International Journal of Computer Applications Technology and Research
Volume 13–Issue 06, 01 - 07, 2024, ISSN:-2319–8656
DOI:10.7753/IJCATR1306.1001

An Overview Review of Artificial Intelligence with Real-Time Face Detection Application

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Abstract- Artificial Intelligence is like as human in decision making, understanding the common language and recognizing the speech of others. This Artificial Intelligence technology is growing rapidly by developing the new algorithms with different tasks. The data science and machine learning play a major part with in the Artificial intelligence technologies. Computer vision involves the new development by creating new algorithms where it detects and delivers the perfect object in all fields. In last, 20 years major improvement where taken place in the Artificial Intelligence technology in many industries. In Artificial Intelligence applications nowadays majorly, prolog (Programming in Logic) and LISP (List processing) programming language were used. This review paper shows the overall concepts of Artificial Intelligence which used in all applications and the term data science and machine learning how it interconnected with the Artificial Intelligence and it shows the improved development with less human working effort in all fields. This paper shows the real-time face recognition using computer vision using MATLAB.

Keywords: AI, Data Science, Machine Learning, Deep Learning, Computer Vision.

1. INTRODUCTION

In the year 2025, 90 percentage of companies in INDIA going to boost their investment in the Artificial Intelligence technology. In India, the companies started to show their interest in machine learning, data science and Artificial Intelligence. Data science is to understand the business problem and the data science in there around 30 years and in the year 2015, Gil gave an evolution for the term data science. In 1966, Peter used the term data science as “Science of Data”. In 1974, Naur gave a survey regarding the methods which deals with the modern data processing in his book. In 1989, Shapero organized a workshop on first knowledge for the discovery in data base. The data mining conference was held on 1995 and it was an annual ACM conference. In 2001, in the field of statistics William published an action plan for data science. In 2002, the Icsu launched the journal in the name of data science. In 2007, the rise of “Data Scientist” which was wrote by Nathan Yau was published in that year. Data science have many terms related which is meant by overlaps. The terms are Data engineer, Big data, Business Intelligence, Business analytics, Statistics data mining, and Machine learning. In 2010, Loukides gave a definition for the data science as “Data science requires skill ranging from traditional computer science to mathematics to art”.

In 2014, V. Granvilles wrote in his book were “Data science is the intersection of computer science, statistics, operation research, machine learning and domain expertise”. According to V. Granvilles the domain expertise which is very essential for the data science such as marketing, practical physics, web and text mining, Bio informatics and genomics, image processing and computer vision. The data researcher, Data hacker called machine learning engineer and Data engineer. In this data science the newly termed called machine learning is now at the epicenter. Machine learning which relates to the data mining which improve the communication soft skills.

Machine learning is a branch of computer science and Artificial Intelligence which mainly focus on the algorithms by using the data to enable Artificial Intelligence. Machine learning works in three process namely 1. Decision process 2. Error function 3. Optimization process. The subfield of Artificial Intelligence are neural networks deep learning and machine learning. The deep learning is said to be the sub-field of neural networks and this NN is the subfield of machine learning. The areas such as computer vision, speech recognition and natural language processing which progress by the neural network and deep learning.

Machine learning methods were 1. Supervised Machine learning 2. Un supervised Machin learning and 3. Semi supervised machine learning. The train algorithms are used to classify the data from the labeled data sets called the supervised machine learning. This model tries to adjust the input data weights until it has been fitted appropriately. Th process called cross validation where it avoids the underfitting.

To analysis and to subset all the datasets the machine learning algorithms used and this is called unsupervised machine learning. The two approaches in this unsupervised singular value decompensation and principle component analysis. The medium between the unsupervised machine learning and supervised machine learning is called the semi supervised machine learning. During process pf training the data, it analysis the lesser labeled sets to classify the datasets. The algorithms commonly used for machine learning is neural networks, linear regression, logistics regression, clustering, decision tress and random forests.

Table 1. Era of artificial Intelligence

Year	Beginning of Neural Network
1943	Walterpitts published the first mathematical modelling of a neural network to create algorithms

	that mimic the human thoughts process.
1950	Alan Turing introduce the Turing test opening the door by his published work computing machinery and Intelligence which is the gateway for AI.
1951	Marvin Minsky developed the ANN called SNARC using 3000 vacuum tubes to simulate the network of 40 neurons.
1952	Arthur Samuel developed the world first self-learning programs to play games.
1956	Allen wrote the logic theorist which the first AI program to perform automated reasoning.
1958	Frank developed the perceptron an early ANN that could learn from data and it became the foundation for he modern neural network.
1960	James who is the graduate student construct the Stanford cart by developing the controlling the remote vehicle using the video information.
1963	Donald developed a program called matchbox educable noughts and crosses engine which learns how to play a perfect game.
1966	Stanford research institute developed the shakey the worlds' first mobile intelligent robot that combines AI, computer vision, navigation and NLP.
1969	Marvin published perceptron's which describes the limitation od simple neural network and AI research to thrive.
1973	James released the Artificial intelligence with a general survey how the British government to significantly reduces support for he AI research.
1979	Kunihiko released the work on neocognition, multi-layered ANN used for pattern reorganization tasks.
1989	Axcelis released evolver, the first commercially available genetic algorithm software package for personal computers
1997	Sepp proposed the long short-term memory recurring neural networks which could process the entire data like video or speech.
1998	Yann team released the data set known as modified national institute of standard and technology database which adopted for the handwriting reorganization evaluation benchmark.
2002	The first open source machine learning library and torch was released.
2006	Geoffrey coined the term deep learning to describe algorithms that helps computer recognized different types of objects and text characteristics in pictures and videos.
2010	Anthony launched the Kaggle as a platform for the machine learning competitions.
2012	Geoffrey introduced the deep CNN architectures that wins the ImageNet challenge and triggers the explosion the deep learning and implementation.
2014	Facebook develops the deep learning facial reorganization system called DEEP FACE, which identifies the human faces in digital images with near human face accuracy.
2017	Google researchers developed the concept of transformers by inspiring the subsequent research into tools that could automatically parse unlabeled text into large language models.
2019	Microsoft launched the Turing natural language generation as generative language model with 17 billion parameters.
2021	Open AI introduces the DALL-E multimodal AI system that can generate images from text prompts.
2022	Open AI released the chatGPT in November to provide a chat-based interface to its GPT-3.5LLM
2023	Elon Musk urged a six month pause on training "AI system more powerful that the GPT-4".

