

A
PROJECT REPORT
On
FACE MASK DETECTION BASED AUTOMATIC DOOR LOCK
DURING PANDEMIC

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in

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Under the supervision of

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JULY 2022

DECLARATION

We hereby declare that the work presented in this report entitled **“FACE MASK DETECTION BASED AUTOMATIC DOOR LOCK DURING PANDEMIC”**, was carried out by us. We have not submitted the matter embodied in this report for the award of any other degree or diploma of any other University or Institute. We have given due credit to the original authors/sources for all the words, ideas, diagrams, graphics, computer programs, experiments, results, that are not our original contribution. We have used quotation marks to identify verbatim sentences and given credit to the original authors/sources.

We affirm that no portion of our work is plagiarized, and the experiments and results reported in the report are not manipulated. In the event of a complaint of plagiarism and the manipulation of the experiments and results, We shall be fully responsible and answerable.

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ABSTRACT

The purpose of our project “Face Mask Detection Based Automatic Door Lock During Pandemic” is to create a tool that detect the face of a human that can calculate the probability that he/she wearing a mask or not. Due to COVID pandemic 2020, we are wearing a face mask and must in order to stay safe and avoid the scattering of disease. As the country starts going through various stages of reopening, face masks have become an important element of our daily lives to stay safe. Wearing face masks will be required in order to socialize or conduct business. So, this application utilizes a camera to detect a person that he is wearing a mask or not. If the person wear the mask then door will automatically open and if the person do not wear mask then door will not open.

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LIST OF ABBREVIATIONS

AI - Artificial Intelligence

ANN- Artificial Neural Networks

ARDS - Acute Respiratory Distress Syndrome

CRRT- Continuous Renal Replacement Therapy

CDC- Centers for Disease Control and Prevention

CI- Confidence Interval

CLIA - Chemiluminescence Assays

COVID-19- Corona Virus Disease 19

CNN-convolutional neural network

ECMO- Extracorporeal Membrane Pulmonary Oxygenation⁹

ELISA- Enzyme-Linked Immunosorbent Assays

EU- European Union

HCoV- Human Coronavirus

ICU-Intensive Care Unit

IDE-Integrated Development Environment

IL- Interleukin

MERS-CoV- Middle East respiratory Syndrome Coronavirus

ML- Machine Learning

POCT - Point of Care Test

PCR- Polymerase Chain Reaction

RBD- Receptor Binding Domain

RRT-PCR- Reverse Real-Time PCR

S protein - Spike Protein

SARS-CoV- Severe Acute Respiratory Syndrome Coronavirus

SARS-CoV-2 -Severe Acute Respiratory Syndrome Coronavirus 2

TCM- Traditional Chinese Medicine

TMPRSS- Surface transmembrane protease/serine protease

TPR – Temperature,Pulse,Respiration

WHO - World Health Organization

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CHAPTER 1

INTRODUCTION

1.1 The COVID-19 pandemic

In December 2019, an outbreak of pneumonia of unknown origin was reported in Wuhan, Hubei Province, China. Pneumonia cases were epidemiologically linked to the Huanan Seafood Wholesale Market. Inoculation of respiratory samples into human airway epithelial cells, Vero E6 and Huh7 cell lines, led to the isolation of a novel respiratory virus whose genome analysis showed it to be a novel coronavirus related to SARS-CoV, and therefore named severe acute respiratory syndrome coronavirus 2 **SARS-CoV-2**. SARS-CoV-2 is a betacoronavirus belonging to the subgenus Sarbecovirus.

The global spread of SARS-CoV-2 and the thousands of deaths caused by coronavirus disease COVID-19 led the World Health Organization to declare a pandemic on **12 March 2020**. To date, the world has paid a high toll in this pandemic in terms of human lives lost, economic repercussions and increased poverty.

1.2 Origin of SARS-CoV-2

Since the discovery of the novel coronavirus, SARS-CoV-2, scientists have debated its origin. It has been speculated that SARS-CoV-2 is the product of laboratory manipulations. However, genetic data does not support this hypothesis and shows that SARS-CoV-2 did not derive from a previously known virus backbone.

Genomes analysis and comparison with previously known coronavirus genomes indicate that SARS-CoV-2 presents unique features that distinguish it from other coronaviruses: optimal affinity for angiotensin converting enzyme 2 ACE2 receptor and a polybasic cleavage site at the S1/S2 spike junction that determines infectivity and host range.

Since the outbreak of SARS-CoV-2, the use of face masks has become ubiquitous. Policies on wearing face masks differ among countries. WHO discourages the use of facemask among healthy people unless they are taking care of a person with suspected SARS-CoV-2 infection or with respiratory symptoms. However, the use of face mask is always recommended because it could prevent infection transmission from

asymptomatic carriers. In China, national policy encourages the use of face masks among people with low or moderate risk of infection but discourages those with a very low risk of infection from wearing a mask. People in quarantine should wear a face mask if they leave their home for any reason to prevent potential transmission in the asymptomatic phase. In addition, vulnerable populations such as the elderly or those with underlying medical conditions should wear a mask.

A recent study by Leung et al. showed that wearing face mask significantly reduced the shedding of respiratory viruses such as influenza virus and coronavirus.

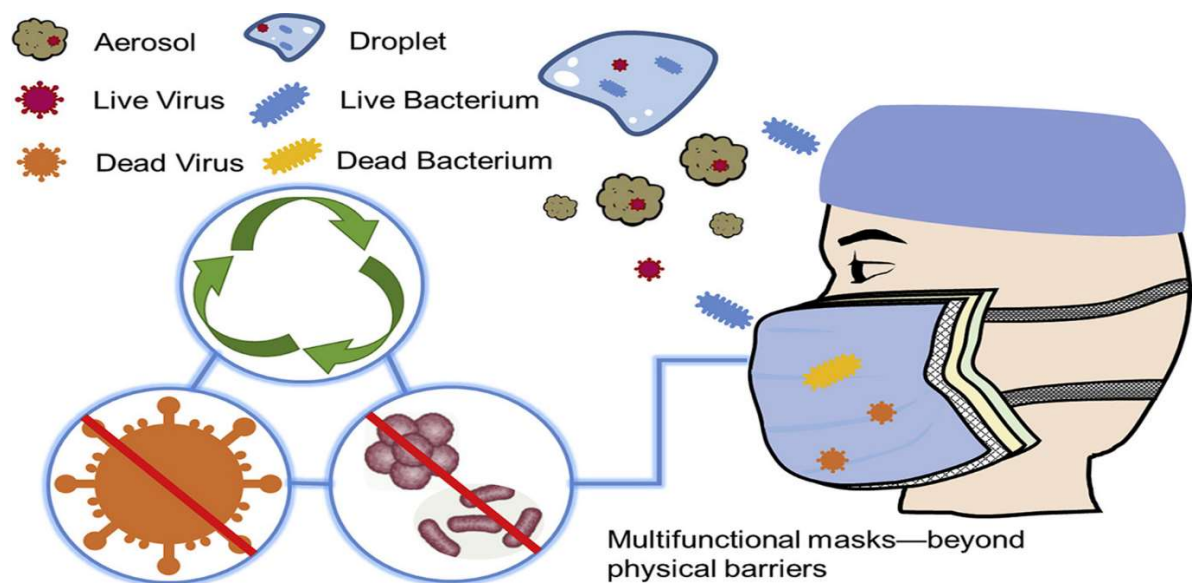


Fig 1.1 : Wearing face mask significantly reduced the shedding of respirator viruses

Based on these recent findings and in an attempt to reduce the spread of SARS-CoV-2 in the so-called second phase of the epidemic, many EU governments have made it mandatory to wear face masks in public.

The potential air propagation of SARS-CoV-2 depends on many factors including the particle size, the speed of exhaled air (increased by breathing < speaking < coughing < sneezing) as well as temperature and humidity. The WHO, CDC and European Center for Disease Prevention and Control strongly recommend that people perform hand hygiene frequently and avoid touching their eyes, nose and mouth.

1.3 Policy or recommendation of mask wearing in different countries to prevent COVID-19 transmission.

Table 1.1

The Country or International Organization	Policy about Public Mask Wearing
1. The WHO	The WHO advises that governments should encourage the general public to wear masks where there is widespread transmission and physical distancing is difficult, such as on public transport, in shops, or in other confined or crowded environments.(June 6, 2020)
2. The USA	CDC recommends that people wear masks in public settings and when around people who do not live in your household, especially when other social distancing measures are difficult to maintain. (August 7, 2020) Masks should not be worn by children under the age of 2 or anyone who has trouble breathing, is unconscious, incapacitated, or otherwise unable to remove the mask without assistance.
3. China	Masks were relatively common even before the coronavirus pandemic, which is credited to populations used to wearing coverings because of either pollution or previous experience with the SARS and H1N1 outbreaks.
4. Germany	Individual states have been given the power to implement their own rules regarding masks. Most states now require residents to wear face masks or coverings while in shops, grocery stores, and shopping malls, as well as on local public transportation.

	Berlin is the only state where masks are not required in shops and supermarkets, but rather ‘strongly recommended’. (April 22, 2020)
5. Italy	Italy’s government said that from 6 pm to 6 am, the wearing of masks would be mandatory in public areas where groups could form. (August 16, 2020)
6. Canada	Wearing a homemade nonmedical mask/facial covering in the community is recommended for periods of time when it is not possible to consistently maintain a 2-m physical distance from others, particularly in crowded public settings, such as: stores, shopping areas, and public transportation. The best thing you can do to prevent spreading COVID-19 is to wash your hands frequently with warm water and soap for at least 20 s. If none is available, use a hand sanitizer containing at least 60% alcohol.
7. Australia	Everyone in the state of Victoria must wear a face covering whenever they leave home unless an exemption applies. This is because of the higher rates of community transmission of coronavirus in the state.(August 2, 2020) People in New South Wales should consider wearing a face mask in situations where physical distancing is not possible.
8. Vietnam	Vietnam made face masks compulsory for people to wear in public on March 16.
9. Spain	Spain made it compulsory on May 20 for everyone older than six to wear masks in indoor public spaces and outdoor ones when it is impossible to

	keep more than two meters apart. (May 20, 2020)
10.South Africa	South Africa is moving to make it mandatory to wear nonmedical cloth masks when people are outside their homes.

1.4 What is the purpose of Face masks ?

Face masks (or other face coverings that cover your mouth and nose) are one of the most effective measures that help to reduce spreading of the virus. The face covering helps to avoid spreading of the virus by stopping the respiratory droplets which contain viral particles.

Face masks are only effective when worn correctly – over your nose and your mouth.

Face masks are used to prevent spreading of COVID -19 and are recommended by sufficient professional organizers including the World Health Organization (WHO). To cover your mouth and nose, it is recommended to use face masks (either medical or textile masks), respirators or scarves. Masks should be used as part of a comprehensive strategy of measures to suppress transmission and save lives.

Wear the most protective mask you can that fits well and that you will wear consistently. Wearing a well-fitted mask along with vaccination, self-testing, and physical distancing, helps protect you and others by reducing the chance of spreading COVID-19.

1.5 Different masks can be classified as :



Fig 1.2 : Filtering Face Piece Mask Without Valve



Fig 1.3 : Filtering Face Piece Mask With Valve



Fig 1.4: Homemade Facemask For Everyday Use



Fig 1.5: Surgical Mask

Full masks half and quarter masks : Full mask covers the whole face, a half-mask fits from under the chin to above the nose, a quarter mask fits from the top of the nose

to the top of the chin. The breathing resistance varies proportionally to the density of the mask material.

FFP masks filtering face piece are classified as half masks. Their use is required to prevent the entry of pathogens through the airway and have the role of protecting both the wearer and the surrounding people. They are different from medical MNC, (often referred to as “surgical masks”), and from “self-made” masks for everyday use. MNCs and self-made masks are not “leak-proof” and do not provide complete respiratory protection since air can escape through them. FFP masks come without or with a valve. FFP **filtering face piece** masks with valves provide an air flow from the inside to the outside of the mask. FFP 1 masks are dust masks and mainly used for this purpose. They do not prevent COVID-19 infections. FFP1 masks are suitable for work environments in which only non-toxic dusts are found. FFP2 masks are suitable for work environments where there are pathogens and mutagens in the air composition.

Masks for everyday use **temporary masks made from fabric**: These masks grant no protection for the user from being infected. However, it is safe to assume there is a small risk reduction for droplet transmission, especially during exhalation, resulting in a reduction of potential viral spread. These masks should not be used in the health care system, but are commonly recommended for the general population for walking, shopping, or using public transportation.

MNP medical mouth-nose protection: often referred to as a “surgical mask”. The industrial production of MNP abides to strict rules to provide protections against infection. The filtering capability is like the one for everyday use masks and they are intended to protect patients. They are approved for medical staff use, warranting only patient-protection, specifically aimed against aerosols.

FFP2-mask face filtering piece/N95-mask: FFP2-masks fulfil a set of stricter protective norms. They protect the person wearing them, as >95% of particles and droplets are held back when inhaling. FFP2-masks also effectively protect the environment as long as there is no exhaling valve. In contrast, masks with an exhaling valve let exhaled air pass out unfiltered, with contamination of the immediate environment.

FFP3-mask: FFP3-masks protect the user even more effectively than FFP2, as > 99% of droplets and particles are filtered when inhaling. FFP3-masks also protect the environment in the absence of an exhaling valve. Masking is a critical public health tool and it is important to remember that any mask is better than no mask.

