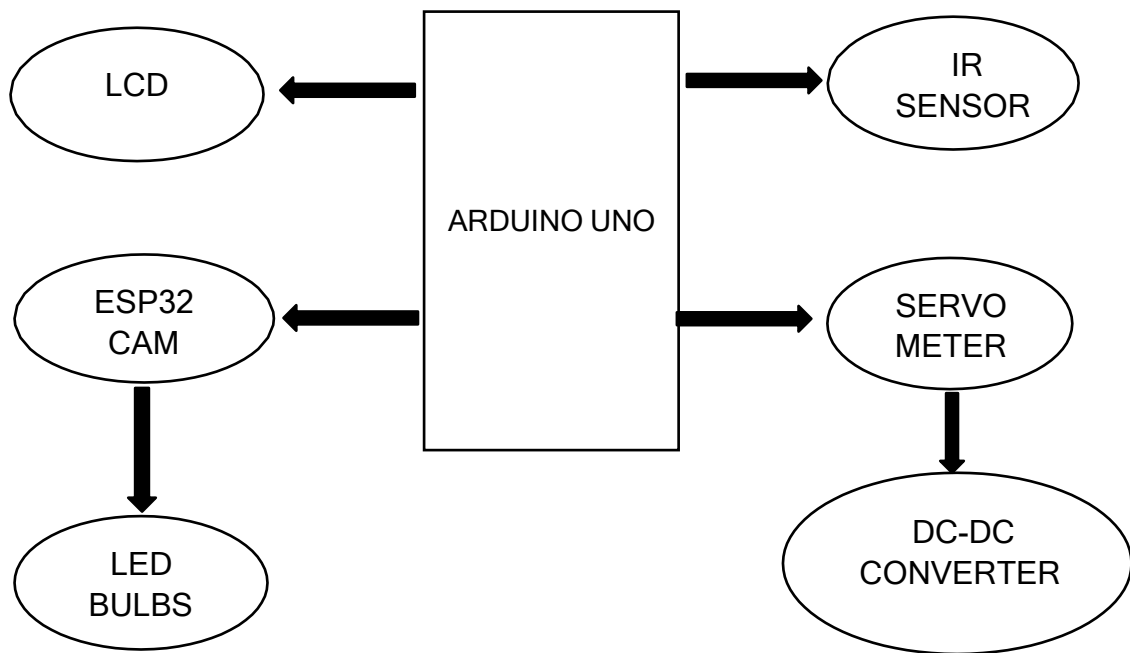


FIG:4.1: HARDWARE BLOCK DIAGRAM OF PROPOSED SYSTEM

4.2 ARDUINO MICRO-CONTROLLER

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

Arduino has a simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

- **Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than \$50.

- **Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.
- **Simple, clear programming environment** - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.
- **Open source and extensible software** - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVRC code directly into your Arduino programs if you want to.
- **Open source and extensible hardware** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

4.2.1 ARDUINO UNO

The Arduino UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family.

Arduino UNO is a microcontroller board based on the **ATmega328P**. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

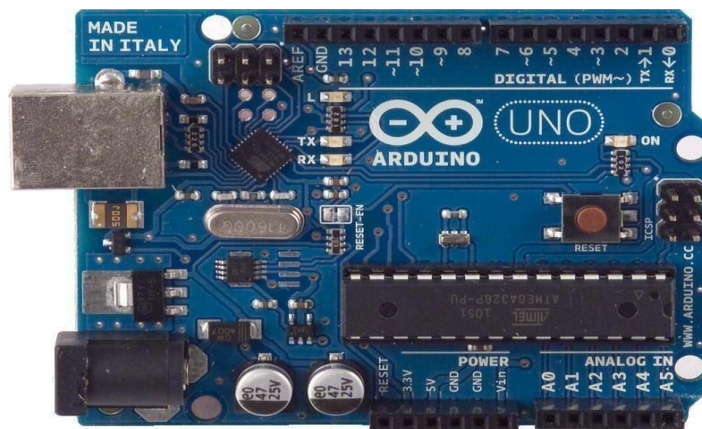


Fig:4.2: Arduino Uno

TABLE: 4.1: ARDUINO UNO TECHNICAL SPECIFICATIONS

Microcontroller	Atmega328P
Operating Voltage	5V
Recommended input voltage	7-12V
Input Voltage Limits	6-20V
Analog Input pins	6
Digital I/O Pins	14
DC Current on I/O Pins	40mA
DC Current On 3.3V Pins	50MA
Flash Mmemory	32KB
SRAM	2KB
EEPROM	1KB
Frequency	16MHz

4.2.2 Applications of Arduino

Prototyping of Electronics Products and Systems

Multiple DIY Projects.

Easy to use for beginner level DIYers and makers

Projects requiring Multiple I/O interfaces and communications

4.2.3 USING ARDUINO BOARD

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has

an internal pull-up resistor of 20-50 KOhms which are disconnected by default.

Out of these 14 pins, some pins have specific functions as listed below:

- **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using `analogWrite()` function.
- **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
- **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with `analogReference()` function.

- Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

- **AREF:** Used to provide reference voltage for analog inputs with `analogReference()` function.
- **Reset Pin:** Making this pin LOW, resets the microcontroller.

Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB

The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

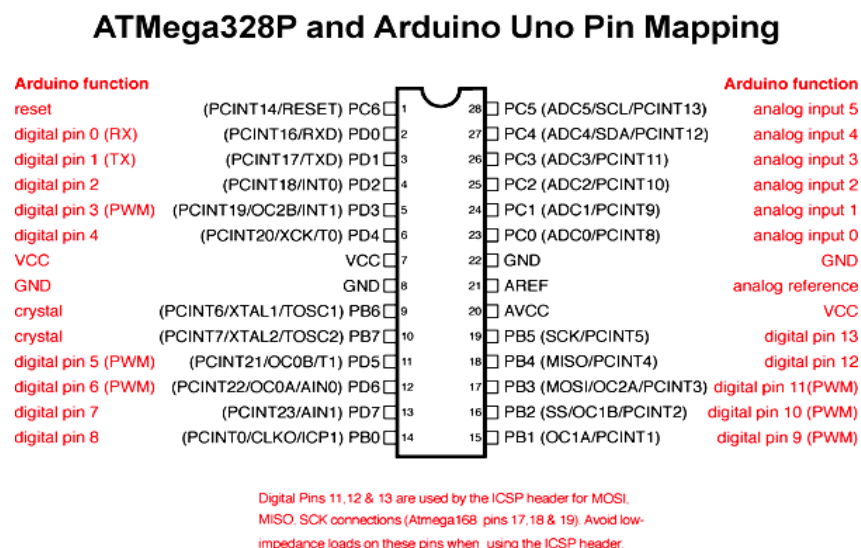


Fig: 4.3: Arduino Uno pin Diagram

4.3 ADJUSTABLE INFRARED SENSOR

The E18-D80NK Adjustable Infrared Proximity Sensor Switch 3-80cm PNP Type is a set of transmitter and receiver with PNP configuration in one of the photoelectric switch sensor. The detection distance can be adjusted according to the demand. The sensor has a detection range of 3-80cm.

The Adjustable Infrared Sensor Switch is small, easy to use, inexpensive, easy to assemble and can be widely used in a robot to avoid obstacles, interactive media, industrial assembly lines, and many other occasions.

The switching signal output differs in accordance with the obstacles. It remains high when no obstacles and remains low when there are obstacles. There is a bright light behind the probe to detect the scope of 3cm - 80cm.