Data science related to Artificial Intelligence: The combination of the computer science and statistics to extract the knowledge for data and also from valuable understandings were the multidisciplinary for data science. It mainly involves the decision- making by collecting the data, cleaning the data and analyzing the data by making the predictions. The interrelationship between the data science, Machine learning and Artificial Intelligence was shown in Figure (1.1).

To achieve the goal data scientist uses the various techniques such as machine learning, data mining, data visualization to achieve the goals. The machine learning needs large amount of data to function the system smoothly.

To create predictive models in the Artificial intelligence apps the data scientist took large data and clean it to analyze the data.

Machine learning connected with Artificial Intelligence: Artificial Intelligence and Machine learning are connected where the machine learning provides the ability to the

artificial intelligence by analyzing the large amount of data, recognizing the patterns and adapting the new information. This makes a better performed in artificial intelligence t perform the better tasks that requires for the human intelligence.

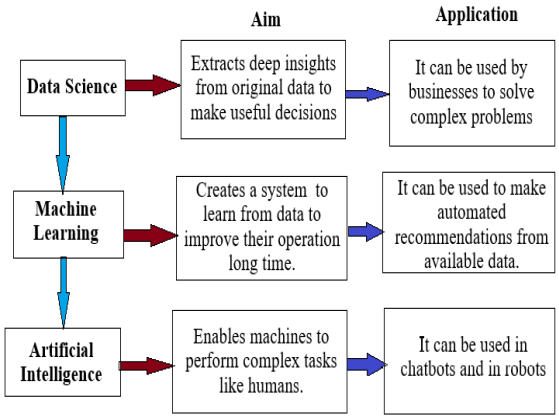

Figure 1 Relation of Data science, Machine learning and Artificial Intelligence

2. APPLICATIONS OF ARTIFICIAL INTELIGENCE

Throughout the world especially in Industries many applications were carried out using Artificial Intelligence by this it makes the human life faster and more comfortable. Human intelligence called AI where both the engineering and science creating a great task by creating an intelligent algorithm as a machine which acts more smart than human. Nowadays humans adopted mostly in the four artificial intelligence namely personalization, predictions, Natural language programming and advanced healthcare and analysis and visualization. Overall application was shown in the "Figure 2".

Internet: News feed provides the continuous information to the users with the updated fillings. Machine learning plays a major role in this Internet facilities to determine the which posts should show toward the searcher in web browsers. Various types of social medias like twitter, LinkedIn, Facebook are also using the machine learning technology.

Virtual Subordinates: Open Artificial Intelligence were using the natural language program to understand the user's natural language quires to import the command again to the users in the same language. Nowadays, Alex by amazon, Siri by Apple's and recently 2023 chatGPT using this NLP.

Real time Face recognition: The data base stored in the cloud which helps for the facial recognition technology which has capable of matching the faces by capturing in the form of digital frames. It gives 98% accuracy and, in all mobiles, human where using as face lock or unlock.

Agriculture: The predictive analysis where mainly using the machine learning to analysis the predictive models for certain applications. In agriculture artificial Intelligence plays a major role and identifying the defects and producing the solution for the defects to the farmers. Farmers are getting more support through the Artificial Intelligence in the form of increasing the yields by improving the pesticides handlings. The agronomist uses the artificial intelligence for their research fields and also to improve the quality of crops.

Crop Monitoring and Soil monitoring: Machine learning plays a major role to monitor the crops as well as to monitor the soil. It mainly helps check the moisture in the soil and to detect the pests and also to predict what kind of disease affected the crops in the farms. Artificial Intelligence technology improves the monitor section work in the time.

Education: Artificial Intelligence gives a scope for the administration and students in education fields. Many courses through online is now utilized by the educators as well as students to gaining more understandable knowledge. Artificial Intelligence supports to the management by sending the automated message and circulars for the student and parents regarding their report on their subjects and extracurricular activities. It crests many attractive puzzles and games such that kids can learn in their own way and this makes the kids brain to engaged with the concept orient critical thinking.

Healthcare monitoring: In early days Artificial Intelligence plays a major role where this technology itself detect and diagnose the disease especially in cancer treatment. Artificial neural network supports in the medical field by storing the data of the patients in various aspects like persons specific information in though the Electronic Medical Record for their medical diagnose.

Remote Healthcare system: Artificial Intelligence supports for medical field by remote monitoring and reporting to the nearby hospital regarding the critical patient health. Patients who are under risk of their health in hospital or home this Artificial intelligence technology supports them with first aid.