The coronavirus disease 2019 (COVID-19) pandemic is currently perceived as one of the greatest global threats

Corona virus has been harming mankind continuously and deadly for last three years, we do not know when this pandemic will end, but it is better that we always be ready , like we have given priority to oxygen plant , hospital and vaccine , in the same way we should now stay alert and stay safe.

1.6 INDIA SITUATION - As of 14 June 2022

India reported a total of 43,236,695 confirmed cases, with 524,777 deaths. Currently, the number of cases per million is 30,428.

- There have been 51,646 new cases recorded in the country in the last seven days, with Maharashtra reporting the most (18,229, or 35% of total cases), followed by Kerala (15,118) and Delhi (4,435).
- In the past week (1-7 June), as compared to the previous week (8-14 June), 30 states have shown an increase in cases, while 4 states have shown a decline. Larger declines were reported from Manipur (-60%), Arunachal Pradesh (-33%), and Jharkhand (-29%).
- More than 20% TPR is seen in 6 states, (Mizoram 3 districts (Saitual, Mamit and Kolasib), Mumbai in Maharashtra and Namsai in Arunachal Pradesh and Umaria in MP).

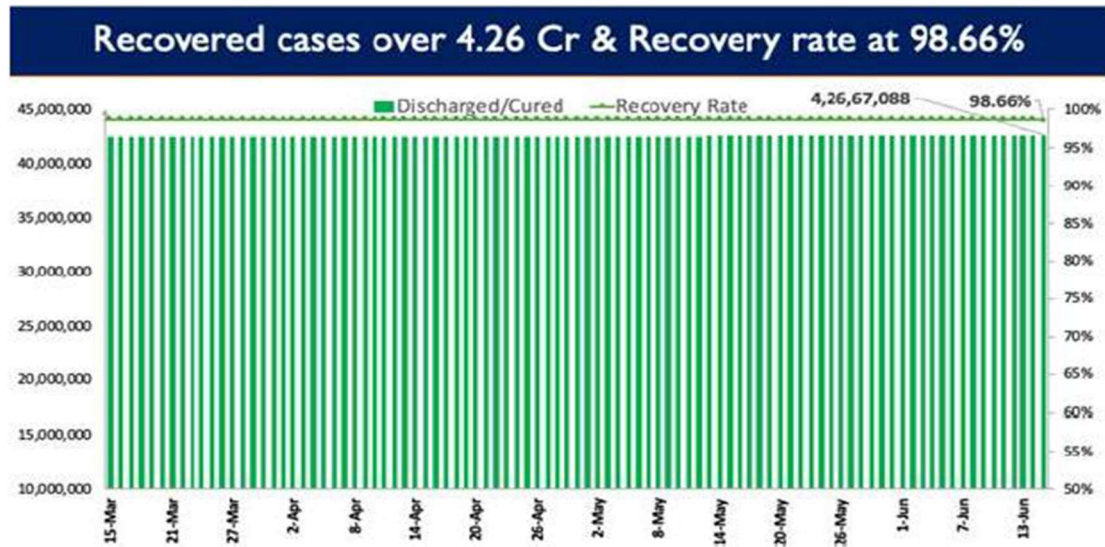


Fig 1.6 :Recovery rate

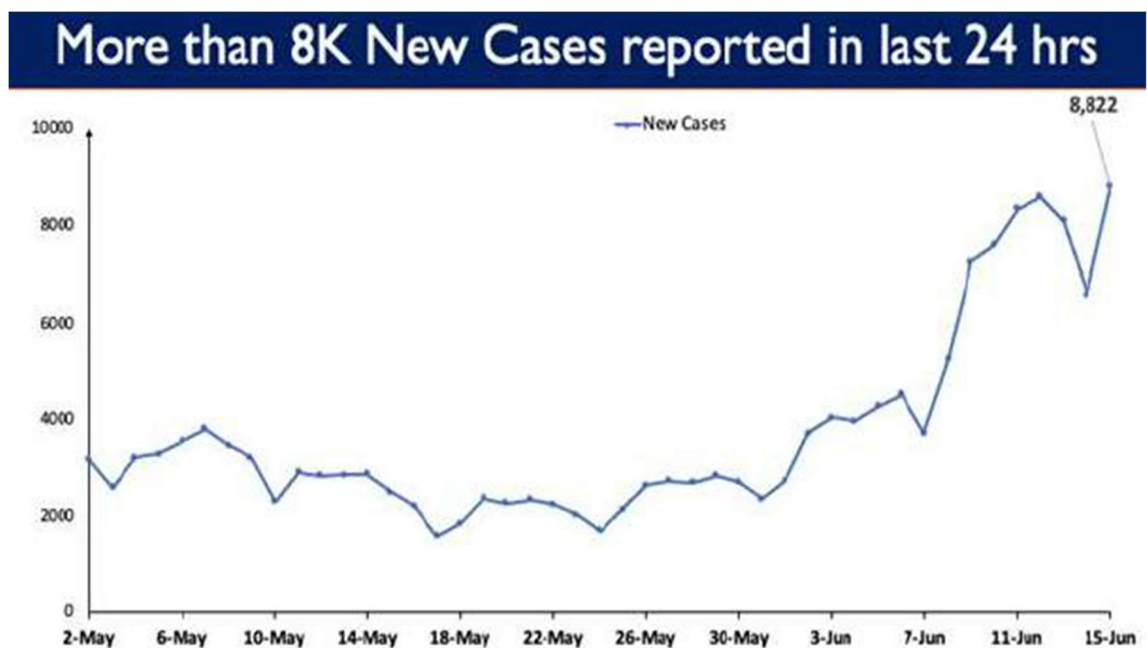


Fig 1.7 : 8,822 new cases recorded in the last 24 hours

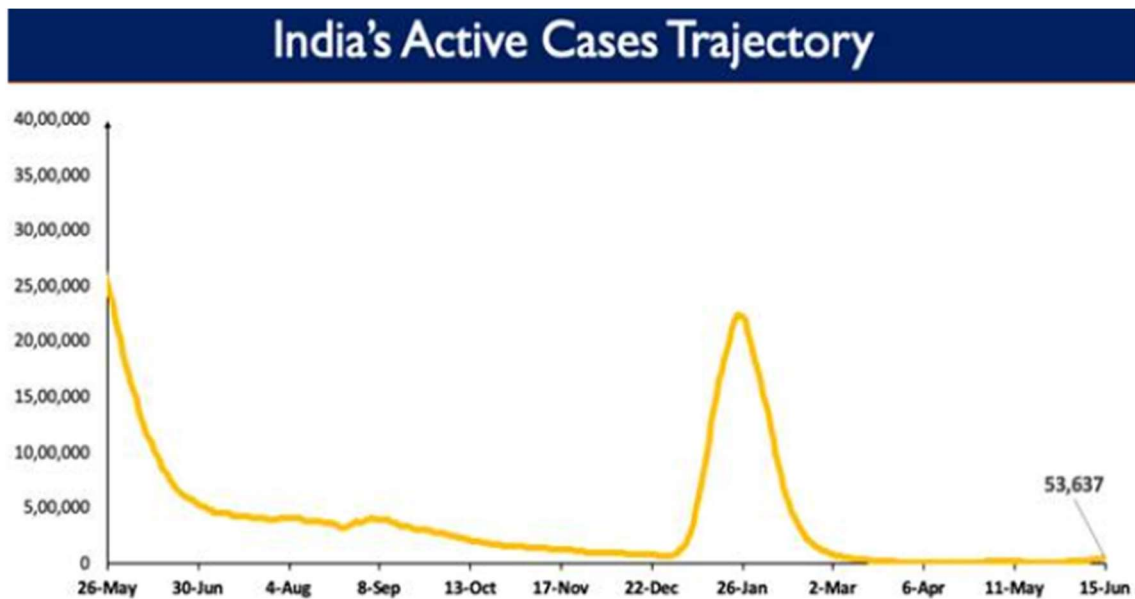


Fig 1.8:India's Active Cases Trajectory

1.7 Measures to help prevent the spread of respiratory viruses including:

- ❖ Avoid close contact with sick people.
- ❖ Do not touch your lips, your nose and your mouth with unwashed hands.
- ❖ When you're sick, stay home.
- ❖ Use tissue to cover the cough or sneeze, then chuck the tissue in the garbage.
- ❖ The regularly handled items and surfaces are washed and
- ❖ disinfected using a regular household spray or scrub.
- ❖ Follow CDC's Facemask instructions.

Your hands must be washed often for at least 20 seconds with soap and water, especially after getting to the bathroom; before eating; and after blowing your nose, coughing, or sneezing. Use an alcohol-based hand sanitizer with at least 60 per cent alcohol if soap and water are not readily available. Where hands are visibly dirty, wash hands using soap and water always.

Stay home except for medical treatment: you can avoid activities outside your house, except for medical treatment. Do not go to work, to school or to public spaces. None use of public transport, ride-sharing, or taxis. Separate yourself from other people in your

house : you should live in a specific room as much as possible and in your home away from other people. If available, you should also use a separate bathroom.

Wear a facemask: when you are with people (e.g. sharing a room or vehicle) and before entering the office of a health care provider, you will wear a facemask; If you can't wear a facemask (for example, because it creates breathing difficulties), either people who live with you shouldn't stay with you in the same room, or they should wear a facemask if they enter yourhouse.

Protect your coughs and sneezes: If you cough or sneeze protect your mouth and nose with a tissue. Throw used tissues into a lined trash can and wash your hands for at least 20 seconds with soap and water. If there is no detergent and water at the moment, clean your hands immediately with an alcohol-based hand sanitizer containing at least 60 percent alcohol, covering the surfaces of your hands and rubbing them together until they feel warm. When hands are obviously unclean, soap and water should be used preferentially.

Avoid sharing personal household items : In your home, you should not share dishes, drink glasses, cups, eating utensils, towels, or bedding with others. They should be washed scrupulously with detergent and water after using those things.

1.8 Determine the treatment site according to the condition of the patient

According to the severity of a patient's symptoms and the medical resources available in a region, different treatment sites may be selected to observe and isolate patients. The specific classification, from Chinese guidelines, is as follows:

Asymptomatic cases: They have not been confirmed and should not be considered as new cases. The main treatment measure is centralized quarantine for 14 days and further monitoring by the local Public Health Department. If these cases are in home isolation, household members should stay in a different room, or if this is not possible, maintain a distance for at least 1 meter from the quarantined person.

Suspected cases: After informed consent, patients who have the ability to self-care, age ≤ 65 years old, without primary diseases such as respiratory diseases, cardiovascular diseases and mental health issues, should go to a health care facility voluntarily. During

quarantine observation, the person should in principle stay in a single room and not leave the room at random;

Mild cases: They are treated in a mobile cabin hospital if available or at home if hospitalization is not possible because of the heavy burden on the health care system. In this case, they should be followed up and cared for by family members. If patients are in the same room, the space between beds should not be less than 1.2 m, and the room should be equipped with its own facilities. At the same time, family visits and nursing should be declined.

Severe/critically ill cases: Patients who are initially diagnosed as critically ill should be admitted into the Intensive Care Unit (ICU) immediately for treatment. For patients whose status changes from mild to severe, after hospital triage and prescreening expert consultation in the mobile cabin hospital or at home, they should be transferred to the critical observation and treatment area of a sheltered hospital, and following consultation, they should be transferred to a designated hospital for treatment

CHAPTER 2

BACKGROUND AND RELATED WORK

2.1 INTRODUCTION

With the continuous improvement of science and technology, face detection and recognition are applied in more and more fields, such as the verification of identity by each application face scanning, the monitoring system of the bank self-service cash machine, the face unlocking of the mobile phone. All need to pass the detection and recognition technology for the face. Under the prospect of the gradual diversification of the technology, face detection and recognition have become a technology closely related to our lives. Face detection and recognition technology not only make life easier and faster but also add a touch of technology fun. Through the face of a series of operations such as unlocking the phone, paying for the face, and intelligently identifying, using high-tech technology to ensure the security of our property and identity and to realize the combination of technology and life, it is a vital part of our lives.

Face recognition is one of the most relevant applications of image analysis. It's a true challenge to build an automated system which equals human ability to recognize faces. Although humans are quite good identifying known faces, we are not very skilled when we must deal with a large amount of unknown faces. The computers, with an almost limitless memory and computational speed, should overcome humans limitations. Face recognition remains as an unsolved problem and a demanded technology

Face Detection requires expression recognition, face tracking, and pose estimation. Given a solitary image, the challenge is to identify the face from the picture. Face detection is a difficult errand because the faces change in size, shape, color, etc and they are not immutable.

Face detection comes with two major challenges:

- 1) unavailability of sizably voluminous datasets containing both masked and unmasked faces
- 2) exclusion of facial expression in the covered area face detection requires expression recognition, face tracking, and pose estimation.

2.2 Face detection

Face detection also called facial detection - is an Artificial Intelligence (AI) based computer technology used to find and identify human faces in digital images. Face detection technology can be applied to various fields including security, biometrics, law enforcement, entertainment and personal safety to provide surveillance and tracking of people in real time. Face detection has progressed from rudimentary computer vision techniques to advances in machine learning (ML) to increasingly sophisticated Artificial Neural Networks ANN and related technologies the result has been continuous performance improvements. It now plays an important role as the first step in many key applications - including face tracking, face analysis and facial recognition. Face detection has a significant effect on how sequential operations will perform in the application.