4.3.1 Features of Infrared sensor

- Diffuse reflective type
- Digital output
- Adjustable Detection Distance
- Low consumption
- Comp
- Very small in size
- Less influence on the color of reflected objects, reflectivity
- Industrial grade quality
- Can detect colour difference from certain range
- TTL output high whenever sensor sense an obstacle
- Detecting distance of 3cm to 80cm
- External cloud circuit unnecessary
- Low cost
- Has inbuilt lenses assembly and potentiometer to set range of the module
- Output indication LED act size

4.3.2 Connections of wires

- Red Wire: +5
- Green Wire: GND
- Yellow Wire: Digital Output

TABLE:4.2: SPECIFICATIONS OF IR SENSOR

Light source	Infrared
Sensing Range	3cm - 80cm
Input Voltage	5
Current Consumption	100mA
Dimentions	17*50, 50 grams
Cable Length	1 Meter

4.3.3 Applications of IR sensors

1. PROXIMITY SENSOR

These are used in smartphones to find the distance of objects. They use a principle called Reflective Indirect Incidence. Radiation transmitted by the transmitter is received by the receiver after being reflected from an object. Distance is calculated based on the intensity of radiation received.

2. ITEM COUNTER

This uses the direct incidence method to count the items. Constant radiation is maintained between transmitter and receiver. As soon as the object cuts the radiation, the item is detected and the count is increased. The same count is shown on a display system.

3. BURGLAR ALARM

This is one of the widely and commonly used sensor applications. It is another example of the direct incidence method. It works similar to the item counter, where the transmitter and receiver are kept on both sides of a door frame. Constant radiation is maintained between transmitter and receiver, whenever an object crosses the path alarm starts.

4. HUMAN BODY DETECTION

This method is used in intrusion detection, auto light switches, etc. An intrusion alarm system senses the temperature of the human body. If the temperature is more than the threshold value, it sets the alarms. It uses an electromagnetic system that is suitable for the human body to protect it from unwanted harmful radiation.

5. GAS ANALYZERS

Gas Analyzers are used to measure gas density by using the absorption properties of gas in the IR region. Dispersive and Non Dispersive types of gas analyzers are available.

6. RADIATION THERMOMETERS

It is one of the key applications of Infrared sensors. The working of a radiation thermometer depends on temperature and type of object. These have faster response and easy pattern measurements. They can do measurements without direct contact with an object.

4.3.4 WORKING OF IR SENSOR

IR LED is one kind of transmitter that emits IR radiation. This LED has the appearance of a standard LED, and the radiation it emits is not visible to the human eye. An infrared transmitter is used to detect the radiation by infrared receivers. These infrared receivers are available in photodiode form. IR Photodiodes are different from regular photodiodes in that they only detect IR radiation. Different types of infrared receivers exist based on voltage, wavelength, package, and other factors.

When used as an IR transmitter and receiver, the wavelength of the receiver must match that of the transmitter. The transmitter is an infrared LED, and the receiver is an infrared photodiode. The infrared photodiode is activated by the infrared light produced by an infrared LED. The photodiode's resistance and the change in output voltage are proportional to the amount of infrared light obtained. This is the IR sensor's fundamental working principle.

Once the infrared transmitter generates emission, when it arrives at the object & some of the emission will reflect toward the infrared receiver. The sensor output can be decided by the IR receiver depending on the intensity of the response.



Fig: 4.4: IR Sensor

4.4 MG995 SERVO MOTOR

MG995 is a **servo motor** that is popular for its performance and low price. The motor is used in many applications mainly being robotics and drones.

Since MG995 is a servo motor providing precise rotation over 180° range its applications are many and in them a few are stated below

- The servo is suited for designing robotic arm in which wear and tear of motor is high. Being metal geared, the servo has long life and can be installed on system like robotic arm where motor work is huge.
- The servo is also suited to be used in drones and toy planes. Having a satisfying torque which is enough to overcome air resistance and control wings of plane, the servo is preferred in toy planes and drones which need precision control no matter the condition.

4.4.1 USING SERVO MOTOR

The Red wire is connected to +5V regulated power which can deliver current up to 1Amp, Brown wire is grounded and Orange wire is connected to PWM (Pulse Width modulation) output of a microcontroller. In the circuit if microcontroller and

servo has different power sources then the microcontroller ground needed to be connected to servo ground.

Now for controlling of servo there are only two important things to remember:

Frequency of PWM: MG995 takes in PWM signal of frequency 50Hz and any higher and lower frequency PWM will lead to error. As shown in figure the every single cycle of PWM needs to be 20ms width for 50Hz frequency.

Duty cycle of PWM: The duty cycle of PWM (or ratio of ON time to total cycle time) determines the position of servo axis. If a PWM signal of 0.5ms ON time over 20mS complete cycle is provided, the servo axis will move to 0°.

And if a PWM signal of 1.5ms ON time over 20mS complete cycle is provided, the servo axis will move to 90°. At last if a PWM signal of 2.5ms ON time over 20mS complete cycle is provided, the servo axis will move to 180°.

Based on these standard values any other degree of rotation is calculated. After calculation we just have to adjust the duty cycle of the PWM for the servo to read the signal and change to that stated position.

This is the way one should control the servo position using PWM signal of any microcontroller or processor. In Arduino and other development boards will have libraries readily available to make it even easier to control the servo. If those libraries can directly use state the servo position instead of adjusting the PWM duty cycle every single time.

4.4.2 APPLICATIONS OF SERVO MOTOR

- Drones and RC planes
- Security Camera
- Robotics
- Solar Tracking and Positioning
- Door lock and safe locks

➤ Hobby Projects

4.4.3 MG995 FEATURES

- Metal geared servo for more life
- Stable and shock proof double ball bearing design
- High speed rotation for quick response
- Fast control response
- Constant torque throughout the servo travel range
- Excellent holding power
- Weight: 55 g
- Dimension: 40.7×19.7×42.9mm
- Operating voltage range: 4.8 V to 7.2 V
- Stall torque: 9.4kg/cm (4.8v); 11kg/cm (6v)
- Operating speed: 0.2 s/60° (4.8 V), 0.16 s/60° (6 V)
- Rotational degree: 180°
- Dead band width: 5 μs
- Operating temperature range: 0°C to +55°C
- Current draw at idle: 10mA

TABLE:4.3: PIN DESCRIPTION OF SERVO MOTOR

Pin	Name	Function
1.	Signal Pin (Orange Pin)	The PWM signal which states the axis position is given through this pin
2.	VCC (Red Pin)	Positive power supply for servo motor is given to this pin
3.	Ground (Brown Pin)	This pin is connected to ground of circuit or power supply



Fig: 4.5 :MG995 Servo Motor

4.5 ESP32 CAM WiFi Module

The ESP32 CAM WiFi Module Bluetooth with OV2640 Camera Module 2MP For Face Recognition has a very competitive small-size camera module that can operate independently as a minimum system with a footprint of only 40 x 27 mm; a deep sleep current of up to 6mA and is widely used in various IoT applications.

It is suitable for home smart devices, industrial wireless control, wireless monitoring, and other IoT applications.

This module adopts a DIP package and can be directly inserted into the backplane to realize rapid production of products, providing customers with high-reliability connection mode, which is convenient for application in various IoT hardware terminals.

ESP integrates WiFi, traditional Bluetooth, and BLE Beacon, with 2 high-performance 32-bit LX6 CPUs, 7-stage pipeline architecture. It has the main frequency adjustment range of 80MHz to 240MHz, on-chip sensor, Hall sensor, temperature sensor, etc.