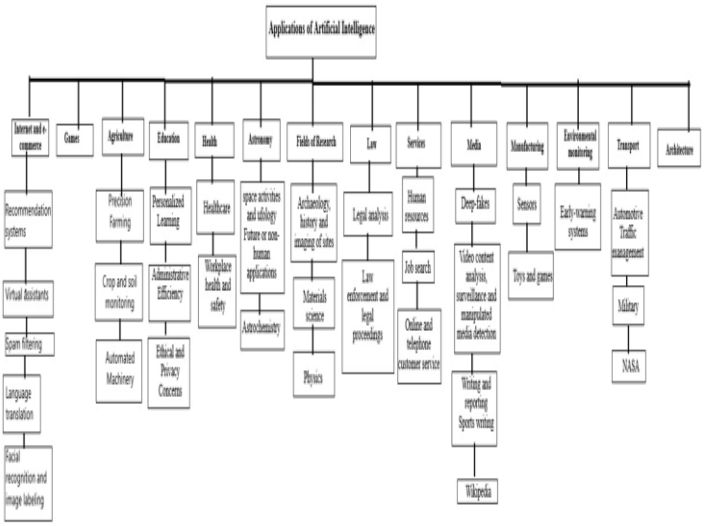

Figure 2. Overall applications of AI

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Manufacturing unit: Nowadays, every automated technology works with sensor as an input such that Artificial Intelligence helpful for the home appliance like monitoring the water quality and this works with the combination of digital instrument called spectrometry which separates and also measures the spectral components. In gas and oil companies the Artificial intelligence technology widely used to check the equipment problems and to increase the output of the gas and oil.

AI cars: For self-driving cars the artificial intelligence acts as a brain. In the self-driving drives many sensors were present and this makes the drive smoothly by deciding the stopping or turning the vehicles. In many vehicles the artificial intelligence technology controls automatically, the speed of the vehicles while driving in the highway and this helps to prevent the accidents.

Data Security: Artificial Intelligence plays a major role in data security works like a detective agent. The big piles of data watching if any stranger takes place in the form of theft the details from the online and it gives alert to the owner in the form of Anamoly recognition.

III Artificial Intelligence tools: The software application which use the algorithm of AI to perform the reputed tasks and to solve the problems.AI tools was used in health care, education, to analyze the data and used for decision making. Artificial Intelligence tools works by the machine learning algorithms to analyze the raw data and perform the decision making based on the trends and patterns of the data.

Machine Learning Models in MATLAB: The machine learning models basically classified in two ways in terms of set of classes and continuous process.1. ML classification 2. ML Regression.

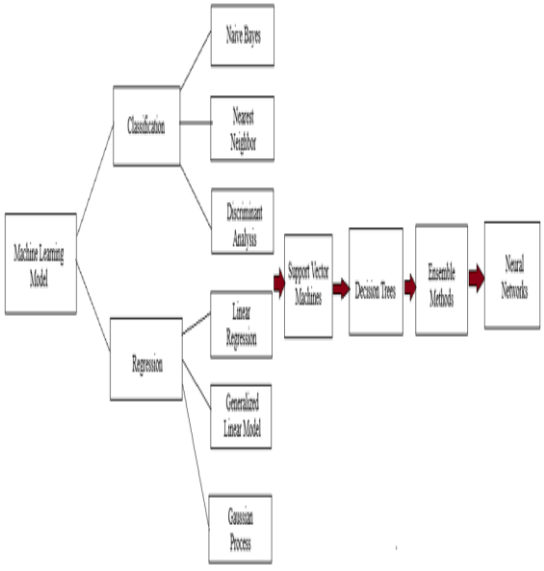

Figure 3. Machine learning model

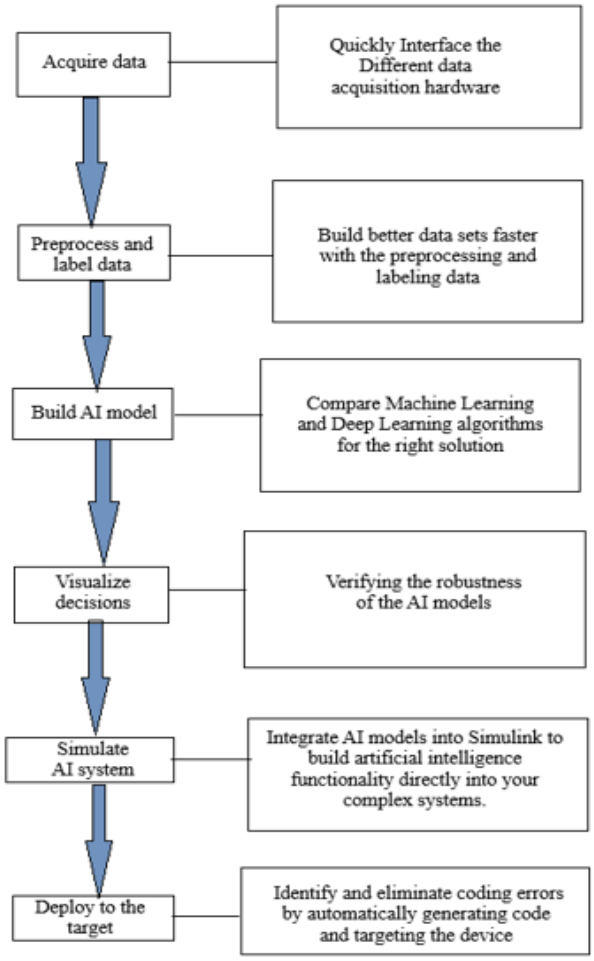

Figure 4. Work flow of the artificial intelligence technology using the machine learning and Deep learning process

The above “Figure 4” show the work flow of the artificial intelligence technology using the machine learning and Deep learning process using MATLAB. In all applications this process helps to reach the right solution and give good accuracy. In the below section the face recognition using MATLAB was carried out using the computer vision tool box and its an application which can be used for the industries and educational purpose.

3. OVERVIEW ON ALGORITHMS USED FOR ARTIFICIAL INTELLIGENCE TECHNOLOGY

Artificial Intelligence algorithm can apply for the computer science and mathematics and it is a set of instructions that are followed in calculation or other operations. So, the algorithm of AI shows how the system to learn and operate by tis own like human. AI algorithm works by taking the training data and it majorly helps the algorithm m to study.

Linear Regression: Linear Regression is mainly used to forecast and to predict the values within the continuous range and this is said to be supervised algorithm.

Decision -making: It can handle a complex data and also it is ease and simple. This algorithm is popular in machine learning it identifies the decision and gather the information finally it gives the alternative resolutions.