In face analysis, face detection helps identify which parts of an image or video should be focused on to determine age, gender and emotions using facial expressions. In a facial recognition system - which maps an individual's facial features mathematically and stores the data as a faceprint. face detection data is required for the algorithms that decides which parts of an image or video are needed to generate a faceprint. Once identified, the new faceprint can be compared with stored faceprints to determine if there is a match.

2.3 How face detection works

Face detection applications use algorithms and ML to find human faces within larger images, which often incorporate other non-face objects such as landscapes, buildings and other human body parts like feet or hands. Face detection algorithms typically start by searching for human eyes one of the easiest features to detect. The algorithm might then attempt to detect eyebrows, the mouth, nose, nostrils and the iris. Once the algorithm concludes that it has found a facial region, it applies additional tests to confirm that it has, in fact, detected a face. To help ensure accuracy, the algorithms need to be trained on large data sets incorporating hundreds of thousands of positive and negative images. The training improves the algorithms' ability to determine whether there are faces in an image and where they are.

The methods used in face detection can be knowledge-based, feature-based, template matching or appearance-based. Each has advantages and disadvantages:

- Knowledge-based, or rule-based methods, describe a face based on rules. The challenge of this approach is the difficulty of coming up with well-defined rules.
- Feature invariant methods - which use features such as a person's eyes or nose to detect a face - can be negatively affected by noise and light.
- Template-matching methods are based on comparing images with standard face patterns or features that have been stored previously and correlating the two to detect a face. Unfortunately these methods do not address variations in pose, scale and shape.
- Appearance-based methods employ statistical analysis and machine learning to find the relevant characteristics of face images. This method, also used in feature extraction for face recognition, is divided into sub-methods.

❖ **Some of the more specific techniques used in face detection include:**

- Removing the background. For example, if an image has a plain, mono-color background or a pre-defined, static background, then removing the background can help reveal the face boundaries.
- In color images, sometimes skin color can be used to find faces; however, this may not work with all complexions.
- Using motion to find faces is another option. In real-time video, a face is almost always moving, so users of this method must calculate the moving area. One drawback of this method is the risk of confusion with other objects moving in the background.
- A combination of the strategies listed above can provide a comprehensive face detection method.

Detecting faces in pictures can be complicated due to the variability of factors such as pose, expression, position and orientation, skin colour and pixel values, the presence of

glasses or facial hair, and differences in camera gain, lighting conditions and image resolution. Recent years have brought advances in face detection using deep learning, which presents the advantage of significantly outperforming traditional computer vision methods.

Major improvements to face detection methodology came in 2001, when computer vision researchers Paul Viola and Michael Jones proposed a framework to detect faces in real time with high accuracy. The Viola-Jones framework is based on training a model to understand what is and is not a face. Once trained, the model extracts specific features, which are then stored in a file so that features from new images can be compared with the previously stored features at various stages. If the image under study passes through each stage of the feature comparison, then a face has been detected and operations can proceed.

Although the Viola-Jones framework is still popular for recognizing faces in real-time applications, it has limitations. For example, the framework might not work if a face is covered with a mask or scarf, or if a face is not properly oriented, then the algorithm might not be able to find it.

To help eliminate the drawbacks of the Viola-Jones framework and improve face detection, other algorithms - such as region-based convolutional neural network (R-CNN) and Single Shot Detector (SSD) - have been developed to help improve processes.

A convolutional neural network (CNN) is a type of artificial neural network used in image recognition and processing that is specifically designed to process pixel data. An R-CNN generates region proposals on a CNN framework to localize and classify objects in images.

While region proposal network-based approaches such as R-CNN need two shots - one for generating region proposals and one for detecting the object of each proposal - SSD only requires one shot to detect multiple objects within the image. Therefore, SSD is significantly faster than R-CNN.

2.4 Advantages and Disadvantages of face detection

As a key element in facial imaging applications, such as facial recognition and face analysis, face detection creates various advantages for users, including:

- **Improves security:** Face detection improves surveillance efforts and helps track down criminals and terrorists. Personal security is also enhanced since there is nothing for hackers to steal or change, such as passwords.
- **Easy to integrate:** Face detection and facial recognition technology is easy to integrate, and most solutions are compatible with the majority of security software.
- **Automated identification:** In the past, identification was manually performed by a person; this was inefficient and frequently inaccurate. Face detection allows the identification process to be automated, thus saving time and increasing accuracy.

Disadvantages of face detection

While face detection provides several large benefits to users, it also holds various disadvantages, including:

- **Massive data storage burden:** The ML technology used in face detection requires powerful data storage that may not be available to all users.
- **Detection is vulnerable:** While face detection provides more accurate results than manual identification processes, it can also be more easily thrown off by changes in appearance or camera angles.
- **A potential breach of privacy:** Face detection's ability to help the government track down criminals creates huge benefits; however, the same surveillance can allow the government to observe private citizens. Strict regulations must be set to ensure the technology is used fairly and in compliance with human privacy rights.

2.5 Face detection vs. face recognition

Although the terms face detection and face recognition are often used together, facial recognition is only one application for face detection. Facial recognition is used for

unlocking phones and mobile apps as well as for Biometric verification. The banking, retail and transportation-security industries employ facial recognition to reduce crime and prevent violence.

In short, the term face recognition extends beyond detecting the presence of a human face to determine whose face it is. The process uses a computer application that captures a digital image of an individual's face - sometimes taken from a video frame and compares it to images in a database of stored records.

Uses of face detection

Although all facial recognition systems use face detection, not all face detection systems are used for facial recognition. Face detection can also be applied for facial motion capture, or the process of electronically converting a human's facial movements into a digital database using cameras or laser scanners. This database can be used to produce realistic computer animation for movies, games or avatar.

CHAPTER 3

SOFTWARE AND HARDWARE REQUIREMENT

3.1 SOFTWAREEQUIPMENT

1. Arduino IDE
2. Teachable Machine

3.1.1Arduino IDE

Arduino IDE, where IDE stands for Integrated Development Environment - An official software introduced by Arduino.cc, that is mainly used for writing, compiling and uploading the code in almost all Arduino modules/boards. Arduino IDE is open-source software and is easily available to download & install from Arduino's Official Site.

- Arduino IDE is an open-source software, designed by Arduino.cc and mainly used for writing, compiling & uploading code to almost all Arduino Modules.
- It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.
- It is available for all operating systems i.e. MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role in debugging, editing and compiling the code.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.
- Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.
- The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.
- The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.
- This environment supports both C and C++ languages.

Download, install, Arudino Integrated Development Environment.

- Open Internet Explorer or another Internet browser and navigate to the Arduino™ website **<http://www.Arduino.cc>**.
- Locate the "Download" section of the page and select [Windows]. this will begin the download of the package that will install the IDE.
- Double-click the Arduino™ icon. A warning message may appear. If it does, click the [Run] button.
- The IDE work space should then appear.

The IDE environment is mainly distributed into three sections

1. Menu Bar
2. Text Editor
3. Output Pane

As you download and open the IDE software, it will appear like an image below:

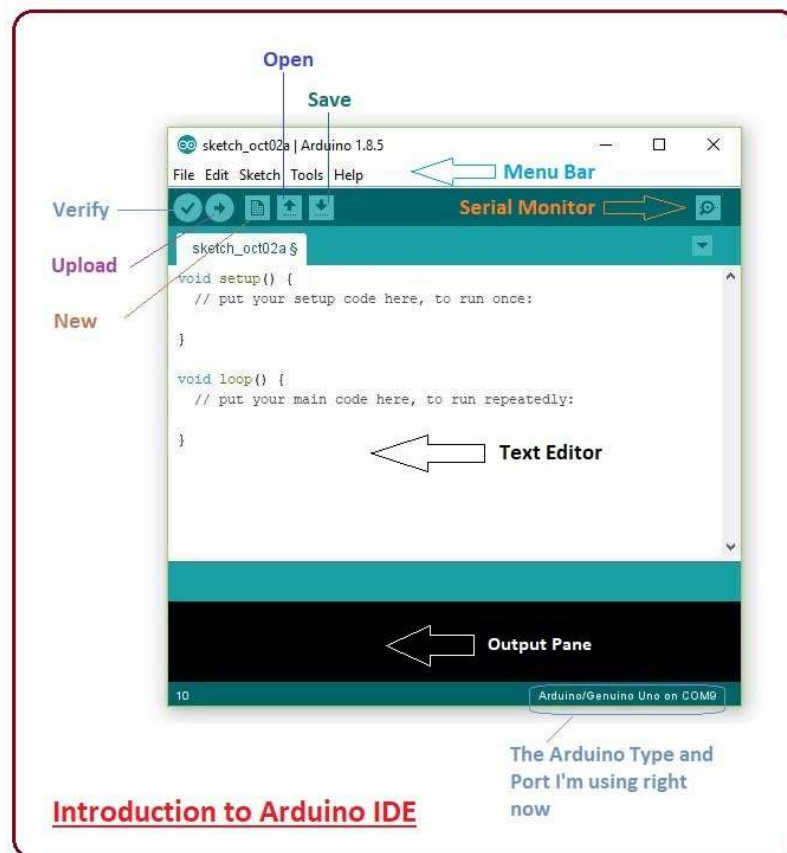


Fig 3.1 : Arduino IDE

1. Verify: Compile your code. Any syntax problem will be prompted with errors.
2. Upload: Upload the code to your board. When you click the button, the RX and TX LEDs on the board will flicker fast and won't stop until the upload is done.
3. New: Create a new code editing window.
4. Open: Open an .ino sketch.
5. Save: Save the sketch.
6. Serial Monitor: Click the button and a window will appear. It receives the data sent from your control board. It is very useful for debugging.
7. File: Click the menu and a drop-down list will appear, including file creating, opening, saving, closing, some parameter configuring, etc.
8. Edit: Click the menu. On the drop-down list, there are some editing operations like Cut, Copy, Paste, Find, and so on, with their corresponding shortcuts.
9. Sketch: Includes operations like Verify, Upload, Add files, etc. More important function is Include Library – where you can add libraries.
10. Tool: Includes some tools – the most frequently used Board (the board you use) and Port (the port your board is at). Every time you want to upload the code, you need to select or check them.
11. Help: If you're a beginner, you may check the options under the menu and get the help you need, including operations in IDE, introduction information, troubleshooting, code explanation, etc.
12. In this message area, no matter when you compile or upload, the summary message will always appear.
13. Detailed messages during compile and upload. For example, the file used lies in which path, the details of error prompts.
14. Board and Port: Here you can preview the board and port selected for code upload. You can select them again by Tools -> Board / Port if any is incorrect.

❖ Arduino Libraries

Libraries are very useful for adding extra functionality into the Arduino Module. There is a list of libraries you can check by clicking the Sketch button in the menu bar and going to Include Library. Arduino environment can be extended through the use of libraries, just like most programming platforms. 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 **Sketch > Import Library**.

Arduino Libraries used in this project

1. esp32 by Espressif Systems

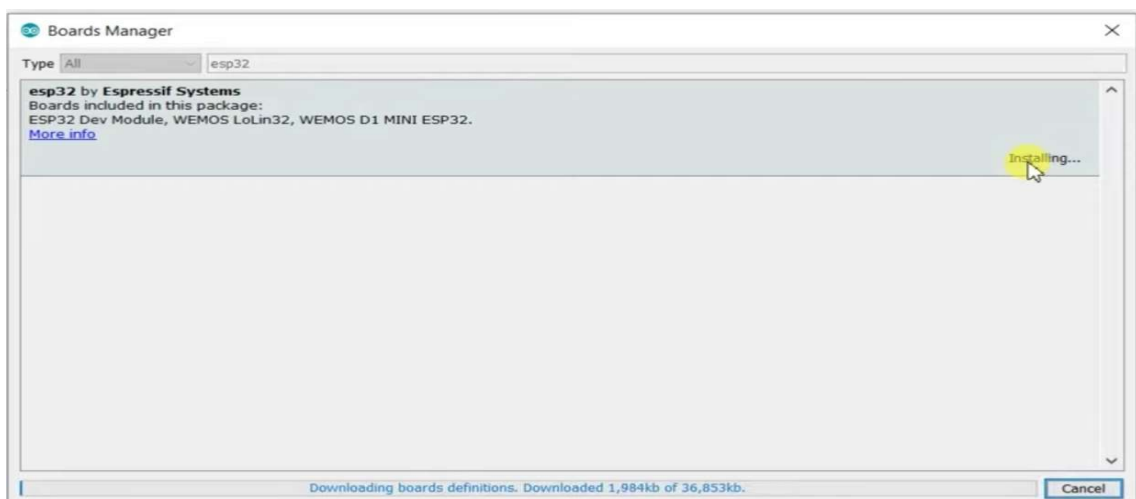


Fig 3.2 : esp32 by Espressif Systems

2. Liquid crystal I2C by Frank de Brabander

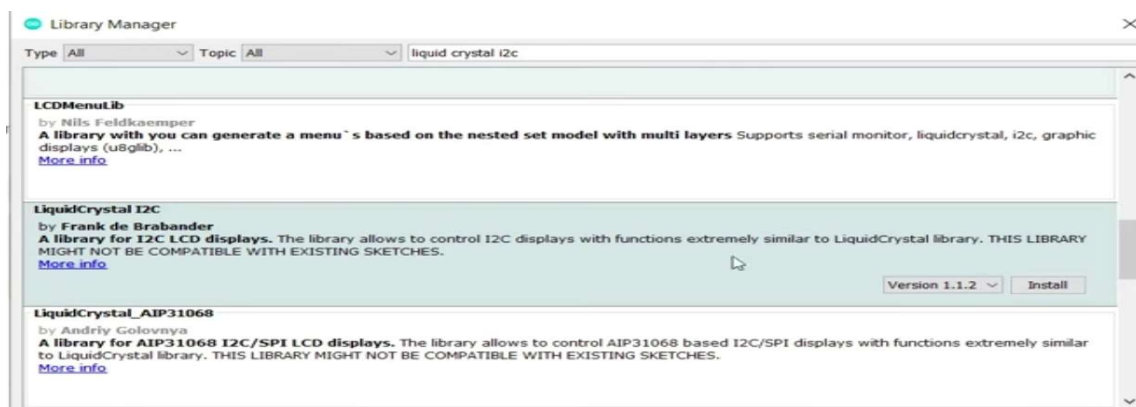


Fig 3.3 : Liquid crystal I2C by Frank de Brabander

3.1.2 Teachable Machine

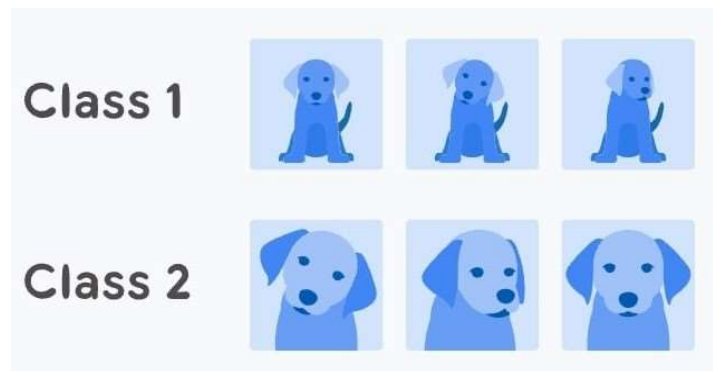
Train a computer to recognize your own images, sounds, & poses. A fast, easy way to create machine learning models for your sites, apps, and more – no expertise or coding required.