4.5.1 FEATURES OF ESP32 CAM

1. The smallest 802.11b/g/n Wi-Fi BT SoC module.
2. Low power 32-bit CPU, can also serve the application processor.
3. Up to 160MHz clock speed, summary computing power up to 600 DMIPS. Built-in 520 KB SRAM, external 4MPSRAM.

4. Supports UART/SPI/I2C/PWM/ADC/DAC.
5. Support OV2640 and OV7670 cameras, built-in flash lamp.
6. Support image WiFi upload.
7. Supports TF card.
8. Supports multiple sleep modes.
9. Embedded Lwip and FreeRTOS.
10. Supports STA/AP/STA+AP operation mode.
11. Support Smart Config/AirKiss technology.
12. Support for serial port local and remote firmware upgrades (FOTA).

4.5.2 SPECIFICATIONS OF ESP32 CAM

1. Wireless Module: ESP32-SWiFi 802.11 b/g/n + Bluetooth 4.2 LE module with PCB antenna, u.FL connector, 32Mbit SPI flash, 4MBit PSRAM.
2. External Storage: micro SD card slot up to 4GB.
3. Camera
 - FPC connector.
 - Support for OV2640 (sold with a board) or OV7670 cameras.
 - Image Format: JPEG(OV2640 support only), BMP, grayscale.
 - LED flashlight.
4. Expansion: 16x through-holes with UART, SPI, I2C, PWM.
5. Misc: Reset button.
6. Power Supply: 5V via pin header.
7. Power Consumption
 - Flash LED off: 180mA @ 5V.
 - Flash LED on to maximum brightness: 310mA @ 5V.
 - Deep-sleep: 6mA @ 5V min.
 - Modem-sleep: 20mA @ 5V min.
 - Light-sleep: 6.7mA @ 5V min.
8. Dimensions (ESP32): 40 x 27 x 12 (LxWxH) mm.
9. Temperature Range: Operating: -20 °C ~ 85 °C; storage: -40 °C ~ 90 °C @< 90%RH.

TABLE :4.4: SPECIFICATIONS OF CAM

INPUT VOLTAGE	5
OPERATING TEMPERATURE	-20 ~ 85
SPI FLASH	Default 32Mbit
RAM	520KB SRAM + 4MB PSRAM
BLUETOOTH	Bluetooth 4.2 BR/EDR and BLE standards
WiFi	802.11b/g/n/
UART BAUDRATE	115200 bps
IMAGE OUTPUT FORMATE	JPEG(OV2640 SUPPORT only),BMP,GRAYSCALE
SPECTRUM RANGE	2412 ~ 2484 MHz
SHIPMENT WEIGHT	0.082 kg
SHIPMENT DIMENSIONS	8 × 6 × 2 cm

4.5.3 Package Includes In ESP32 CAM

- 1 x ESP32 CAM WiFi Module.
- 1 x OV2640 Camera Module 2MP.

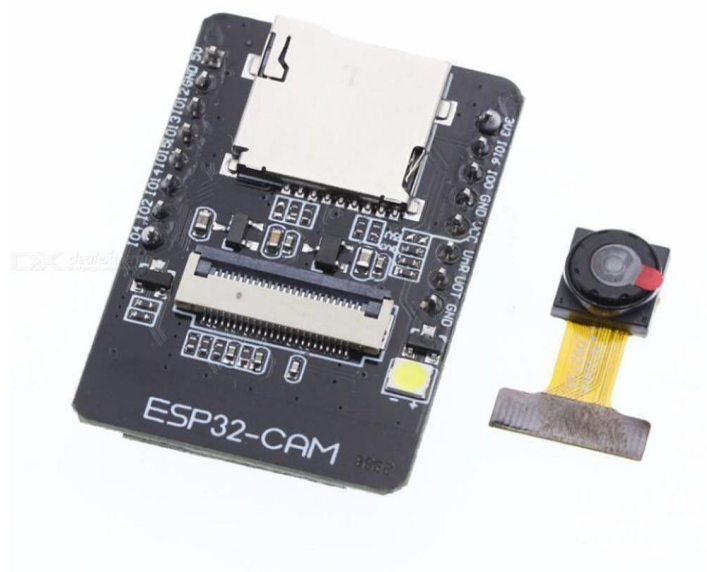


Fig:4.6: ESP32-CAM

4.6 LCD DISPLAY 16×2

Nowadays, people use the devices which are made up of LCDs such as CD players, DVD players, digital watches, computers, etc. These are commonly used in the screen industries to replace the utilization of CRTs. Cathode ray tube use huge power when compared to LCDs and CRTs heavier as well as bigger. These devices are thinner as well power consumption is extremely less. The LCD 16*2 working principle is, it blocks the light rather than dissipate. To discuss an overview of LCD 16*2, pin configuration and its working

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

4.6.1 LCD 16x2 Pin Configuration

- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (VO/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1 (0=data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V
- Pin 16 (-ve pin of the LED): This pin is connected . to GND

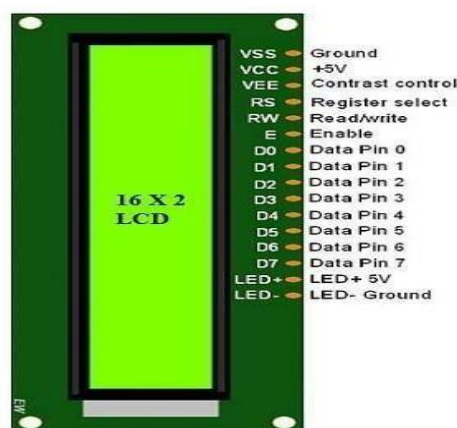


Fig:4.7: LCD Pin Diagram

4.6.2 FEATURES OF LCD 16×2

The features of LCD mainly include the following.

- The operating voltage of this LCD is 4.7V-5.3V.
- It includes two rows where each row can produce 16-characters.
- The utilization of current is 1mA with no backlight
- Every character can be built with a 5×8 pixel box
- The alphanumeric LCDs alphabets & numbers
- Its display can work on two modes like 4-bit & 8-bit
- These are obtainable in Blue & Green Backlight
- It displays a few custom generated characters.

4.6.3 16×2 LCD I2C

This display overcomes the drawback of LCD1602 Parallel LCD Display in which you'll waste about 8 Pins on your Arduino for the display to get working. Luckily in this product, an I2C adapter is directly soldered right onto the pins of the display. So all you need to connect are the I2C pins, which show a good library and little coding.

The I2C is a type of serial bus developed by Philips, which uses two bidirectional lines, called SDA (Serial Data Line) and SCL (Serial Clock Line). Both must be connected via pulled-up resistors. The usage voltages are standard as 5V and 3.3V.

4.6.4 Features of LCD I2C

- I2C reduces the overall wiring.
- 16 characters wide, 2 rows.
- I2C adapter allows flexibility in connections.
- White text on the blue background
- Single LED backlight included can be dimmed easily with a resistor or PWM.
- Arduino IIC/I2C interface was developed to reduce the IO port usage on the Arduino board

4.6.5 REGISTERS OF LCD

A 16×2 LCD has two registers like data register and command register. The RS is mainly used to change from one to another. When the register set is '0', then

it is known as command register. Similarly, when the register set is '1', then it is known as data register.

4.6.6 Command Register

The main function of the command register is to store the instructions of command which are given to the display. So that predefined tasks can be performed such as clearing the display, initializing set the cursor place and display control. Here commands processing can occur within the register.