Random forest: The random forest algorithm is not a single tree to decide the solution it is a numerous tree which takes data from the training dataset and individually trained with various random samples. Overfitting is the common issue occur in the random forest algorithm.

Support Vector Machine: In Machine Learning very most important algorithm is a SVM algorithm because it has capable for nonlinear and linear classification and outlier recognition. This SVM algorithm can be used as classification and regression difficulties. It was capable to give better results even if there was a less data.

Logistics Regression: Logistics regression algorithm used for the classification task as well as regression but this algorithm is widely used for the classification tasks. The true or false value is identified by the separation of line in the S-shape.

Naive Bayes: Naive Bayes algorithm always follows the Bayes theorem. This algorithm before going into the decision steps it takes the previous probability sets of the classes of the target instead of skipping into directly into the data.

K- Nearest neighbors: KNN algorithm can be used for the predictive and classification modelling. It classifies the output by its closeness with the other output present in the graph. KNN algorithm is used for estimate tasks.

Natural Language Programming: NLP mainly deals with the interaction between computers and human language. NLP techniques mainly include the three techniques namely 1. Sentiment investigation 2. Entity reform and 3. Machine conversion. This technique permits the machine to understand and generate the human linguistic in spoken or textual forms.

Computer Vision: Computer vision plays a major role in Artificial Intelligence technology to analyze and recognize the various images as well as videos. Computer vison supports for the industrial application by recognizing the face, barcode scanning and detecting and object detection.

Gradient Boosting: If one use plenty of data to produce high prediction power in terms of prediction this boosting algorithm supports for the perfect resolutions. To build a strong predictor by the combination of average and weak predicters. In data science this gradient boosting algorithm is used to improve the models.

Learning vector quantization: Artificial neural network algorithm plays major role that allows the engineer to choose how many training data to suspend onto and learns exactly with the data what that occurrence should look like. It helps to reduce the memory requirement by loading the entire data for the KNN algorithm.

Linear Discriminant Analysis: The Linear Discriminant Analysis algorithm of Artificial Intelligence technology is the straight forward approach to predict the modelling and for data classification. The mean value and the total variance for all classes for the data was calculated in statistical method in this algorithm.

Dimensionally Reduction: It works under the principle of component analysis. This algorithm helps to compress the data results in less storage space in the system. It speeds up the control of the system and also removes the noise and redundant structures.

4. REAL-TIME FACE MONITORING USIGN COMPUTER VISION ALGORITHM.

In Industries and medical field, the face detection is the major role to predict the worker and patient face and also it is the need to monitor the surroundings of the campus. Mainly the face detection and reorganization also been used for many applications like for security and authentication in government related documents. Computer vision algorithm-based face detection was carried out in this work. Face detection helps for industries to easily capture the workers faces to maintain the attendance and also it automatically detects the human face through the picture or videos. The Artificial Intelligence technology where the computer vision automatically extracts the data, analysis the data, classifies the data and understanding it in the form of single images, three-dimensional data and in video sequences.

Algorithm to detect the human face: Viola- Jones algorithm used for the work to detect the single an multiple human face. This algorithm shows the interaction between the image processing and computer science. This algorithm works with the gray scale video or picture image and it looks at many minor subregions and tries to find the human face for exact features like nose, eye and mouth in each subregion. “Figure 5” shows the main steps for the Viola- Jones algorithm.

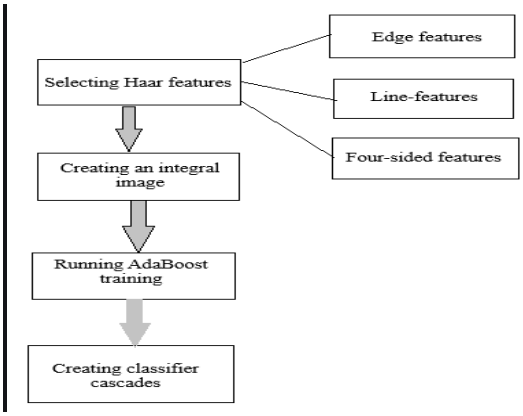

Figure 5. Viola-jones algorithm

To detect the face the cascaded object detector uses the Viola-Jones algorithm in the form of detecting the eyes, mouth, nose and upper body. The computer vison tool box in MATLAB

gives the train cascaded object detector function to train the client classifier. The positive images (Human faces) and negative image (Trees, bicycle and buildings) is stored in the data base and the trained cascaded object detector trains the positive and negative images as a function f_x. The cascade classifier classifies the data in three stages 1. when the positive image is classified the output will be true positive 2. When the negative image is mistakenly classified as positive then the output will be false positive and finally 3. When the positive image is mistakenly classified as negative image the output will be false negative. For each stage it should have low rate of false negative such that true images (human face) well defined by this detector.

5. MATLAB RESULTS AND DISCUSSION

In computer vision application the face detection and tracking are very important which included automotive safety, reorganization and surveillances. In this work three steps were used to detect the single and multiple face in the image. “Figure 6” shows the flow chart for the work which was carried out to detect the face from the live or stored videos.

Step 1: Created the cascaded object detector.

Step 2: Stored video file or live video reader reads the file using video reader.

Step 3: Read frame reads the live video or stored video.

Step 4: bbox computes the bounding box values by creating rectangle shape in the face present in the image.

Step 5: Imshow which shows only the captured rectangle shaped- faces from the image.