Teachable Machine is a web-based tool that makes creating machine learning models fast, easy, and accessible to everyone

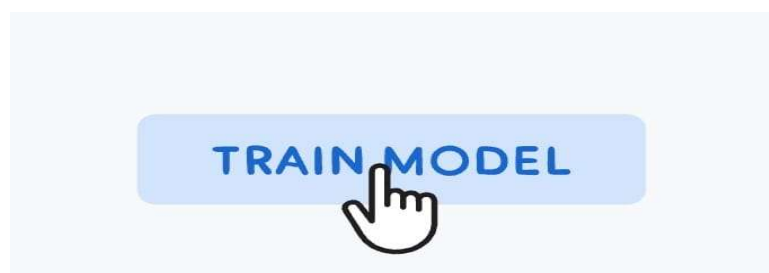
The **Teachable Machine** is an effort by **Google** to make Machine Learning and AI accessible to the wider public, without requiring any specialized training, knowledge in Computer Science or coding.

How to use it?

- ❖ Gather and group your data into classes, that you want your computer to learn, be it image, voice, action, etc.



- ❖ Now train your computer by simply clicking on Train button and test whether it is working correctly or not.



- ❖ Now when your model is trained and is working properly, its time to export your model to sites, apps, any project and host it for free.

3.2HARDWARE USED

- ❖ Arduino UNO
- ❖ ESP32-CAM WIFI
- ❖ Tower Pro MG995 Servo Motor.
- ❖ 16x2 12C LCD.
- ❖ Jumper wire
- ❖ Breadboard
- ❖ LED
- ❖ CH340G USB to TTL Serial Converter
- ❖ Active Buzzer (5V)

❖ ARDUINO UNO

An Arduino is a tiny computer that you can program to process inputs and outputs going to and from the chip. The Arduino is what is known as a Physical or Embedded Computing platform, which means that it is an interactive system, that through the use of hardware and software can interact with its environment. The Arduino™ is an extremely popular single-board computer that can be used to make a vast variety of intelligent devices. The Arduino hardware and software are both Open Source, which means the code, the schematics, design, etc. are all open for anyone to take freely and do what they like with it. The key component of the Arduino™ is a microcontroller from the Atmel Corporation. Learning to program and apply an Arduino™ is also learning to program and apply a microcontroller, a skill that is in heavy demand in industry. As a basis for learning other programming languages: The Arduino™ is programmed in a version of the C programming language. Consequently, knowledge of the syntax of Arduino™ C transfers to learning higher-level languages, including C++, C#, Java, and Python, which are all currently used in industry. The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board. The Arduino Integrated Development Environment IDE is a crossplatform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards.

Arduino Uno is a popular microcontroller development board based on 8-bit ATmega328P microcontroller. Along with ATmega328P MCU IC, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller.

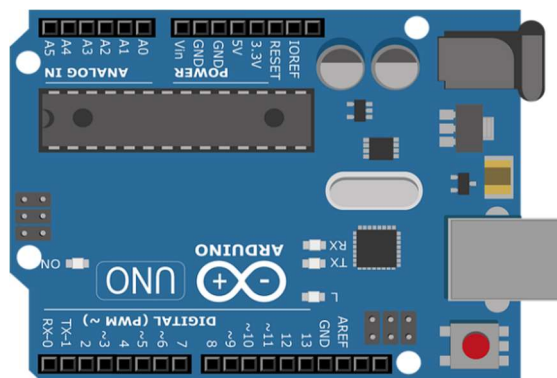


Fig3.4 : ARDUINO UNO

Table 3.1 Arduino Uno Pinout Configuration

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: Ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pin	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
AREF	AREF	To provide reference voltage

Table 3.2 Arduino Uno Technical Specifications

Microcontroller	ATmega328P- 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40mA
DC Current on 3.3V Pins	50mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

❖ ESP32-CAM, Camera Module Based on ESP32

The ESP32-CAM is a small size, low power consumption camera module based on ESP32. It comes with an OV2640 camera and provides onboard TF card slot.

The ESP32-CAM can be widely used in intelligent IoT applications such as wireless video monitoring, WiFi image upload, QR identification, and so on.

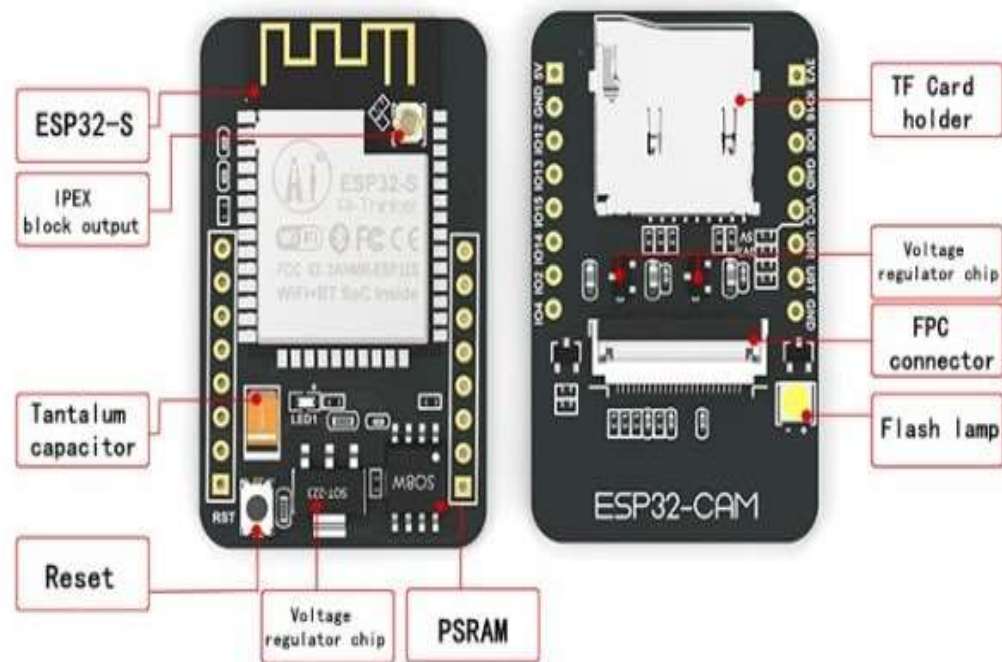


Fig 3.5 ESP32-CAM

Features of ESP32-CAM

1. Onboard ESP32-S module, supports WiFi + Bluetooth
2. OV2640 camera with flash
3. Onboard TF card slot, supports up to 4G TF card for data storage
4. Supports WiFi video monitoring and WiFi image upload
5. Supports multi sleep modes, deep sleep current as low as 6mA
6. Control interface is accessible via pinheader, easy to be integrated and embedded into user products.

Specifications of ESP32-CAM

- WIFI module: ESP-32S
- Processor: ESP32-D0WD
- Built-in Flash: 32Mbit
- RAM: Internal 512KB + External 4M PSRAM
- Antenna: Onboard PCB antenna
- WiFi protocol: IEEE 802.11 b/g/n/e/i
- Bluetooth: Bluetooth 4.2 BR/EDR and BLE
- WIFI mode: Station / SoftAP / SoftAP+Station
- Security: WPA/WPA2/WPA2-Enterprise/WPS
- Output image format: JPEG (OV2640 support only), BMP, GRAYSCALE
- Supported TF card: up to 4G
- Peripheral interface: UART/SPI/I2C/PWM
- IO port: 9
- UART baudrate rate: default 115200bps
- Power supply: 5V
- Transmitting power:
 - 802.11b: $17 \pm 2\text{dBm}(@11\text{Mbps})$
 - 802.11g: $14 \pm 2\text{dBm}(@54\text{Mbps})$
 - 802.11n: $13 \pm 2\text{dBm}(@\text{HT20},\text{MCS7})$
- Receiving sensitivity:
 - CCK,1Mbps: -90 dBm
 - CCK,11Mbps: -85 dBm
 - 6Mbps(1/2 BPSK): -88 dBm
 - 54Mbps(3/4 64-QAM): -70 dBm
 - HT20,MCS7(65Mbps, 72.2Mbps): -67 dBm
- Power consumption:
 - Flash off: 180mA@5V
 - Flash on and brightness max: 310mA@5V
 - Deep-Sleep: as low as 6mA@5V
 - Modern-Sleep: as low as 20mA@5V
 - Light-Sleep: as low as 6.7mA@5V
- Operating temperature: -20 °C ~ 85 °C

- Storage environment: -40 °C ~ 90 °C, <90%RH
- Dimensions: 40.5mm x 27mm x 4.5mm

Applications

The ESP32-CAM suit for IOT applications such as:

- Smart home devices image upload
- Wireless monitoring
- Intelligent agriculture
- QR wireless identification
- facial recognition

ESP32 Pinout Reference

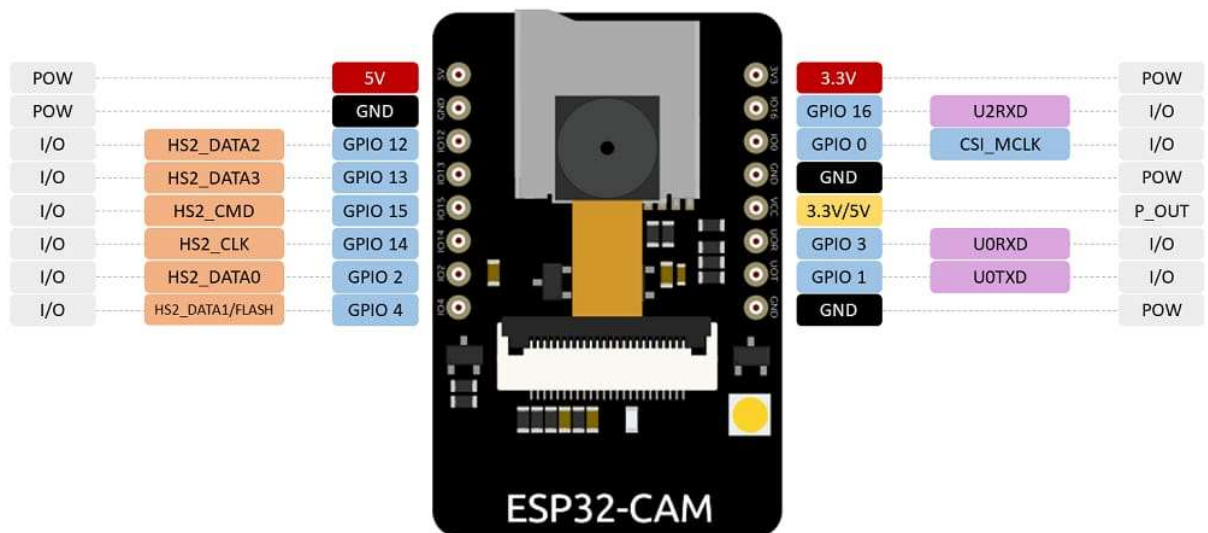


Fig 3.6 ESP32 Pinout Reference

Power Pins

The ESP32-CAM comes with three GND pins (colored in black color) and two power pins (colored with red color): 3.3V and 5V. You can power the ESP32-CAM through the 3.3V or 5V pins.

GPIO 0

GPIO 0 determines whether the ESP32 is in flashing mode or not. This GPIO is internally connected to a pull-up 10k Ohm resistor.

When GPIO 0 is connected to GND, the ESP32 goes into flashing mode and you can upload code to the board.

GPIO 0 connected to GND - ESP32-CAM in flashing mode .To make the ESP32 run “normally”, you just need to disconnect GPIO 0 from GND.

Serial Pins

GPIO 1 and GPIO 3 are the serial pins (TX and RX, respectively). Because the ESP32-CAM doesn't have a built-in programmer, you need to use these pins to communicate with the board and upload code.