4.6.7 Data Register

The main function of the data register is to store the information which is to be exhibited on the LCD screen. Here, the ASCII value of the character is the information which is to be exhibited on the screen of LCD. Whenever the information is sent to LCD, it transmits to the data register, and then the process will be starting there. When register set = 1, then the data register will be selected

TABLE: 4.5: COMMAND CODES OF LCD

HEX CODE	COMMAND TO LCD INSTRUCTION REGISTER
01	Clear Display Screen
02	Return home
04	Decrement cursor(shift cursor to left)
06	Increment cursor(shift cursor to right)
05	Shift display right
07	Shift display left
08	Display off, cursor off
0A	Display off, cursor on
0C	Display off, cursor off
0E	Display on, cursor blinking
0F	Display off, cursor blinking
10	Shift cursor position to left
14	Shift cursor position to right
18	Shift the entire display to the left
1C	Shift the entire display to the right
80	Force cursor to beginning(1 st line)
C0	Force cursor to beginning(2 nd line)
38	2 lines and 5×7 matrix

4.7 LM2596 Adjustable DC-DC Converter module

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version.

The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

LM2596 DC-DC buck converter step-down power module with the high-precision potentiometer, capable of driving a load up to 3A with high efficiency, which can work with Freeduino UNO, other mainboards, and basic modules. When the output current keeps greater than 2.5A (or output power greater than 10W), please add a heat sink to it.

This device is internally compensated to minimize the number of external components to simplify the power supply design. Since LM2596 converter is a switch-mode power supply, its efficiency is significantly higher in comparison with popular three-terminal linear regulators, especially with higher input voltages. The LM2596 operates at a switching frequency of 150 kHz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators.

4.7.1 FEATURES OF LM2596 CONVERTER

- Input voltage: 3-40V
- Output voltage: 1.5 - 35V
- Output Current: Rated current is 2A, maximum 3A(Additional heatsink is required)
- Module Properties: non-isolated constant voltage module
- Rectification: non-synchronous rectification
- Short circuit protection: current limiting, since the recovery.

4.7.2 Packages Includes of LM2596 CONVERTER

1 × LM2596S DC-DC Buck Converter Power Supply

TABLE: 4.6: SPECIFICATIONS OF LM2595 CONVERTER

Input voltage	3-40v
Output voltage	1.5-35V
Output current	Rated current is 2A, maximum 3a(Additional heatsink is required)
Switching frequency	150KHz
Operating temperature	Industrial grade(-40 to +85)
Conversion efficiency	92%(highest)
Load Regulation	0.5%
Voltage Regulation	0.5%
Dynamic Response Speed	5% 200uS
Dimension	45*20*14mm(L*W*H)
Shipment Weight	0.011 kg
Shipment Dimensions	5×4×2 cm



Fig:4.8: DC-DC Converter Motor

4.8 CH340G USB TO TTL SERIAL CONVERTER

This is CH3450 USB to TTL(serial) converter, USB TO TTL / USB-TTL/STC microcontroller programmer/pl2303 in nine upgrades plate with a transparent cover compatible with Arduino Raspberry pi,AVR,PIC,8051, etc.

This USB-TTL converter is based on CH340G USB to Serial TTL converter chip. The module can be used for 3.3V logic level signals, the and has the option to switch from 5V to 3.3V logic level using a 2 pin shunt supplied with the module.

The CH340 USB to serial adaptor makes use of the CH340 USB to serial IC provide a low-cost alternative to our popular FTDI based module. Although much cheaper this module doesn't lack in features or usability. Once you have installed the drivers the module will appear as a normal serial COM port on your computer making it compatible with most terminal programs and development environments such as the Arduino IDE

The module includes a small switch which allows the voltage available at the VC (Supply output) pin to be switched between 3.3 and 5V Data pins include TX, RX. These digital pins are at 5V TTL levels allowing them to be directly interfaced most 5V microcontrollers.

4.8.1 FEATURES CH340G USB TO TTL SERIAL CONVERTER

- Built-in USB to TTL Transfer chip.
- Designed to be used for USB to TTL electronic Projects.
- TTL interface output, easy to connect to your MCU.
- Dual 3.3V and 5V Power output work with 3.3V and 5V target device.
- The mini-module is designed specifically for STC download and ARDUINO PRO supports all series of STC.
- Microcomputer with cold start reset button.
- Supports WIN7/VISTA/MAC/LINUX(32bit/64bit system)
- USB to TTL conversion board used for STC microcontroller download DVD/hard disk/router/GPS upgrade.
- For STC Download: SCM must be a minimum system and external crystal oscillator.

TABLE: 4.7: SPECIFICATIONS OF SERIAL CONVERTOR

IC Chip	CH340G
Length (mm)	54
Width (mm)	18
Height (mm)	8
Weight (gm)	6

4.8.2 SUPPORTS

- Support WINDOWS 98 / ME / 2000 / XP / Server 2003 / VISTA / Server 2008
- / WIN 7 / WIN 8 32 Bit / 64.
- Support YSB 1.1 or USB2.0 / USB3.0 for communication.
- Provide RS232, RS485, RS422 interface.
- Simulation interface, you can upgrade serial peripherals.

- Supports common MODE contact signal.
- Supports IRDA SIR infrared communication.
- Programming does not affect the target board program runs.

4.8.3 PACKAGE INCLUDES OF CH340G: 1× USB to TTL converter UART module
CH340G CH340 3.3V 5V switch.

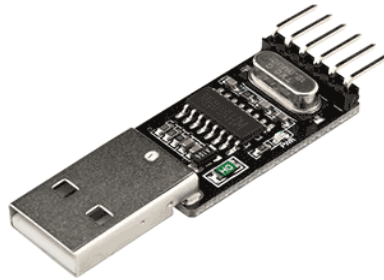


Fig:4.9: CH340G USB To TTL Converter

4.9 SOFTWARE REQUIREMENT

ARDUINO SOFTWARE (IDE)
EMBEDDED C

4.9.1 ARDUINO SOFTWARE (IDE)

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 and Genuino hardware to upload programs and communicate with them.



Fig:4.10: Arduino IDE

4.9.2 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.

TABLE: 4.8: ABOUT ARDUINO IDE

1.	Verify Checks your code for errors compiling it.
2.	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"
3.	New Creates a new sketch
4.	Open Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content. Note: due to a bug in Java, this menu doesn't scroll; if you need to open a sketch late in the list, use the File Sketchbook menu instead.
5.	Save Saves your sketch
6.	Serial Monitor Opens the serial monitor

Additional commands are found within the five menus: **File**, **Edit**, **Sketch**, **Tools**, and help. The menus are context sensitive, which means only those items relevant to the work currently being carried out are available.

4.9.3 Programmer

For selecting a hardware programmer when programming a board or chip and not using the onboard USB-serial connection. Normally you won't need this, but if you're burning a boot loader to a new microcontroller, you will use this.

4.9.4 Burn boot loader

The items in this menu allow you to burn a boot loader onto the microcontroller on an Arduino board. This is not required for normal use of an Arduino or Genuino board but is useful if you purchase a new ATmega microcontroller (which normally comes without a boot loader). Ensure that you've selected the correct board from the Boards menu before burning the boot loader on the target board. This command also set the right fuses.

4.9.5 Help

Help provides you easy access to find a number of documents that come with the Arduino Software (IDE). You have access to Getting Started, Reference, this 61 guide to the IDE and other documents locally, without an internet connection. The documents are a local copy of the online ones and may link back to our online website.