Flow work to detect the face:

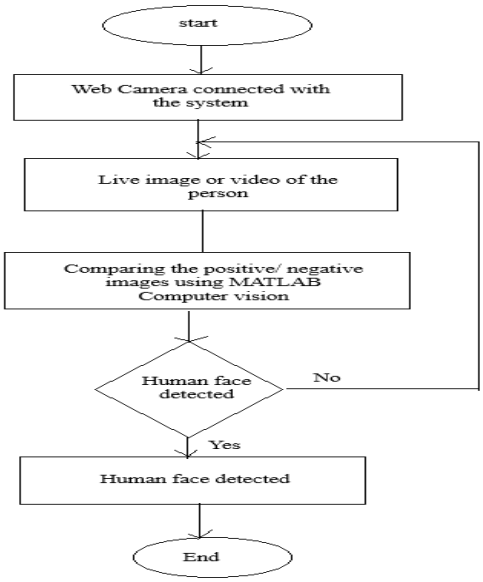

Figure 6. Flow chart for the prosed work

“Figure 7” shows the single face captured with the presence of many objects around in the video and in Figure 8” shows the two faces captured only the positive image and the program which framed is not captured the negative image like plants, clothes and buildings in the live video taken for the work. Finally, the figure 1.9 shows multiple humans were sitting and only three of the face was captured and remaining they turned their face above the camera, finally this shows only the absolute face was detected using the computer vision algorithm.

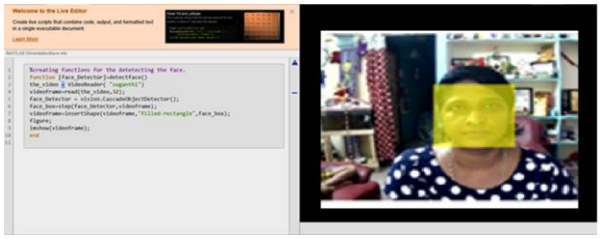

Figure 7. Single face detected

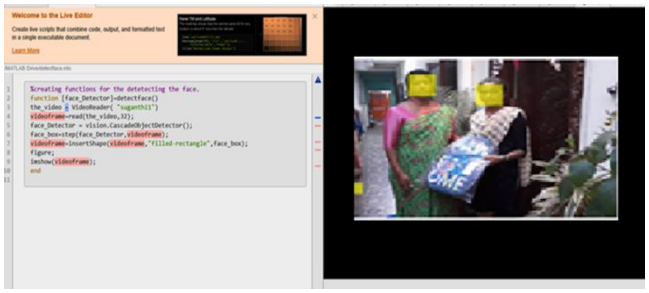

Figure 8. Two face detected

Figure 9. Multiple face detected

6. CONCLUSION

In this paper overview review of Artificial intelligence was worked out and this gives a better understanding about the AI and how it was reshaping the human life and how the algorithms used for the various applications. Especially the application of the Artificial Intelligence becoming more transformative in day today life in a thoughtful way. The work which carried out by detecting the human face with the help

of the MATLAB which will be useful for the industries as well as for residential applications. In future to improve the computational effectiveness, processing time and perfect resolution can try for the KLT algorithm and Eigen faces algorithm to detect the faces and also in medical sector using the face reorganization method one can easily check the previous medical data of the patients by analyzing patients face itself.

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International Journal of Computer Applications Technology and Research
Volume 13–Issue 06, 08 – 17, 2024, ISSN:-2319–8656
DOI:10.7753/IJCATR1306.1002

Drone Based Weather Monitoring System

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Abstract: Over the past few years, the manner of life has undergone a significant evolution. The development of robotics and the Internet of Things (IoT) through technology has not only enhanced our way of life but has also grown to be an indispensable aspect of it. A world without vehicles, phones, computers, etc. seems unimaginable in the modern era. Since there is still much to be done, new, creative ideas continue to be generated. The similar thought process guided the beginning of this research. The need to monitor our environment has arisen because of the ongoing improvements in technology. In this research, we attempt to offer a method for drone-based continuous environmental monitoring.

Keywords: Drone, Environment Monitoring, Unmanned Aerial Vehicle (UAV)

1. INTRODUCTION

The wonders of science are endless. The way we live has been fundamentally transformed by technology. No area of our lives is exempt from their involvement. Time and space have been mastered by science and technology. For instance, the geographical and natural boundaries separating one country from another have been completely eliminated by modern transportation methods. It has forged ties among all nations in the world. People work hard to create new items and devices that could improve our lives as technology advances and living standards rise. Quadcopters, UAVs, and general robotics are two examples of such fields.

But not all wonders are advantageous to the cosmos. These inventions have the potential to result in devastating global accidents.

With 5 million deaths brought on annually by air pollution, it is one of the top causes of death worldwide. Additionally, it is rising to the top of the list of:

- a variety of illnesses. pollution of the air
- contributes approximately 9% of all fatalities worldwide. Massive costs to human, animal, and forest life are incurred each year as the number of wildfires rises.
- At least 80% of all fire deaths take place in houses, making fire the third most common unintentional fatality in a house.

When we consider the points, we must manage environmental pollution, which is growing at an alarming rate, and monitor the neighborhood where we reside. Therefore, a combined drone unit mounted with a smart environment monitoring system appears to be quite effective for achieving our goals of reducing environmental pollution and lowering the risk to life through observation of our immediate surroundings. We can assess the situation at that specific place and take the necessary actions with the assistance of the surveillance data given.

Due to their numerous applications in resolving issues in daily life, quadcopters are becoming more and more popular. Additionally, it has numerous industrial uses and facilitates physical labor.

This paper describes the functions, modelling, and features of an Arduino Nano-based quadcopter-based environment monitoring and surveillance system. Every component has been thoroughly analysed and constructively described. The key goal is to make it versatile and cost-effective, with an emphasis on the environment. The technology is highly effective and flexible because the drone itself may be utilised in rescue operations, environmental monitoring, firefighting operations, surveillance, payload delivery, and more.

2. LITERATURE REVIEW

The use of drones for environment monitoring has gained a lot of attention in recent years due to their ability to collect data from remote or hart-to-reach areas that are less affected by the same people. Arduino is an open-source microcontroller platform that has become a popular choice or powering drones for environmental monitoring. This review paper provides an overview of the research and implementation of environmental monitoring drones using Arduino.