MicroSD Card Connections

The following pins are used to interface with the microSD card when it is on operation.

Table 3.3

MicroSD card	ESP32
CLK	GPIO 14
CMD	GPIO 15
DATA0	GPIO 2
DATA1 / flashlight	GPIO 4
DATA2	GPIO 12
DATA3	GPIO 13

If you're not using the microSD card, you can use these pins as regular inputs/outputs.

- The ESP32-CAM has a very bright built-in LED that can work as a flash when taking photos. That LED is internally connected to GPIO 4

- Next to the RST button, there's an on-board red LED. That LED is internally connected to GPIO 33. You can use this LED to indicate that something is happening. For example, if the Wi-Fi is connected, the LED is red or vice-versa. That LED works with inverted logic, so you send a LOW signal to turn it on and a HIGH signal to turn it off.

Camera Connections

The pin definition for the ESP32-CAM AI-Thinker on the Arduino IDE should be as follows:

```
#define PWDN_GPIO_NUM 32
#define RESET_GPIO_NUM -1
#define XCLK_GPIO_NUM 0
#define SIOD_GPIO_NUM 26
#define SIOC_GPIO_NUM 27
#define Y9_GPIO_NUM 35
#define Y8_GPIO_NUM 34
#define Y7_GPIO_NUM 39
#define Y6_GPIO_NUM 36
#define Y5_GPIO_NUM 21
#define Y4_GPIO_NUM 19
#define Y3_GPIO_NUM 18
#define Y2_GPIO_NUM 5
#define VSYNC_GPIO_NUM 25
#define HREF_GPIO_NUM 23
#define PCLK_GPIO_NUM 22
```


❖ Tower Pro MG995 Servo Motor

MG995 Servo Motor Overview

MG995 is a digital metal gear high torque servo for airplane, helicopter, RC-cars from 10 to 6-th scale truggy and monster and many RC model.

A servo motor is an electrical device which can push or rotate an object with great precision. Servo motors or “servos”, as they are known, are electronic devices and rotary or linear actuators that rotate and push parts of a machine with precision. Servos are mainly used on angular or linear position and for specific velocity, and acceleration.

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.

How to use MG995 Servo Motor

First let us consider the circuit connection of servo as shown below. Here 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.

MG995 Servo Motor Circuit

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 we provide a PWM signal of 0.5ms ON time over 20ms complete cycle, the servo axis will move to 0°.

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

- ❖ Based on these standard values we can also calculate any other degree of rotation. 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.



Fig 3.7 : Tower Pro MG995 Servo Motor

Servo Motor Features

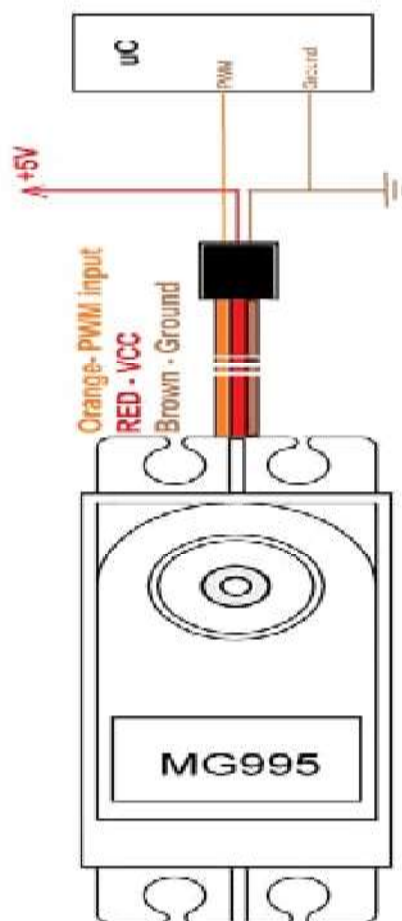
- Model: Towerpro Servos MG995
- Dead Band: 0.100 ms
- Control System: +Pulse Width Control
- Working Frequency: 20ms period / 50hz (Analog Control)
- (RX) Required Pulse: 3.0 ~ 5 Volt Peak to Peak Square Wave
- Operating Voltage: 4.8 ~ 6 V DC Volts
- Operating Temperature Range: -0 to + 55 Degree C
- Operating Speed (4.8v): 0.200 sec/60° degrees at no load
- Operating Speed (6v): 0.160 sec/60° degrees at no load
- Stall Torque (4.8v): 9.4kg/cm
- Stall Torque (6v): 11kg/cm
- Motor Type: Brushed Motor
- Potentiometer Drive: Direct Drive
- Bearing Type: Output Bearing
- Gear Type: Brass & Aluminum Gears
- Case Material: Plastic
- Programmable: NO
- Connector Wire Length: 32.0cm (12.6 inch)

- Dimensions: 40.7×19.7×42.9mm
- Weight: 55 grams (2.64 oz)

MG995 Servo Motor Pinout Configuration

MG995 has three terminals as mentioned in pin diagram and the function of each pin is given below.

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



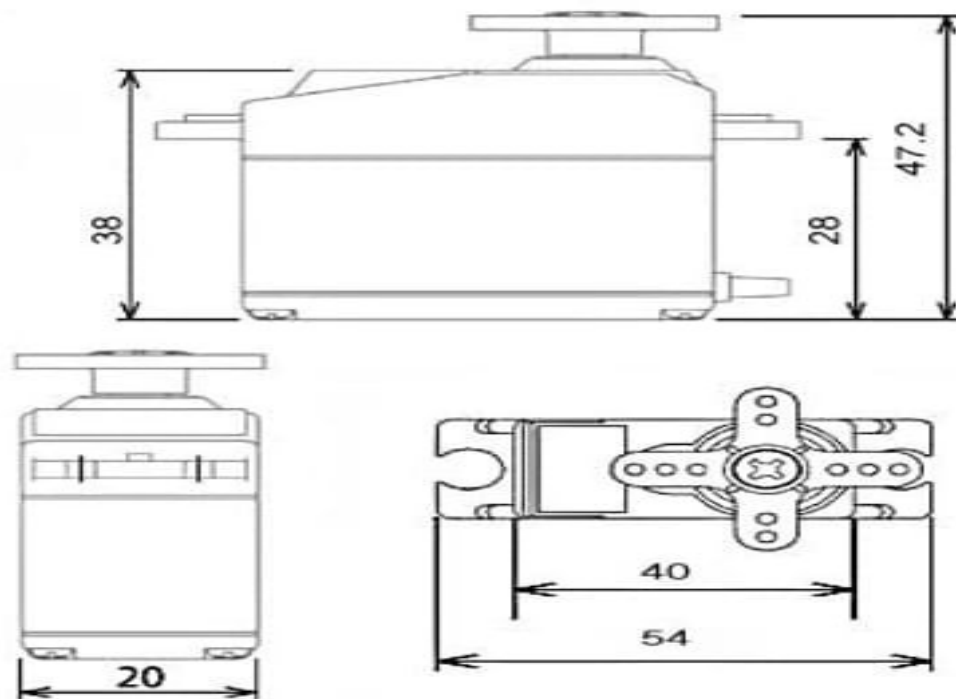


Fig 3.8 MG995 Servo Motor

Applications

- Drones and RC planes
- Security camera
- Robotics
- Solar tracking and positioning
- Door lock and safe locks
- Hobby projects

I2C 16x2 LCD

- ❖ This is LCD16x2 Parallel LCD display that provides a simple and cost-effective solution for adding a 16×2 Liquid Crystal Display into your project. The display is 16 character by 2 line display has a very clear and high contrast. I2C Module is a parallel to serial converter compatible with LCD2004 and LCD1602. By using this module, LCD can be interfaced with using only 2 wires. LCD displays take 8 pins so sometimes user can get out of resources, mostly using All type of development board , but this device helps to save the resources as it takes only 4 pins.
- ❖ It is able to display 16×2 characters on 2 lines.
- ❖ It only need 4 pins for LCD display: VCC,GND,SDA,SCL
- ❖ In LCD 16×2, the term LCD stands for Liquid Crystal Display that uses a plane panel display technology, used in screens of computer monitors & TVs, smartphones, tablets, mobile devices, etc. Both the displays like LCD & CRTs look the same but their operation is different. Instead of electrons diffraction at a glass display, a liquid crystal display has a backlight that provides light to each pixel that is arranged in a rectangular network.

What is LCD 16X2?

- ❖ An electronic device that is used to display data and the message is known as LCD 16×2. As the name suggests, it includes 16 Columns & 2 Rows so it can display 32 characters ($16 \times 2 = 32$) in total & every character will be made with 5×8 (40) Pixel Dots. So the total pixels within this LCD can be calculated as 32 x 40 otherwise 1280 pixels.
- ❖ 16x2 displays mostly depend on multi-segment LEDs. There are different types of displays available in the market with different combinations such as 8×2, 8×1, 16×1, and 10×2.

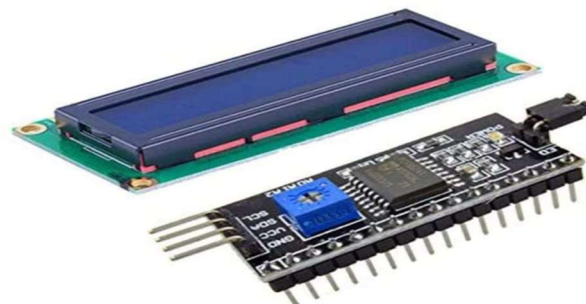


Fig 3.9 : LCD 16X2

Specifications of LCD 16X2

- The operating voltage of this display ranges from 4.7V to 5.3V
- The display bezel is 72 x 25mm
- The operating current is 1mA without a backlight
- PCB size of the module is 80L x 36W x 10H mm
- HD47780 controller
- LED color for backlight is green or blue
- Number of columns - 16
- Number of rows - 2
- Number of LCD pins - 16
- Characters - 32
- It works in 4-bit and 8-bit modes
- Pixel box of each character is 5×8 pixel
- Font size of character is 0.125Width x 0.200height

LCD 16X2 Pin Configuration

- Pin1 (Ground): This pin connects the ground terminal.
- Pin2 (+5 Volt): This pin provides a +5V supply to the LCD
- Pin3 (VE): This pin selects the contrast of the LCD.
- Pin4 (Register Select): This pin is used to connect a data pin of an MCU & gets either 1 or 0. Here, data mode = 0 and command mode =1.
- Pin5 (Read & Write): This pin is used to read/write data.
- Pin6 (Enable): This enables the pin must be high to perform the Read/Write procedure. This pin is connected to the data pin of the microcontroller to be held high constantly.
- Pin7 (Data Pin): The data pins are from 0-7 which are connected through the microcontroller for data transmission. The LCD module can also work on the 4-bit mode through working on pins 1, 2, 3 & other pins are free.
- Pin8 – Data Pin 1
- Pin9 – Data Pin 2
- Pin10 – Data Pin 3
- Pin11 – Data Pin 4
- Pin12 – Data Pin 5

- Pin13 – Data Pin 6
- Pin14 – Data Pin 7
- Pin15 (LED Positive): This is a +Ve terminal of the backlight LED of the display & it is connected to +5V to activate the LED backlight.
- Pin16 (LED Negative): This is a -Ve terminal of a backlight LED of the display & it is connected to the GND terminal to activate the LED backlight.

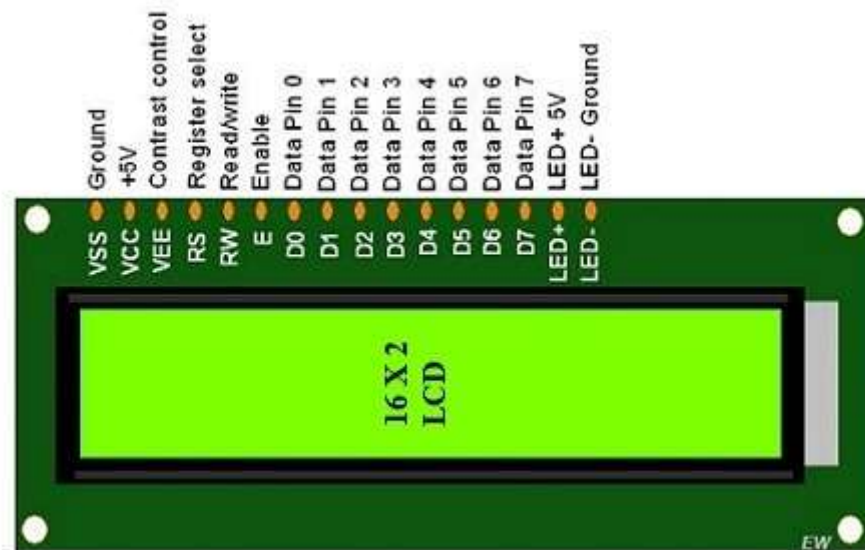


Fig 3.10 LCD 16X2 Pin Configuration

I2C is short for Inter-IC. And it is a type of BUS. This is designed by Philips semiconductors. I2C is a synchronous, multi slave, multi master packet switched, single-ended serial bus. ie. multiple chips can be connect to the same bus. I2C uses only two bidirectional open collector or open drain lines, Serial Data Line (SDA) and Serial Clock Line (SCL), pulled up with resistors. Typical voltages used are +5 V or +3.3 V





Fig 3.11: I2C Module to Arduino Uno

After soldering connect the I2C Module to Arduino Uno.