UPLOADING: Before uploading your sketch, you need to select the correct items from the **Tools > Board** and **Tools > Port** menus. The boards are described below. On the Mac, the serial port is probably something like **/dev/tty.usbmodem241** (for an Uno or Mega2560 or Leonardo) or **/dev/tty.usbserial-1B1** (for a Duemilanove or earlier USB board), or **/dev/tty.USA19QW1b1P1.1** (for a serial board connected with a Keyspan USB-to-Serial adapter). On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. On Linux, it should be **/dev/ttyACMx** , **/dev/ttyUSBx** or similar. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto- reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error.

Inorder to upload a sketch, an Arduino bootloader is used it is a small program that has been loaded on to the microcontroller on your board. It 62 allows you to upload code without using any additional hardware. The bootloader is active for a

few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The boot loader will blink the on-board (pin13) LED when it starts (i.e. when the board resets).

LIBRARIES: Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with the sketch. Because libraries are uploaded to the board with the sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code.

There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch.

4.10 EMBEDDED C

Embedded C is most popular programming language in software field for developing electronic gadgets. Each processor used in electronic system is associated with embedded software.

Embedded C programming plays a key role in performing specific function by the processor. In day-to-day life people use many electronic devices such as mobile phone, washing machine, digital camera, etc. These all device working is based on microcontroller that are programmed by embedded C.

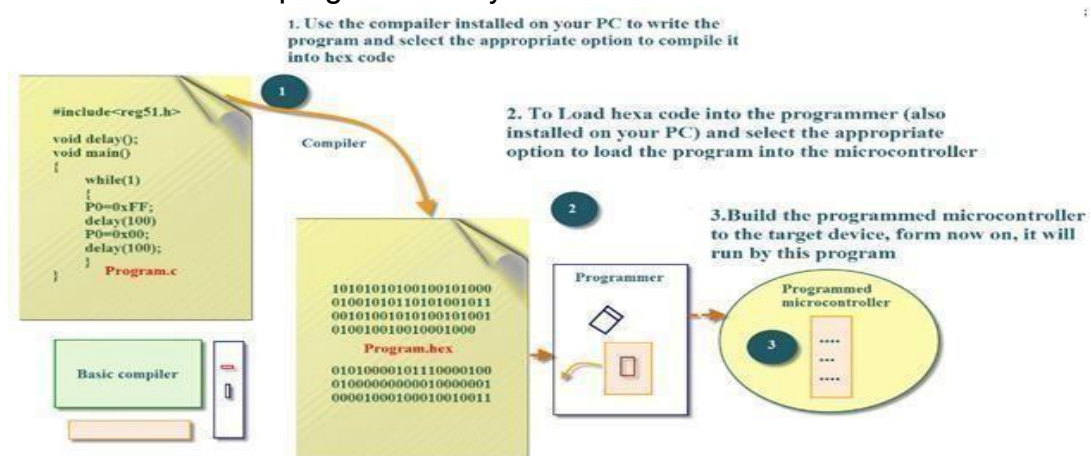


Fig:4.11: Embedded C

The Embedded C code written in above block diagram is used for blinking the LED connected with Port0 of microcontroller.

In embedded system programming C code is preferred over other language. Due to the following reasons:

- Easy to understand
- High Reliability
- Portability

4.10.1 EMBEDDED SYSTEMS PROGRAMMING

Function is a collection of statements that is used for performing a specific task and a collection of one or more functions is called a programming language. Every language is consisting of basic elements and grammatical rules. The C language programming is designed for function with variables, character set, data types, keywords, expression and so on are used for writing a C program.

The extension in C language is known as embedded C programming language. As compared to above the embedded programming in C is also have some additional features like data types, keywords and header file etc is represented by `#include<microcontroller name.h>`.

4.11 BASIC IMAGE PROCESSING CONCEPTS USED

IMAGE PROCESSING : Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them. It is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps.

- Importing the image with optical scanner or by digital photography. · Analyzing and manipulating the image which includes data compression and image enhancement and spotting patterns that are not to human eyes like satellite photographs.
- Output is the last stage in which result can be altered image or report that is based on image analysis.

Purpose of image processing

The purpose of image processing is divided into 5 groups. They are:

1. Visualization - Observe the objects that are not visible.
2. Image sharpening and restoration - To create a better image.
3. Image retrieval - Seek for the image of interest.
4. Measurement of pattern - Measures various objects in an image.
5. Image Recognition - Distinguish the objects in an image.

4.11.1 TYPES

The two types of methods used for Image Processing are Analog and Digital Image Processing. Analog or visual techniques of image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. The image processing is not just confined to area that has to be studied but on knowledge of analyst.

Association is another important tool in image processing through visual techniques. So analysts apply a combination of personal knowledge and collateral data to image processing. Digital Processing techniques help in manipulation of the digital images by using computers. As raw data from imaging sensors from satellite platform contains deficiencies. To get over such flaws and to get originality of information, it has to undergo various phases of processing. The three general phases that all types of data have to undergo while using digital technique are Pre- processing, enhancement and display, information extraction.