“unmanned aerial vehicles (UAVs) have great potential to aid new applications in many fields, including Military, Défense, Medical, Surveillance applications, and Vehicle tracking.” Developing unmanned drones and multiple drone systems, coordinate and complete missions more efficiently and cost-effectively. However, for drones to be used effectively, many issues need to be resolved, including protection, privacy, and control. Therefore, in this post, we examine new areas for IoT-enabled drones, and 5G technology, identifying sensor needs and analysing flight control systems for designed air traffic, privacy and security issues.
Finally, we propose to promote and facilitate UVA technology. The content of the framework demonstrates the overall architecture that protects drones as “flying” objects in a collaborative environment.

"The main problem of Flight Weather Network (FWN) is subsystem travel. Using Unmanned Aerial Vehicle (UAV) subsystems or modified UAV quadcopters, using a similar operation specific path. The system has many subsystems. E.g. drones, many sensors nodes (IoT devices), weather monitoring, collaboration in FWN system.
When the drone starts flying, it uses the wireless network environment and is in connection with the FWN. Some sensor nodes collect the weather monitoring centre and then send the weather data to the weather monitoring centre. In order to ensure consistency and accuracy in data recording, the subsystem using drone as a telemetry environment should be investigated. The questions were studied and analysed on several fronts, including flight mode tests, quadcopter stretch break stability checks, autonomous mode investigations, and velocity point surveys of drones in autonomous state mode or in real coordinates, and a break-down of the observed failure state. Voltage drop and RC transmitters."

"Integrated electronics and electronic devices play an important role in connecting the scientific and virtual worlds. Millions of devices such as Smartphones, Smartwatches, Wearables, Medical implants, and wireless sensor nodes have been found to make up these devices. It carries sensitive or proprietary information and is used in critical applications, including the use of wireless sensor nodes to remotely capture atmospheric emission data. However, some systems are used to collect data in remote areas because there is no local connection anywhere and is inaccessible to work. The use of wireless sensor nodes has proven to be faster, less energy intensive and more cost effective. The aim of this project is to monitor mountains from afar.
The systems uses drones to collect data from remote streaming sites. The technology used has been proven by environmental research showing the benefits of introducing wireless sensor nodes, including access to remote locations continuous data collection, and the labour and expense associated with data collection in the field."

"Unmanned Aerial Vehicles are frequently used in situations such as weather monitoring, pest control, infrastructure inspection, monitoring of communities where people and vehicles do not enter. Yes, there have been 418 accidents in which drones have been used in the US Situations. The purpose of this article is to create a protection system for the use of the engine and to prevent whether the Raspberry Pi is normal, it is connected to the drone and the temperature is connected to the engine.
The DS-18-820 thermometer is used to measure the temperature. For testing, we created an OS that will open the Raspberry Pi screen on the PC, in the background. If the difference reaches the maximum temperature of the engine, the drone will stop working. The findings show that the new system can make the drone safer by connecting sensors to data from the drone's engine to control the drone."

"Unmanned Aerial Vehicle (UAVs) have gained popularity in two military areas in the past. Also, disasters, terrorism, and based use have grown rapidly when comparing security concerns and capabilities, aka drone network (LAV Nets) – Hoc is one of the communications. Also, these issues need to be addressed to ensure that drones behave properly when controlled with respect to them. Adequate protection and attachment must be considered in many ways, including a good understanding of the vehicle's operating procedures. 'Terrain < Weather < Contact UAV Net'. This can be done by creating a simulator that includes certain factors. With a suitable UAV simulator, performance evaluation becomes an important method, configuration and design, to show results and be used for comparative situations.

Therefore, it is important to maintain the reliability of the simulation results by analysing the advantages and disadvantages of each simulator until the collection becomes significant. Based on this inspiration, we made a comprehensive evaluation of current drone simulators. However, it addressed and clarifies open data problems and research questions. ”

3. PROPOSED METHODOLOGY

The research methodology shall analyze methods and approaches for the handling and evaluation of test data.

For this paper the most important thing is deciding the temperature. This means that a person can't go where he can. We'll defect it with a drone weather monitor which we'll test with a DHT sensor. Additionally, this drone can assess the air pressure and air humidity.

3.1 Specification

3.1.1 Hardware Requirement:

3.1.1.1 UAV Quadrotor: Building a quad-rotor UAV capable of transporting a load of battery packs, sensors, microcontrollers are the first step. You can buy and assemble a quad-rotor UAV, commonly known as a drone, to cut down on the time needed to programme its control and flight capabilities.
A drone's four evenly spaced propeller-equipped rotors are kept together by a lightweight frame in the shape of a 'X'. To achieve balanced flying and help the drone stay upright and not readily slanted by wind or other object during flight, the rotor is situated at the end of the X-shaped chassis. One example of a quad-rotor UAV is shown in Fig. 1.

Fig. 1 Example of Quadrotor UAV Drone

3.1.1.2 DHT11 Sensor: The humidity and temperature sensors utilised in this project are DHT 11 Sensors. The DHT11 is a hybrid sensor that outputs temperature and humidity as calibrated digital signals. It is an extremely stable and dependable component. The parts of the DHT11 humidity and temperature sensor are shown in Fig. 2.

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Fig.2 DTH11 Temperature and Humidity Sensor

3.1.1.3 MQ2 Sensor: The MQ2 sensor is a gas sensor module that can be used to find gas leaks. It reacts almost instantly and is very sensitive. Potentiometers can be used to modify its sensitivity. Liquefied petroleum gas (LPG), methane, and carbon monoxide are all highly sensitive to the MQ2 Gas Sensor. The MQ2 Gas sensor is shown in Fig. 3.

Fig. 3 MQ9 Gas Sensor

3.1.1.4 Arduino Nano: The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Demilune, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one. Arduino Nano is shown in Fig.4.