Connection:

- Analog Pin 4 - SDA
- Analog pin 5 - SCL
- 5V - VCC
- GND – GND

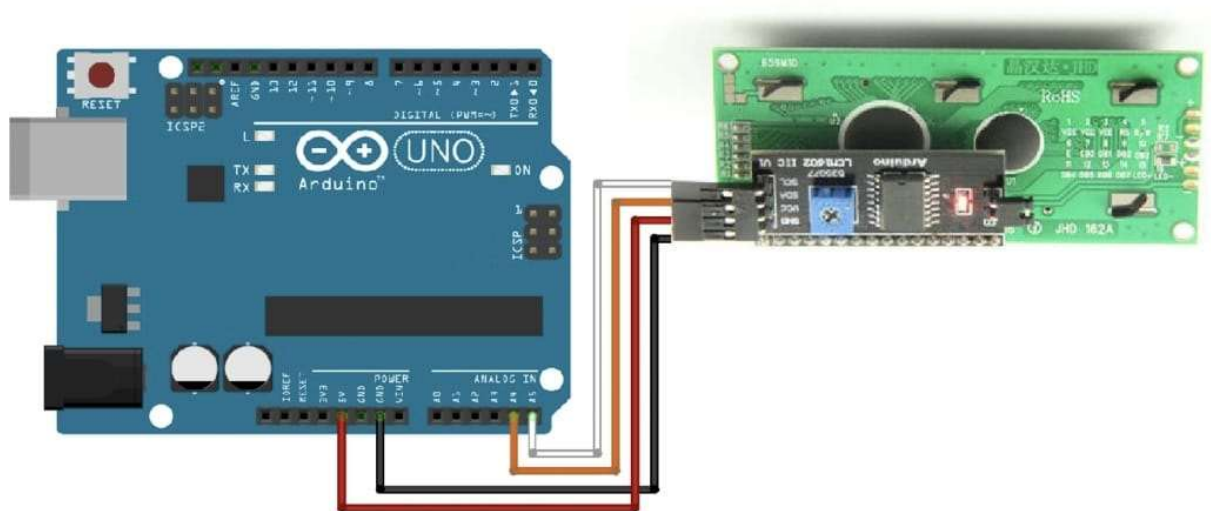


Fig 3.12 Interface I2C 16x2 LCD with Arduino Uno

Include the header "Wire.h". This library help to communicate with I2C device. Then include "LiquidCrystal_I2C.h" for better communication with display.