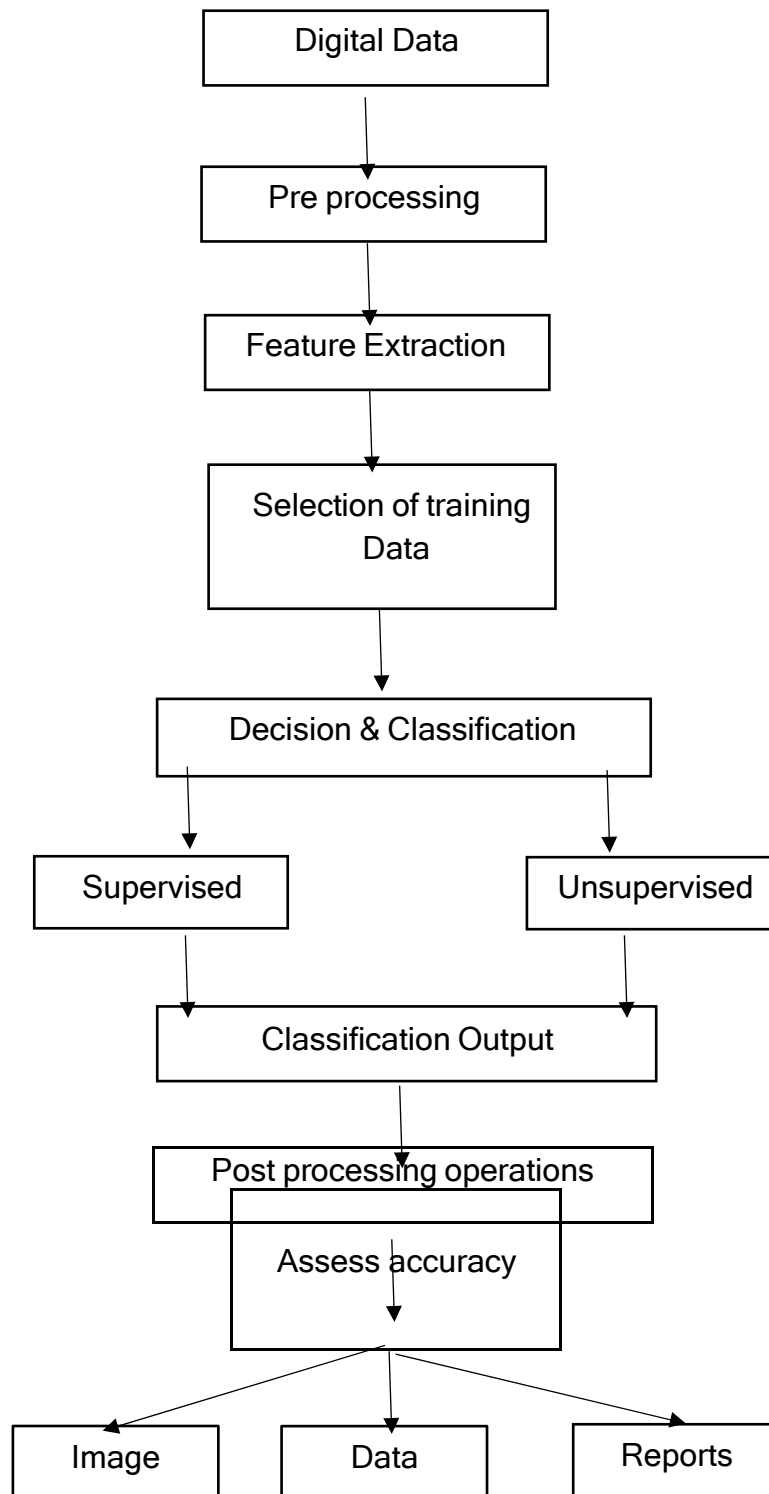


Fig:4.12: FLOW CHART OF PROPOSED SYSTEM

4.11.2 MODULES

- Importing the necessary libraries
- Retrieving the images
- Splitting the dataset
- Building the model
- Apply the model and plot the graphs for accuracy and loss
- Accuracy on test set
- Saving the Trained Model

4.12 IMPORTING LIBRARIES

LIBRARIES FOR ESP32 CAM

- `esp_camera.h` detects and configures camera over I2C interface.
- `<WiFi.h>` this library can instantiate servers, Clients and send/recv UDP packets through wifi.
- `esp_timer.h` is used to identify if the timer is still active or not
- `img_converters.h`
- `Arduino.h` is used to working with hardware or manipulating data.
- `fb_gfx.h`
- `soc/soc.h`
- `soc/rtc_cntl_reg.h`
- `esp_http_server.h`
- `fd_forward.h`
- `fr_forward.h`

These are all the libraries that are needed to install for the efficient working of the ESP32 CAMERA module.

These libraries are mainly used to connect with the wifi for the real-time view with the camera, connecting the camera with the Arduino, and mainly converting the images.

LIBRARIES FOR ARDUINO UNO

- <Wire.h>
- LiquidCrystal_I2C.h
- Servo.h

These are all the libraries that are need to install for the all brainer of the project that is the Arduino Uno.

These libraries are mainly used for the efficient working of the Liquid Crystal Device that is the LCD and the Servo motor which is used to move according to the code.

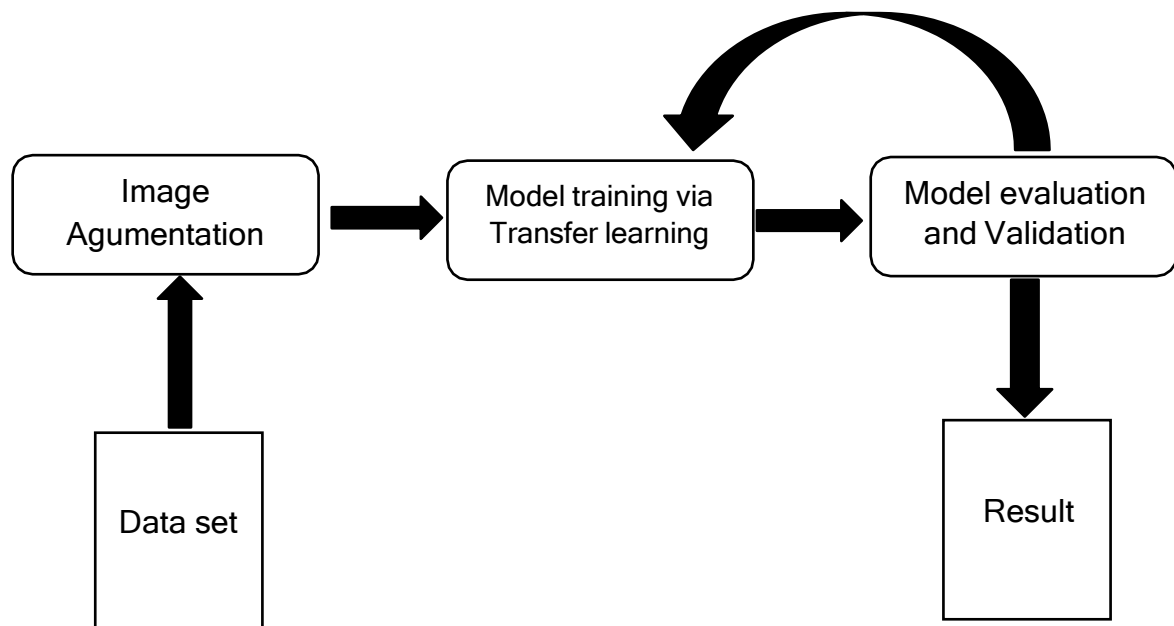


Fig: 4.13: Software Block Diagram Of The Proposed System

Generally, all face detection system uses dataset of images for testing, evaluating and comparing the system accuracy in verifying or identifying individuals.

4.13 DATASET

A dataset is a collection of data. In the case of tabular data, a data set corresponds to one or more database tables, where every column of a table represents a particular variable, and each row corresponds to a given record of the dataset in question.

The dataset lists values for each of the variables such as for example height and weight of an object for each member of the dataset can also consist of a collection of documents or files.

CHAPTER- 5

RESULTS AND DISCUSSION

In this system, the ARDUINO UNO microcontroller is used which acts as brain of the system because the entire system program instructed stored in it. Inorder to determine the person the IR sensor is used. It further turns on the ESP32 Camera module ESP32 camera has been used which helps to detect the face of a person in this system. The Led is turned red colour when a particular person tries to enter without the mask The Led is turned green when the same person tries to enter with the mask on. The concept of Image Processing is used to identify whether the particular person is having his mask on or off. All the data fetch with the help of sensors are update to Arduino therefore all the operations are controlled with the code