Fig. 4 Arduino Nano Microcontroller

3.1.1.5 SD Card Module: A breakout board called an SD Card Module is used for microcontroller-based SD card operations including reading and writing. In this project we use SD Card module to store our data. SD Card Module is shown in Fig.5.

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Fig. 5 SD Card Module

3.1.2 Software Requirement:

DHT11 temperature and humidity sensors can be used with the Arduino microcontroller board thanks to their own library. As a result, the Arduino Uno needs the DHT11 library to identify the component and read data from the DHT11 sensor. The MQ2 gas sensor can be detected by the microcontroller UNO without the need for any library or interface coding. Each sensor's sensitivity can be adjusted using both hardware and software based on the environment.

3.2 Circuit Diagram

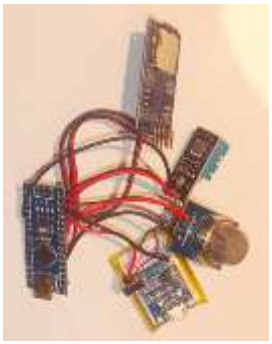

Fig 6. Experimental Setup

3.3 Working

1. Calibrated sensors are used for this monitoring system (sensors used are temperature and humidity sensor, and Gas sensor). SD card module used for storing the data retrieved.
2. After calibration of various sensors and the supply of power through the battery. We start our working module.
3. All the data is collected from the sensors and via calibrated sensors it is sent to Arduino Nano.
4. From Arduino Nano the data gets translated to the digital format and stored in the SD card.

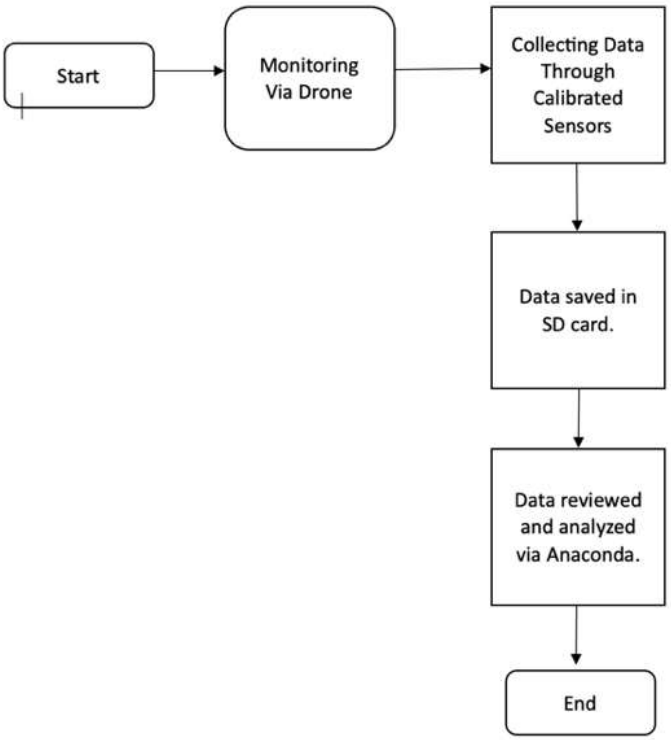

Fig. 7 Flowchart of working

4 RESULT

After analyzing the data gathered from the calibrated sensors and stored with the use of SD card, we collected data at three different timelines, i.e., Morning, Afternoon, and Night. Fig. 8,9, and 10 are the following graphical representation of data collected.

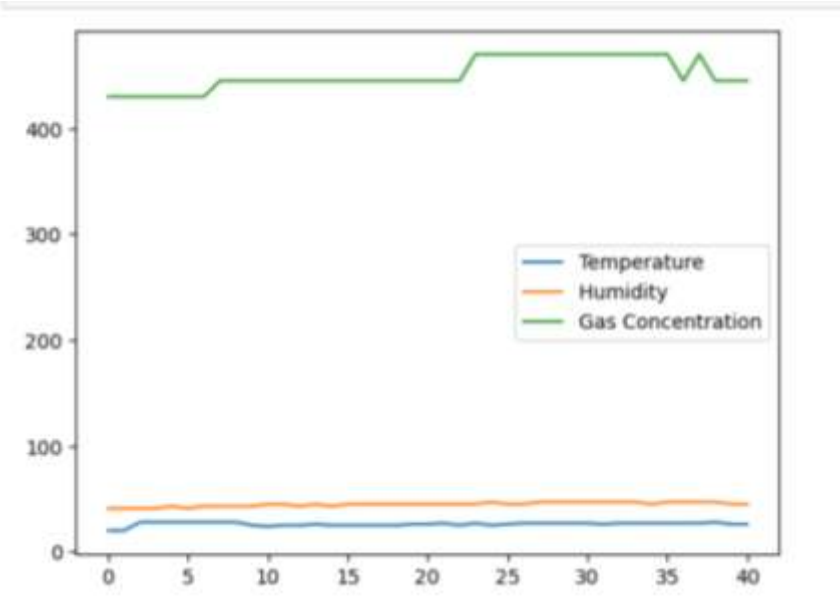

Fig. 8 Graphical representation of data retrieved at Morning.