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
```


Breadboard

In the initial days of electronics manufacturing, engineers and designers have realized that sometimes designing a temporary circuit needs without soldering the components. So, an engineer took cardboard and arranged several rows into it to place nails. As per the circuit diagram, they placed components and nailed them through short wire pieces. The electrical connection can be provided by wrapping wire or soldering around the nails, and then components could be soldered to the wires. But by using cardboard, some resistive features may cause power loss. So, to overcome this process, at present breadboards were implemented by the scientists. Breadboards are one of the most essential rectangular pieces, used to build different circuits without soldering.

What is a Breadboard?

As the name suggests, the term breadboard can be derived from two terms namely bread & board. Initially, this was used to cut the bread into pieces. Further, it was called a breadboard & it was used in electronics projects and electronic devices in the year 1970. A breadboard is also known as a solderless board because the component used on the breadboard does not need any soldering to connect to the board, so it can be reused.

The arrangement of different components on a breadboard can be done by inserting their terminals into the breadboard, so it is frequently known as a plugboard. Breadboard definition is a plastic board in rectangular shape that includes a lot of small holes in it to allow you to place different components to build an electronic circuit is known as a breadboard. The connection on the breadboard is not permanent but they can be connected without soldering the components. If you make any mistake while connecting the components, you can place or remove the components effortlessly. For beginners of electronics, this device is very helpful to make mini-projects. If a designer builds a simple circuit that they desire to analyze, then a breadboard gives a quick solution.

The material used to make the breadboard is white plastic. At present, most of the breadboards are solderless types, so we can directly plug in the components directly and connected them through the exterior power supply. The different kinds of breadboards are accessible according to the specific point holes. For instance 400 point type, 830 point type, etc.

Specifications & Features

- Wire Size is 21 to 26 AWG wire
- Tie Points are two hundred
- Withstanding Voltage is 1,000V AC
- Tie points within IC are 630
- Insulation Resistance is DC500V or 500M Ω
- Dimension is 6.5*4.4*0.3 inch
- Rating is 5Amps

Power Rails

In the breadboard, there are horizontal and vertical rows, where the horizontal rows can be known as power rails and vertical rows are known as terminals. These are mainly useful in connecting the power supply toward the breadboard.

On this board, the red lines are positive rails whereas the blue lines are the negative rails. Usually, breadboards have different connections like power rails which are known as metal strips. While connecting a circuit on a breadboard, we need power in various places, so power rails can provide you easy access wherever you require it within your circuit. Here, power rails (red/black or blue strips) are labeled with positive (+) and negative (-) symbols for indicating the +ve & -ve side

Terminal Strips

Terminal strips in breadboards occupy most of the place. These are made up of small holes, where you can insert your components. The connection of these strips can be done in a specific way depending on their columns & rows. It is essential to recognize the terminal strip layout on the breadboard. Check the breadboard labeling before inserting components

Connection of ICs on Breadboard (DIP Support) Generally, connecting electronic components on a breadboard like resistors, capacitors, diodes, etc is quite easy but connecting integrated circuits (ICs) is quite different. When we notice the board, there is a gap line within the two vertical columns. This gap is very helpful in connecting ICs on a breadboard.

We can place any size of integrated circuits onto the breadboard through break rail without shorting its terminals.

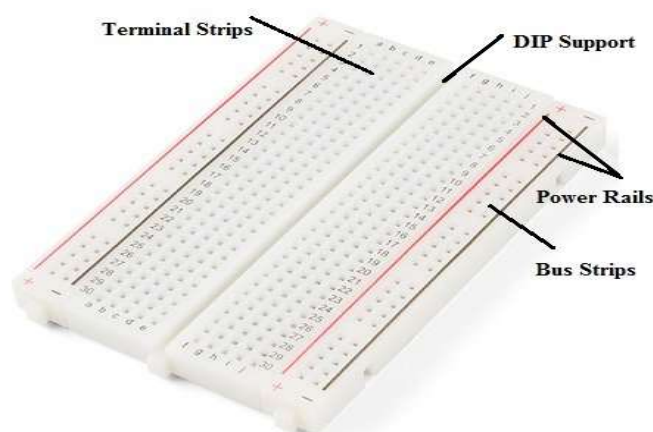


Fig 3.13 Breadboard

Breadboard Sizes

There are different sizes of breadboards are available in the market which is used based on the application.

- Half Size
- Tiny Breadboard
- Little Breadboard Bits
- Large Breadboard
- Half Size

Half-size breadboard

The half-size breadboard is applicable for mini-projects. The length and width of this board is 5.5 cm x 8.5 cm including a standard dual strip within the middle & two power rails on two faces. In this breadboard, power rails can be removed simply to make the board thin.

Tiny Breadboard

These breadboards are very small in size. This kind of breadboard does not include power rails however it includes 17 rows. These boards are applicable when you have fewer components to connect.

Little Breadboard Bits

These breadboards are available in different sizes like 4X4, 2X8, and 2X4. The 4×4 type includes four strips with four-pin terminal strips. The 2×8 type includes 8 strips with two-pin terminal strips. The 2×4 boards include 4 strips with two-pin terminal strips.

Large Breadboards

Large breadboards are big in size, very useful for major projects which are located onto a metal plate. These boards are available with four colored posts which can be used through a bench-top supply. These boards include bumpers to maintain the board from slipping in the region of your desk.

Safety Tips for Breadboard

- It is very important to connect a circuit systematically & neatly on a breadboard so that one can correct it & get it running simply & rapidly. It also assists once someone else requires knowing and inspecting the circuit. The following tips are very useful for breadboard.
- Use the top & bottom bus rails always for connecting power supply instead of using a direct power supply
- When the jumper wires are coded with color then it will help in reducing the confusion while designing a circuit. For instance, green color wires are used for GND connections, red color wire for +Ve power whereas black color one is for -Ve power connections.
- Once the power supply is given to the board, do not connect or remove components

- If water or liquid dropped onto the board, then right away remove it from the power supply.
- Maintain your surroundings clean and in sequence

Advantage

The advantages of solderless breadboards include the following.

- It doesn't require soldering to connect the components on board.
- If the circuit is not working properly then, we can easily check and rectify them by taken out the components & replace them easily.

Disadvantages

The disadvantages of solderless breadboards include the following.

- Components that are connected to the breadboard can come loose once the breadboard is pushed or moved.
- This kind of breadboard is available with high parasitic capacitances because of the capacitances among different components which are being close to each other.
- These breadboards are restricted to below or 10 MHz frequencies

Jumper wire

Jumper wire is an electrical wire that used to connect two devices in an easy way. It helps device to connect each other without soldering. Jumper wires are mainly used in the breadboard connections to make any changes in a easy way

What Are Jumper Wires?

Generally, jumpers are tiny metal connectors used to close or open a circuit part. They have two or more connection points, which regulate an electrical circuit board.

Their function is to configure the settings for computer peripherals, like the motherboard. Suppose your motherboard supported intrusion detection. A jumper can be set to enable or disable it. Jumper wires are electrical wires with connector pins at each end. They are used to connect two points in a circuit without soldering.

You can use jumper wires to modify a circuit or diagnose problems in a circuit. Further, they are best used to bypass a part of the circuit that does not contain a resistor and is suspected to be bad.

This includes a stretch of wire or a switch. Suppose all the fuses are good and the component is not receiving power; find the circuit switch. Then, bypass the switch with the jumper wire.

How much current (I) and voltage (V) can jumper wires handle? The I and V rating will depend on the copper or aluminium content present in the wire.

For an Arduino application is no more than 2A and 250V. We also recommend using solid-core wire, ideally 22 American Wire Gauge (AWG).

Jumper Wire Colours

Although jumper wires come in a variety of colours, they do not actually mean anything. The wire colour is just an aid to help you keep track of what is connected to which.

It will not affect the operation of the circuit. This means that a red jumper wire is technically the same as the black one.

Even so, the colours can be used to your advantage to differentiate the types of connections. For instance, red as ground and black as power.

Types of Jumper Wires

Jumper wires come in three versions:

- Male-to-male jumper
- Male-to-female jumper
- Female-to-female jumper

And two types of head shapes: square head and round head.

The difference between each is in the endpoint of the wire. Male ends have a pin protruding and can plug into things, while female ends do not but are also used for plugging.

Moreover, a male connector is referred to as a plug and has a solid pin for centre conduction. Meanwhile, a female connector is referred to as a jack and has a centre conductor with a hole in it to accept the male pin.

Male-to-male jumper wires are the most common and what you will likely use most often. For instance, when connecting two ports on a breadboard, a male-to-male wire is what you will need.



Fig 3.13 Jumper Wires

Light Emitting Diode

A Light Emitting Diode (LED) is a special type of PN junction diode. The light emitting diode is specially doped and made of a special type of semiconductor. This diode can emit light when it is in the forward biased state. Aluminum indium gallium phosphide (AlInGaP) and indium gallium nitride (InGaN) are two of the most commonly used semiconductors for LED technologies.

Older LED technologies used gallium arsenide phosphide (GaAsP), gallium phosphide (GaP), and aluminum gallium arsenide (AlGaAs). LEDs generate visible radiation by electroluminescence phenomenon when a low-voltage direct current is applied to a suitably doped crystal containing a p-n junction, as shown in the diagram below.

The doping is typically carried out with elements from column III and V of the periodic table. When a forward biased current, I_F , energizes the p-n junction, it emits light at a wavelength defined by the active region energy gap.

Working Principle of Light Emitting Diode

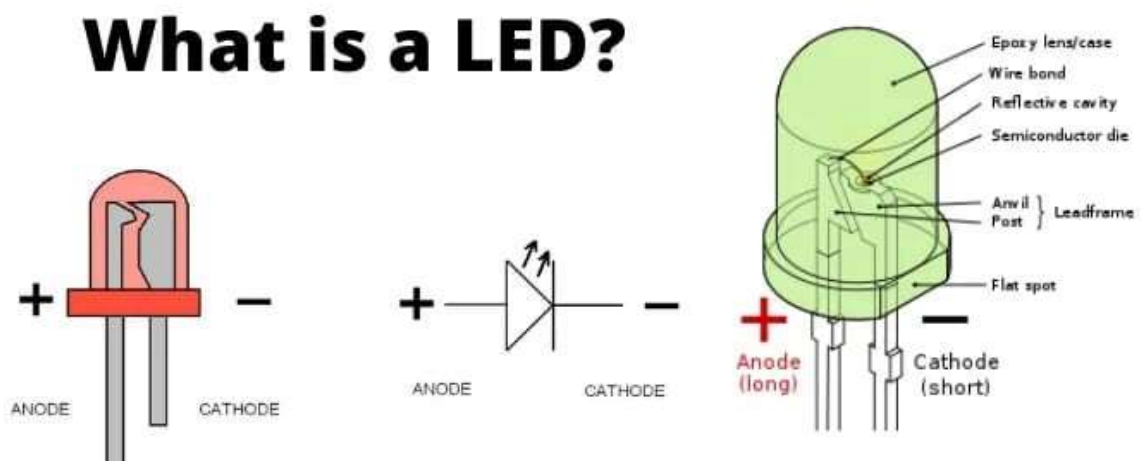


Fig 3.14 LED

When the forward biased current is applied through the p-n junction of the diode, minority carrier electrons are injected into the p-region and corresponding minority carrier electrons are injected into the n-region. Photon emission occurs due to electron-hole recombination in the p-region. Electron energy transitions across the energy gap, called radiative recombinations, produce photons (i.e., light), while shunt energy transitions, called non-radiative recombinations, produce phonons (i.e., heat).

Color of an LED

The color of an LED device is expressed in terms of the dominant wavelength emitted, λ_d (in nm). AlInGaP LEDs produce the colors red (626 to 630 nm), red-orange (615 to 621 nm), orange (605 nm), and amber (590 to 592 nm). InGaN LEDs produce the colors green (525 nm), blue green (498 to 505 nm), and blue (470 nm). The color and forward voltage of AlInGaP LEDs depend on the temperature of the LED p-n junction.

As the temperature of the LED p-n junction increases, the luminous intensity decreases, the dominant wavelength shifts towards longer wavelengths, and the forward voltage drops. The variation in luminous intensity of InGaN LEDs with operating ambient temperature is small (about 10%) from -20°C to 80°C . However, the dominant wavelength of InGaN LEDs does vary with LED drive current; as the LED drive current increases, dominant wavelength moves toward shorter wavelengths.

White LEDs

White LEDs are being manufactured now using two methods: In the first method red, green, and blue LED chips are combined in the same package to produce white light; In the second method phosphorescence is used.

CH340G USB to TTL Serial Converter

It's a small USB to TTL serial tool, using the CH340G chip. You can use it to connect some serial device to your PC via USB port. Designed to be used for USB to TTL electronic projects. Built-in USB to TTL Transfer chip. TTL interface output, easy to connect to your MCU. Dual 3.3V and 5V Power output, work with 3.3v and 5v target device.



Fig 3.15 : CH340G USB to TTL Serial Converter

Active Buzzer (5V)

This buzzer is an active buzzer, which basically means that it will buzz at a predefined frequency (2300 ± 300 Hz) on its own even when you just apply steady DC power. If you are looking for a buzzer can produce varied tones from an oscillating input signal, then take a look at our passive buzzer.

Some people prefer to get active buzzers since they can use them with steady DC power but also be able to produce some variety of tones by applying an oscillating signal. Some consider them to be more versatile than their cousin, the passive buzzer, which is the type that requires an oscillating signal to create any tone. It is possible, and often done, to still create different tones through an active buzzer when you apply an oscillating signal to the buzzer, but the spectrum of possible different tones is very limited and not as crisp or clean of sound as can be produced with a passive buzzer. One advantage to an active buzzer is that you can still produce a sound from the buzzer connected to a microcontroller, such as an Arduino, by just driving a standard high output on the connected pin. The benefits of this are that you don't need to use processing power, hardware timers, or additional code to produce sound.

SPECIFICATIONS:

- Longer pin is the positive pin
- Rated Voltage 5 V
- Operating Voltage 4~8 V
- Max Rated Current ≤ 32 mA
- Min. Sound Output at 10cm 85 dB
- Resonant Frequency 2300 ± 300 Hz
- Operating Temperature -20°C to 45°C
- Dimensions (Excluding Pins)
- Height 9.16 mm (0.36")
- Diameter 11.78 mm (0.46")
- Weight 1.6 g (0.057 oz)



Fig 3.16 Active Buzzer (5V)

CHAPTER 4

CIRCUIT DISIGNING OF FACE MASK

4.1 INTRODUCTION

Our country is densely populated where, some people are alert and aware , while some are careless and We can not put everyone's life in danger on their innocence . During this COVID-19 pandemic the mask plays a vital role in preventing the people from the spread of the disease . Even before this pandemic some industries like chemicals industries, paint industries, cotton industries , etc. Masks are the important thing to prevent the individual life from various diseases. We are currently focusing on the prevention of spread of COVID-19 in public places like ATM'S where people did not wear the mask and spread or being infected by the virus. It's comlex task if we use a human power to monitor the individuals in the public as well as high cost too.

So, we are providing a solution using the :

Face Mask Detection Based Automatic Door Lock System

- In a simple word if an individual wearing a mask means he/she will be allowed to enter otherwise the door will not open.
- Wearing mask plays a major role in this current pandemic situation and we know that it is the only way to prevent yourself from the virus but many of us don't care about this. People now roaming in the public places like ATM's, malls, etc., without wearing mask. The government also can't able to monitor each of them individually.
- And not only in this pandemic situation in general mask kind of protective equipment's are mandatory to work in industries those having toxic environment or those cause a health issue in a long term. But both the workers and the organization didn't care about that. So, to monitor this we are going to give a solution with the of- Face Mask Detection Based Automate Door Lock System .
- New developments and the availability of smart technologies force to the creation of new models, which will help meet the needs of developing countries. In this work, an IoT-enabled smart door is developed to monitor body temperature and detect face masks that can enhance public safety. This will help

to reduce manpower while also providing an extra layer of protection against the spread of Covid-19 infection.

- A variety of public health and hygiene measures have been initiated; the most visually noticeable perhaps is the wearing of face masks

4.2 BLOCK DIAGRAM

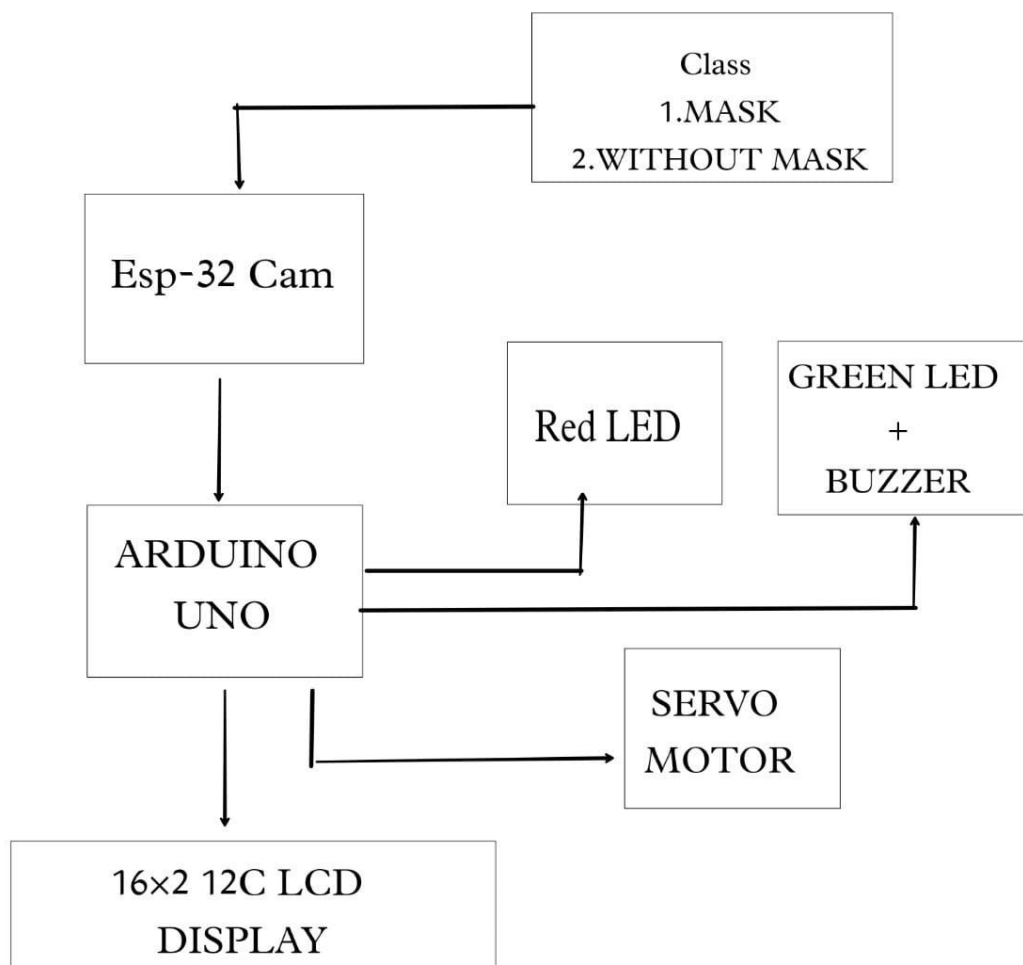


Fig 4.1 : Block Diagram of Face Mask Detection Based Automatic Door lock

- **CLASS**

In the class block we define two cases:

In this project , I'm going to walk you through making a machine learning model to detect person wearing facemask or not

So to get started, I'll go to Teachable Machine and open up an image project.

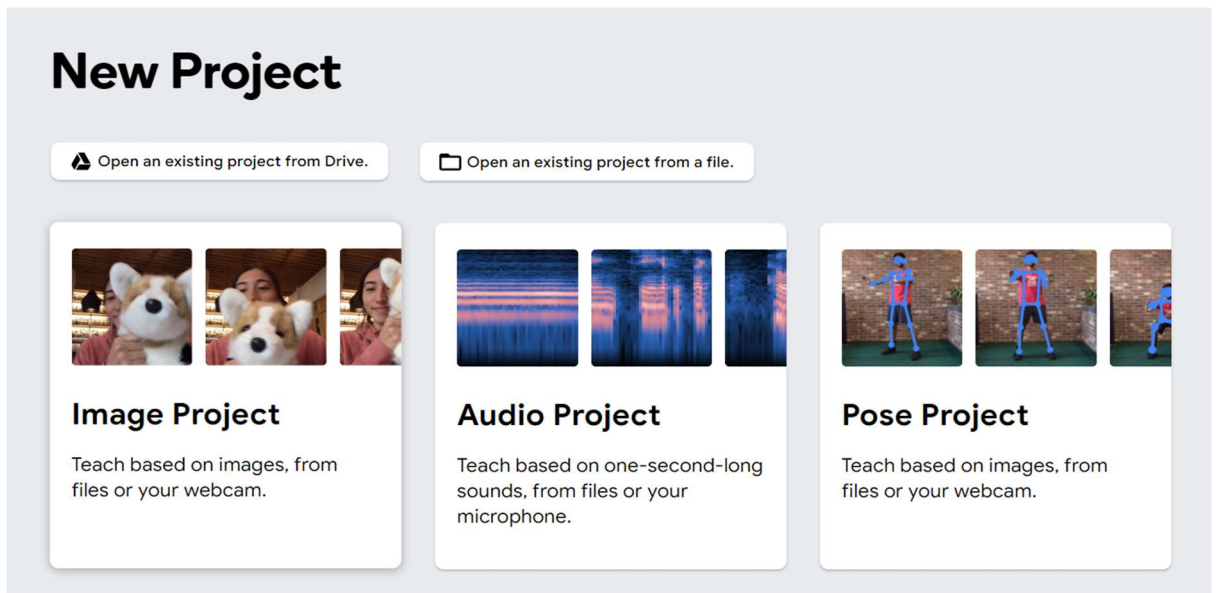


Fig 4.2 : Teachable Machine Project

I'm going to make two classes here - one with facemask, and other without facemask.

1. With Mask
2. Without Mask

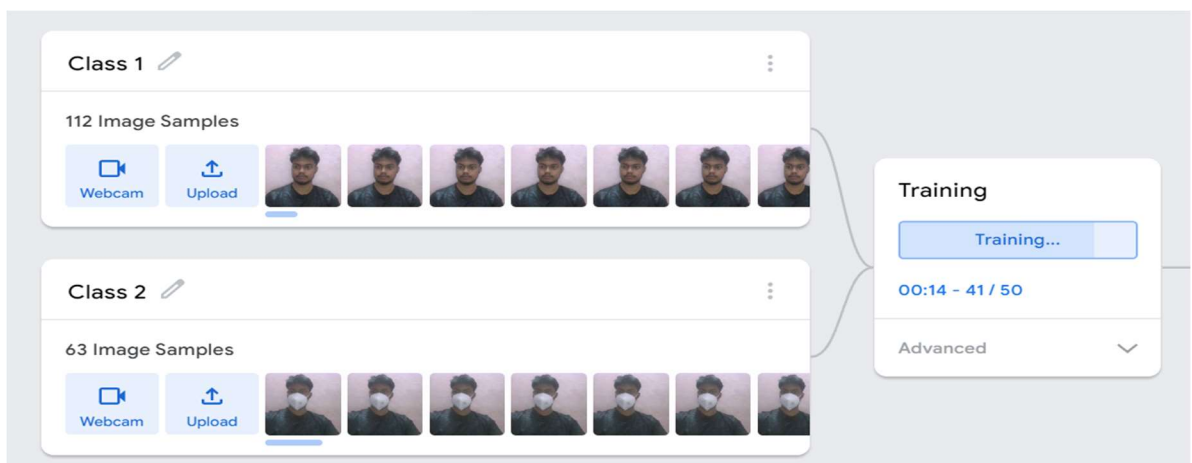


Fig 4.3 : Teachable Machine Class

Integration of ESP32-CAM with Teachable Machine

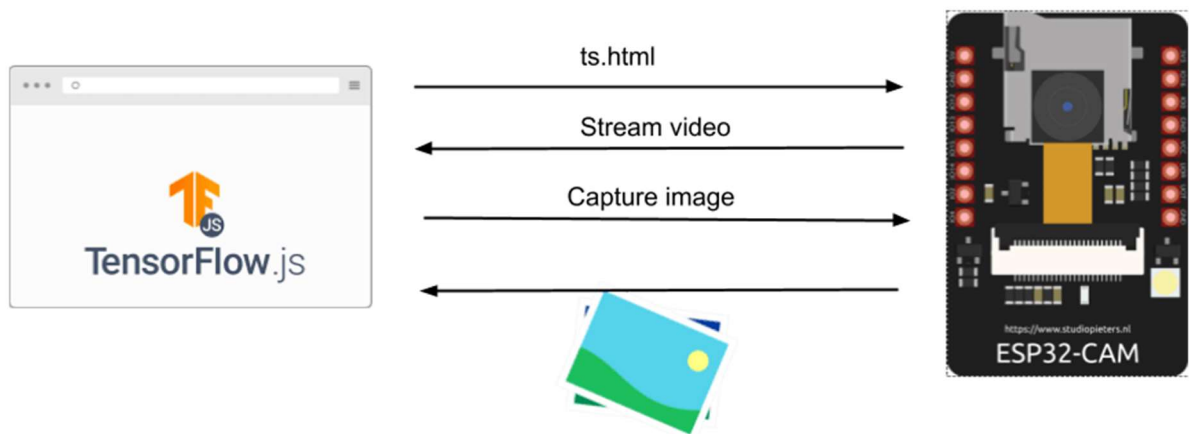


Fig 4.4 Tntegration of ESP32-CAM with Teachable Machine

These are the main steps:

1. The browser connects to the ESP32-CAM Web server requesting *ts.html* page
2. The ESP32-CAM provides the *ts.html* page that holds all the HTML and Javascript code to run Tensorflow.js
3. The user clicks on capture image sending the request to the ESP32-CAM that sends back the captured image
4. Tensorflow.js model runs on the user browser and classifies the image captured

Therefore, the ESP32-CAM has these tasks:

- Stream video
- Capture image
- Provide the HTML page that will be shown in a browser that runs the Tensorflow.js machine learning models

ARDUINO UNO

Uses by I2C 16x2 LCDto display instructions:

- Please wear mask
- Please Enter

Red LED

- When camera detect No Mask

Green LED + 5V Buzzer

- When Camera detect Mask

Servo Motor

- Arduino is uses to control servo
 - 0 -90 Degree when mask is Detected – Door open.
 - Delay 5 second , then close the door 90-0 Degree.
- Servo motor do not respond when no mask is detected.

CIRCUIT DIAGRAM

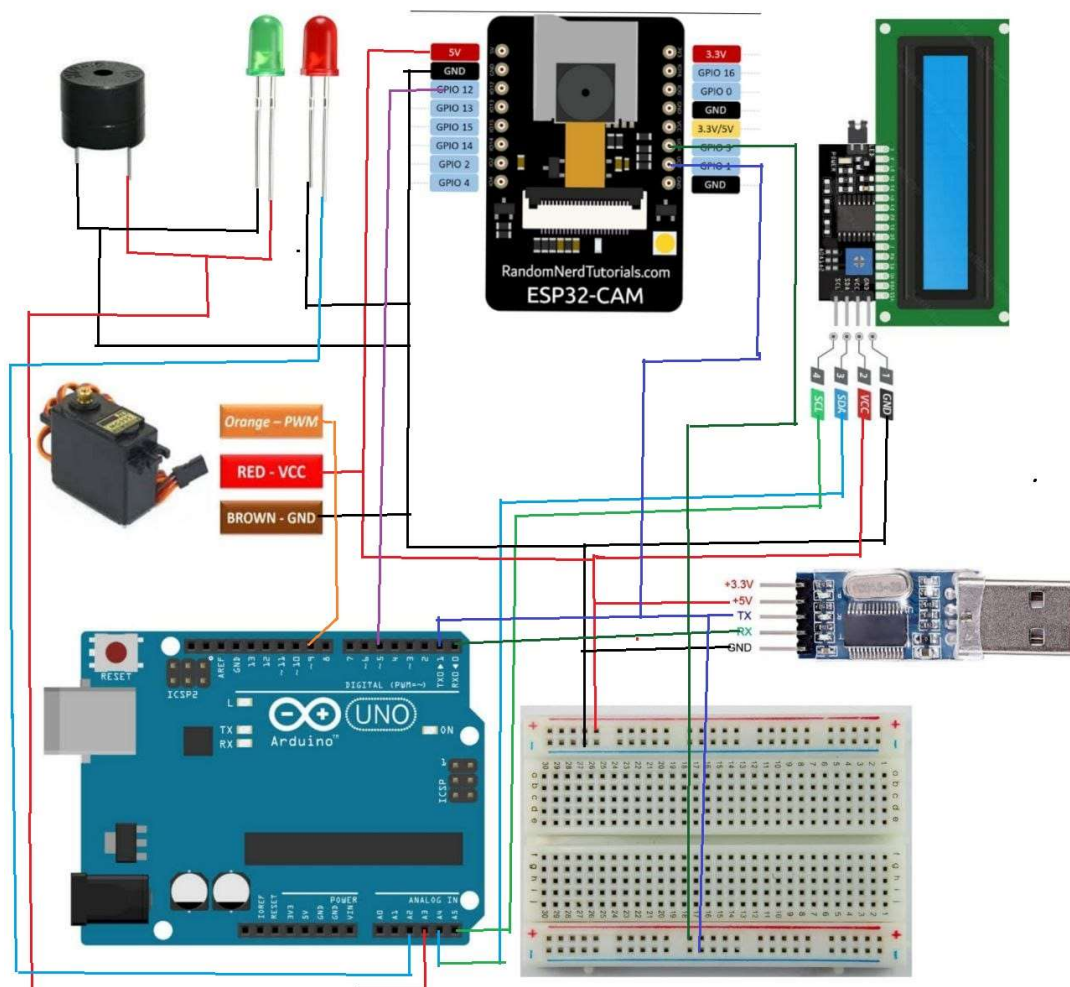


Fig 4.5 : Circuit Diagram of Face Mask Detection Based Automatic Door Lock

CONNECTIONS :

LED

- Analog Pin 4 - SDA
- Analog pin 5 - SCL
- 5V - VCC
- GND – GND

SERVO

- GND-GND
- VCC-5V
- SIGNAL- 9

ESP-32 CAM

- TX-RX
- RX-TX
- GPIO12-5
- GND-GND
- VCC-5V

USB to TTL Serial Converter

- TX-RX
- RX-TX
- GND-GND
- VCC-5V

GREEN LED

- ANODE- A3
- CATHODE - GND

RED LED

- ANODE- A2
- CATHODE - GND

BUZZER

- ANODE- A3
- CATHODE - GND

4.3 ARDUINO CODING