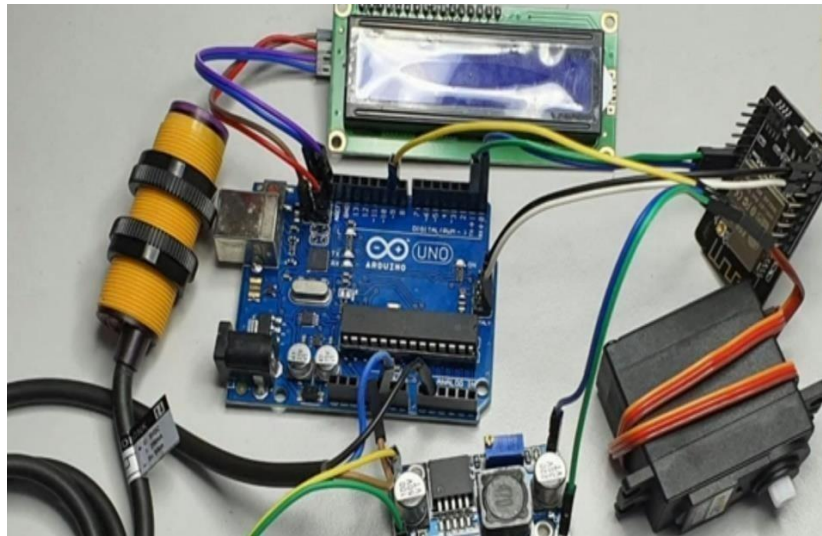
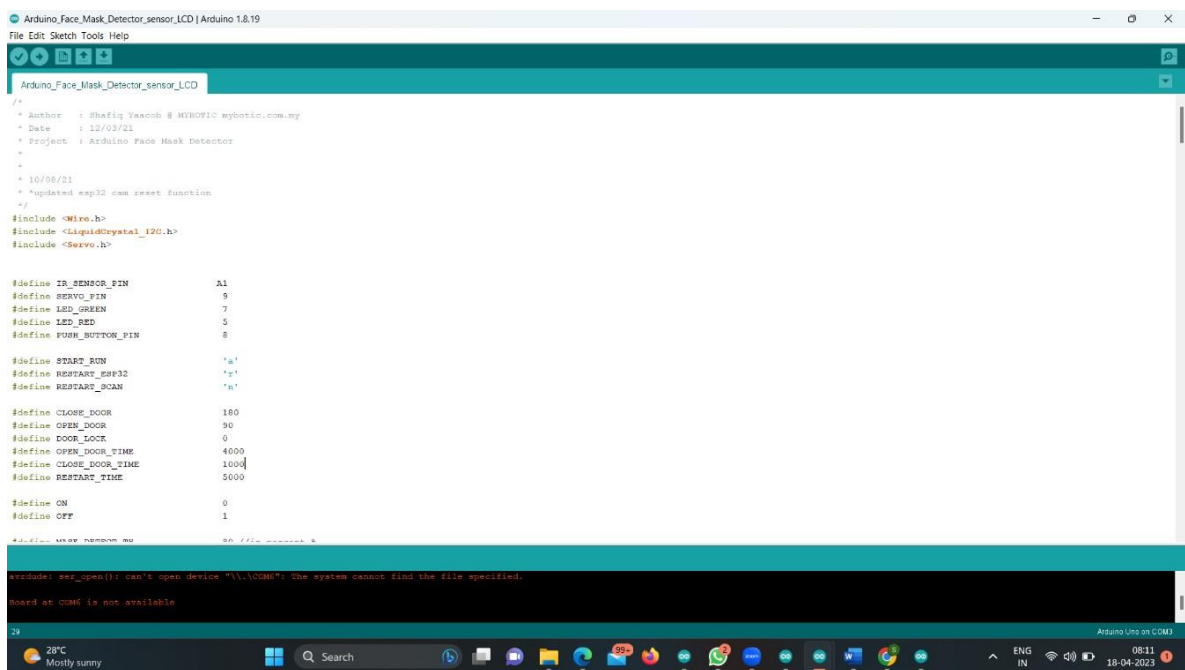


Fig:5.1: Final Developed Model Of Proposed System

In spite of trying the best to rectify the errors, there are a few limitations under which the model has to be operated.

- As the battery is not used the power supply should be continuously turned on.
- Sustainable gate should be implemented to the servo motor instead of non sustainable. .
- The IR Sensor used here has a very little range compared to the range which is need to be used.
- Arduino has been used as the microcontroller but Raspberry pie is a microprocessor which gives a better experience.



```
Arduino_Face_Mask_Detector_sensor_LCD | Arduino 1.8.19
File Edit Sketch Tools Help

Arduino_Face_Mask_Detector_sensor_LCD

/*
 * Author : Shafiq Yacob @ MYBOTIC mybotic.com.my
 * Date : 12/03/21
 * Project : Arduino Face Mask Detector
 *
 * 10/08/21
 * *updated esp32 cam reset function
 */
#include <Micro.h>
#include <LiquidCrystal_I2C.h>
#include <Servo.h>

#define IR_SENSOR_PIN A1
#define SERVO_PIN 9
#define LED_GREEN 7
#define LED_RED 5
#define PUSH_BUTTON_PIN 8

#define START_RUN 'a'
#define RESTART_ESP32 'r'
#define RESTART_OCAN 'n'

#define CLOSE_DOOR 180
#define OPEN_DOOR 90
#define DOOR_LOCK 0
#define OPEN_DOOR_TIME 4000
#define CLOSE_DOOR_TIME 1000
#define RESTART_TIME 5000

#define ON 0
#define OFF 1

//----- USER DEFINED MSG ----- on / off message &

#include: esp32.cpp:1: can't open device "\\.\COM3": The system cannot find the file specified.
Board at COM3 is not available

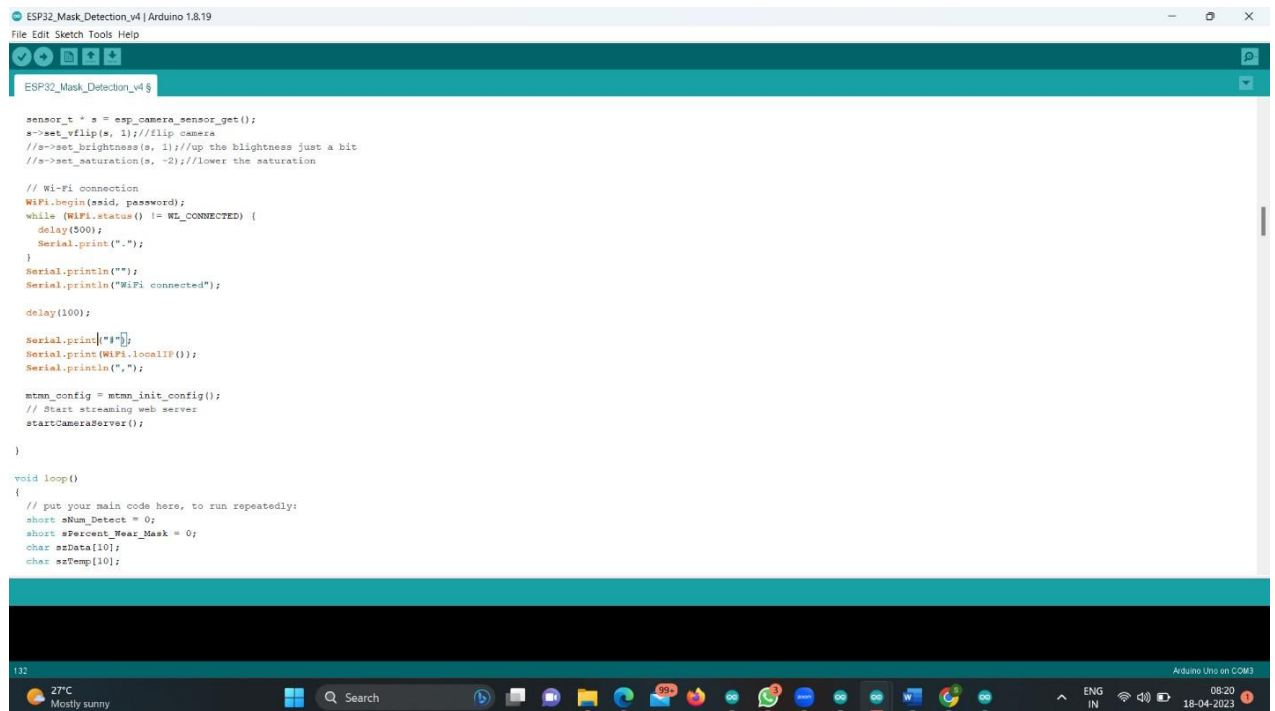
29 Arduino Uno on COM3
28°C Mostly sunny 08:11 18-04-2023
```

Fig:5.2: Arduino Interface of the Final Result

The above diagram follows the code which is needed to be uploaded to the arduino the code consists of the libraries used in the program and pin discription that is which are all the pins that are used.

The esp32 cam sends the commands to the arduino through the code which is uploaded in the esp32 cam. It is known to us that the esp32 cam does not contain any USB to upload the code. In this case the USB to TTL serial converter is used.

In esp32 camera module code the instruction regarding the Wifi connection will be given .



```
ESP32_Mask_Detection_v4$

sensor_t * s = esp_camera_sensor_get();
s->set_vflip(s, 1); //flip camera
//s->set_brightness(s, 1); //up the blightness just a bit
//s->set_saturation(s, -2); //lower the saturation

// Wi-Fi connection
WiFi.begin(ssid, password);
while (WiFi.status() != WL_CONNECTED) {
  delay(500);
  Serial.print(".");
}
Serial.println("");
Serial.println("WiFi connected");

delay(100);

Serial.print("IP:");
Serial.print(WiFi.localIP());
Serial.println("");

mtmn_config = mtmn_init_config();
// Start streaming web server
startCameraServer();
}

void loop()
{
  // put your main code here, to run repeatedly:
  short aNum_Detect = 0;
  short sPercent_Wear_Mask = 0;
  char szData[10];
  char szTemp[10];
```

Fig :5.3: Uploading the ESP32 camera module code through USB to TTL converter



Fig: 5.4: Detecting the face mask

In the mask detection part when the person is wearing the mask the face will not be detected. Hence there will be no box around the face. When the face is detected there will be a yellow colour box around the face, which implies that the face has been detected and the entry for the person is detected.

CHAPTER-6

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

The world is facing a huge health crisis because of pandemic COVID19. The governments of various countries around the world are struggling to control the transmission of the coronavirus. According to the COVID-19 statistics published by many countries, it was noted that the transmission of the virus is more in crowded areas. Many research studies have proved that wearing a mask in public places will reduce the transmission rate of the virus. Therefore, the governments of various countries have made it mandatory to wear masks in public places and crowded areas. It is very difficult to monitor crowds at these places. So in this project, the proposal a deep learning model that detects persons who are not wearing a mask. This proposed model is built using transfer learning of InceptionV3. In this work image augmentation techniques are used to enhance the performance of the model as they increase the diversity of the training data. The proposed transfer learning model achieved accuracy and specificity of 99.92%, 99.9% during training, and 100%, 100% during testing on the SMFD dataset. The same work can further be improved by employing large volumes of data and can also be extended to classify the type of mask, and implement a facial recognition system, deployed at various workplaces to support person identification while wearing the mask

6.2 FUTURE SCOPE

In the future, physical distance integration could be introduced as a feature, or coughing and sneezing detection could be added. Apart from detecting the face mask, it will also compute the distances among each individual and see any possibility of coughing or sneezing. If the mask is not worn properly, a third class can be introduced that labels the image as 'improper mask'. In addition, researchers could propose a better optimizer, improved parameter configuration, and the use of adaptive models.

REFERENCES

- [1] Chen D, Hua G, Wen F, Sun J (2016) Supervised transformer network for efficient face detection. In: European conference on computer vision. Springer, pp 122-138.
- [2] Chen Y, Menghan H u, Hua C, Zhai G, Zhang J, Li Q, Yang SX (2021) Face mask assistant: detection of face mask service stage based on mobile phone. IEEE Sensors J 21(9):11084-11093.
- [3] Cruz AP, Jaiswal J (2021) Text-to-image classification using attnGAN with densenet architecture. In: Proceedings of international conference on innovations in software architecture and computational systems. Springer, pp1- 17
- [4] Ejaz MS, Islam MR, Sifatullah M, Sarker A (2019) Implementation of principal component analysis on masked and non-masked face recognition. In: 2019 1st international conference on advances in science, engineering and robotics technology (ICASERT). IEEE, pp 1-5.
- [5] He K, Zhang X, Ren S, Sun J (2016) Deep residual learning for image recognition. In: Proceedings of the IEEE conference on computer vision and pattern recognition, pp 770-778. [6] Huang Y, Qiu C, Wang X, Wang S, Yuan K (2020) A compact convolutional neural network for surface defect inspection. Sensors 20 (7):1974.
- [6] Hussain SA, Al Balushi ASA (2020) A real time face emotion classification and recognition using deep learning model. In: Journal of physics: Conference series, vol 1432. IOP Publishing, Bristol , p 012087
- [7] Karen S, Zisserman A (2014) Very deep convolutional networks for large-scale image recognition. ArXiv.
- [8] Khan N, Yaqoob I, Hashem IAT, Inayat Z, Ali WKM, Alam M, Shiraz M, Gani A (2014) Big data: survey, technologies, opportunities, and challenges. Scientif World J, 2014. [10] Khan N, Yaqoob I, Hashem IAT, Inayat Z, Ali WKM, Alam M, Shiraz M, Gani A (2014) Big data: survey, technologies, opportunities, and challenges. Scientif World J, 2014
- [9] Li S, Ning X, Yu L, Zhang L, Dong X, Shi Y, He W (2020) Multi-angle head pose classification when wearing the mask for face recognition under the covid- 48 19 coronavirus epidemic. In: 2020 International conference on high

- performance big data and intelligent systems (HPBD&IS). IEEE, pp 1-5. [12] Li C, Wang R, Li J, Fei L (2020) Face detection based on yolov3. In: Recent trends in intelligent computing, communication and devices.
- [10] Mednikov Y, Nehemia S, Zheng B, Benzaquen O, Lederman D (2018) Transfer representation learning using inception-v3 for the detection of masses in mammography. In: 2018 40Th annual international conference of the IEEE engineering in medicine and biology society (EMBC). IEEE, pp 2587-2590
- [11] Militante SV, Dionisio NV (2020) Real-time facemask recognition with alarm system using deep learning. In: 2020 11Th IEEE control and system graduate research colloquium (ICSGRC). IEEE, pp 106-110.
- [12] Militante SV, Gerardo BD, Dionisio NV (2019) Plant leaf detection and disease recognition using deep learning. In: 2019 IEEE Eurasia conference on iot, communication and engineering (ECICE). IEEE, pp 579-582.
- [13] Modes of transmission of virus causing covid-19. Accessed: 22-Nov-2021
- [14] Ning X, Duan P, Li W, Zhang S (2020) Real-time 3d face alignment using an encoder-decoder network with an efficient deconvolution layer. IEEE Signal Process Lett 27:1944-1948.
- [15] Nwankpa C, Ijomah W, Marshall S (2018) Stephen marshall. Activation functions: Comparison of trends in practice and research for deep learning. ArXiv. [19] Ochin S (2019) Deep challenges associated with deep learning. In: 2019 International conference on machine learning, big data, cloud and parallel computing (COMITCon). IEEE, pp 72-75.
- [16] Qin B, Li D (2020) Identifying facemask-wearing condition using image superresolution with classification network to prevent covid-19. Sensors 20(18):5236
- [17] Shashi Y (2020) Deep learning based safe social distancing and face mask detection in public areas for covid-19 safety guidelines adherence. Int J Res Appl Sci Eng Technol 8(7):1368-1375.
- [18] Ud Din N, Javed K, Bae S, Yi J (2020) A novel gan-based network for unmasking of masked face. IEEE Access 8:44276-44287. [23] Venkateswarlu IB, Kakarla J, Prakash S (2020) Face mask detection using mobilenet and global pooling block. In: 2020 IEEE 4Th conference on information & communication technology (CICT). IEEE, pp 1-5.

- [19] WHO coronavirus disease (covid-19) dashboard. Accessed: 22-Nov-2021.
- [20] Yang G, Gewali UB, Ientilucci E, Gartley M, Monteiro ST (2018) Dual-channel densenet for hyperspectral image classification. In: IGARSS 2018-2018 IEEE International geoscience and remote sensing symposium. IEEE, pp 2595-2598