```
#include <Servo.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
Servo myservo1;
const int buttonPin = 5;
const int ledgreen = A3;
const int ledred = A2;
int pos1,pos2;
int buttonState = 0;
LiquidCrystal_I2C lcd(0x27,16,2);
void setup()
{

myservo1.attach(9);
myservo1.write(90);
lcd.begin();
lcd.backlight();

pinMode(ledgreen, OUTPUT);
pinMode(ledred, OUTPUT);
pinMode(buttonPin, INPUT);

}

void loop() {

buttonState = digitalRead(buttonPin);

if (buttonState == HIGH) {
```



```

    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("  EDU GATE");
    lcd.setCursor(2, 1);
    lcd.print("Please Enter");

    digitalWrite(ledgreen, HIGH);
    digitalWrite(ledred, LOW);
    for(pos1 = 89; pos1 <= 179; pos1 += 1)
    {
        myservo1.write(pos1);
        delay(60);
    }
    delay(5000);

    for(pos1 = 179; pos1 >= 89; pos1 -= 1)
    {
        myservo1.write(pos1);
        delay(60);
    }
}
Else
{
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("  EDU GATE");
    lcd.setCursor(2, 1);
    lcd.print("Wear a mask");
    digitalWrite(ledgreen, LOW);
    digitalWrite(ledred, HIGH);

}
delay(3000);}

```

CHAPTER 5

CONCLUSIONS

With the increasing number of COVID-19 cases all over the world, a system to replace humans to check masks on the faces of people is greatly needed. This system satisfies that need. This system can be employed in public places like railway stations and malls. It will be of a great help in companies and huge establishments where there will be a lot of workers. This system will be of a great help there because it is easy to obtain and store the data of the employees working in that Company and will very easy find the people who are not wearing the mask

It can be used for a variety of applications. Wearing a mask may be obligatory in the near future, considering the Covid-19 crisis. Many public service providers will ask the customers to wear masks correctly to avail of their services. The deployed model will contribute immensely to the public health care system.

We have proposed a system that automatically identifies whether or not a person is wearing a face mask and if person wearing facemask door is open otherwise not.

- In the first case when the person do not wear mask the door is not open and red led is ON.



Fig 5.1: Class 1 Face without mask

- In the second case when the person wear mask the door is open and Green led& buzzer is ON.

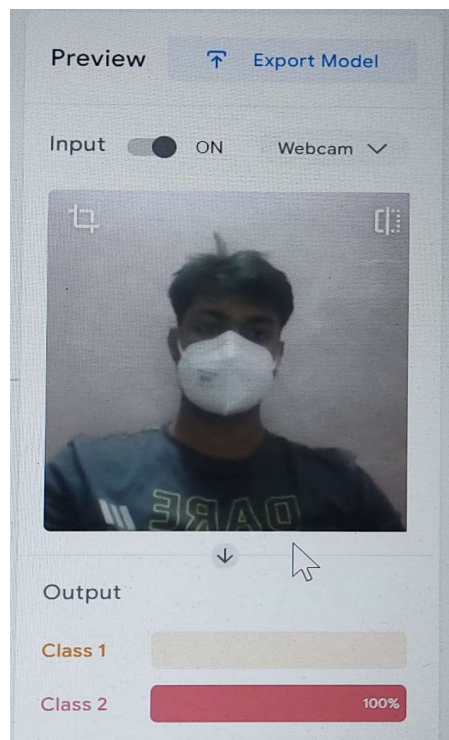


Fig 5.2 : Class 2 Face with mask

now that it's working, you can test out how it works - and even more fun, see where it doesn't work. Try to find the edges of where the model works machine learning has limits!

Remember that to the computer, images are just numbers & patterns of pixels.

And because of this, there are lots of ways it can get confused. So, let's look at a few:

- Different Backgrounds & Lighting
- If two person came at the same time, the model never saw samples that looked like that while it was training, so it might be confused.

CHAPTER 6

FUTURE SCOPE

- ❖ To deal with the pandemic more effectively, developing central systems capable of automatically detecting whether a person is wearing a face mask or not
- ❖ The work opens interesting future directions for researchers. Firstly, the proposed technique can be integrated into any high-resolution video surveillance devices and not limited to mask detection only.
- ❖ The model can be trained and upgraded to mask datasets that include different images related to correctly/incorrectly wear mask and achieve the ultimate purpose of detecting facemask
- ❖ The model can be trained and upgraded to mask datasets that include for multiple person e.g,

If both the person wear mask then open the door.

If one of them do not wear mask then do not open door.

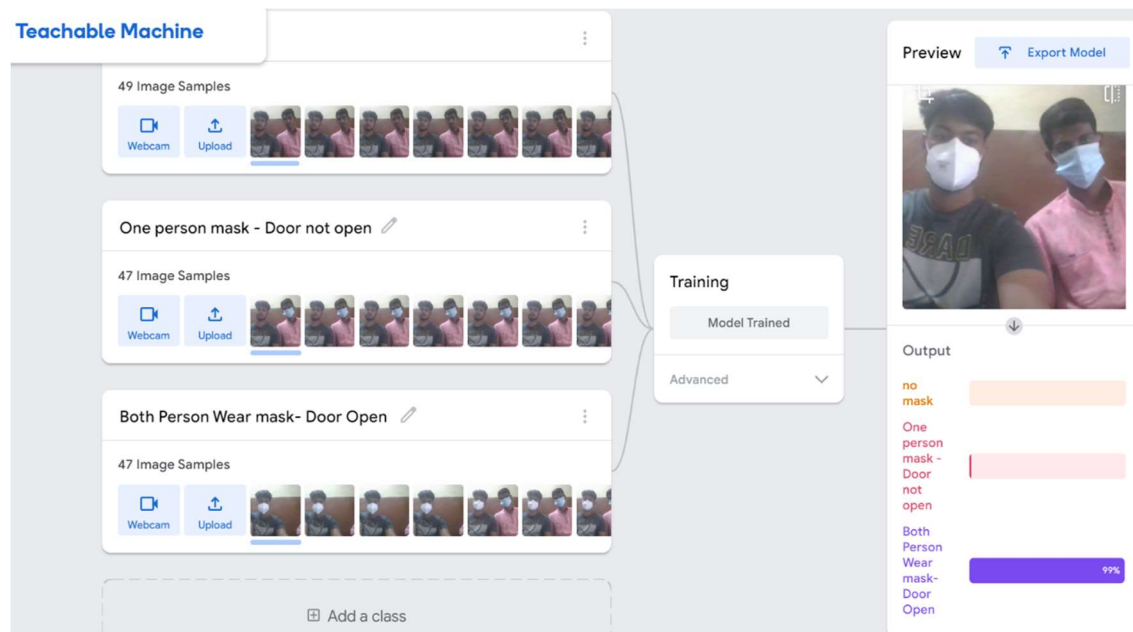


Fig 6.1:Upgraded to mask datasets

- ❖ Public places can be monitored better.
- ❖ The chances of making a mistake are negligible.
- ❖ Precise monitoring and warning.
- ❖ Chemical Industry.
- ❖ Paint and other hazardous Industry for Human Health.
- ❖ Use for monitoring in ATM, shops, supermarket, hospitals etc

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