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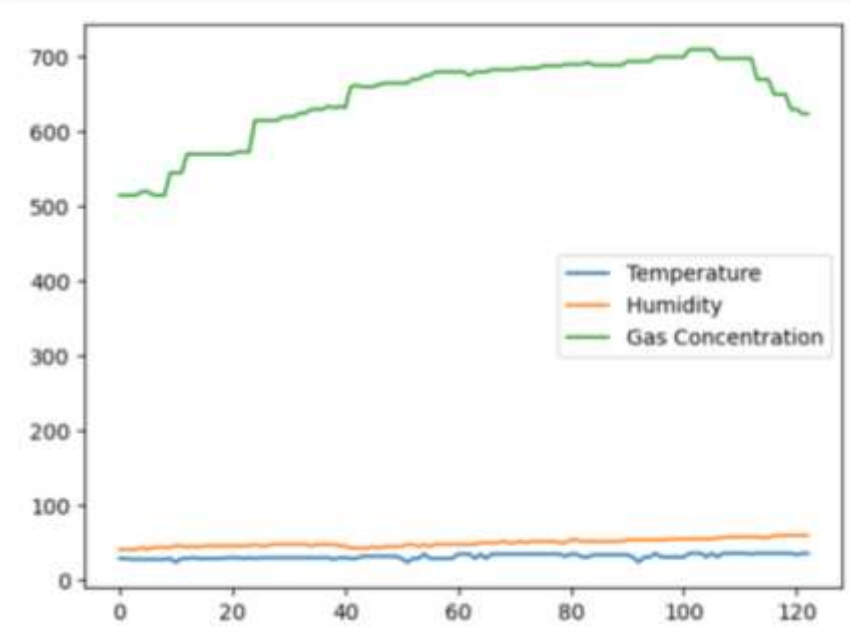

Fig. 9 Graphical Representation of data retrieved at Afternoon.

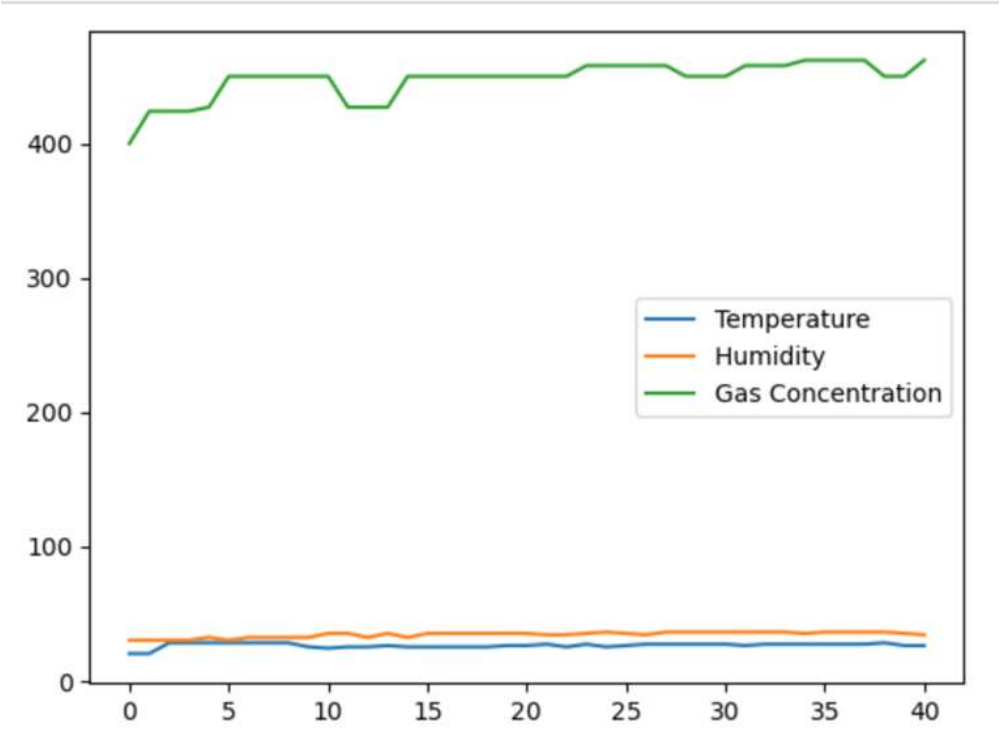

Fig. 10 Graphical Representation of data retrieved at Night.

By correlating the data calibrated at different timelines, we concluded that whenever the suns solar power is more, the temperature and gas concentration increases in the environment. That means, the increase in gas concentration is directly proportional to the temperature of the environment.

5 CONCLUSION

As we already know, increasing air pollution and fire-related fatalities are two serious problems that require quick attention. The model put out in this work attempts to address these issues by swiftly and effectively monitoring the environment. This will allow us to keep an eye on the environment, which is crucial right now, especially in locations like marketplaces, shopping malls, schools, colleges, train stations, and metro stations. By doing this, we are safeguarding lives in addition to preventing potential harm.

6 FUTURE WORK

Since technology is constantly developing, there is a lot of room for advancement. By providing our drone autonomy and the ability to study its environment on its own, we intend to make it "intelligent" and only alert us to potentially dangerous situations.
Other similar drones that support firefighting efforts over a greater affected region may accompany these autonomous UAVs.
Arduino can be used to facilitate communication between these drones, and sensor data is gathered from them using SD Card module.
This model will utilize neural networks that have been trained using environmental data. A swarm of drones would also be useful for future surveillance tasks.

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International Journal of Computer Applications Technology and Research
Volume 13–Issue 06, 18 – 23, 2024, ISSN:-2319–8656
DOI:10.7753/IJCATR1306.1003

Real Time 2D Convolution and Max Pooling Process

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Abstract: In Convolutional Neural Network (CNN) consists of process of 2D convolution and max pooling. 2D convolution is performed to express the shape of an object in an image. Max pooling is one way to reduce the spatial dimensions of an input volume. They are together to create an object's feature. As we know, the feature extraction is an important part in classification and detection task. A good feature can distinguish the shape of one object from another. It will increase the classification and detection accuracy. In this paper, researcher will build and observe the real time 2-D convolution and max pooling process for feature extraction.

Keywords: real time; 2D convolution; max pooling; feature extraction; CNN

1. INTRODUCTION

As we delve into the inner workings of Convolutional Neural Networks, we encounter two fundamental processes: 2D Convolution and Max Pooling. These operations play a crucial role in extracting meaningful features from input images, paving the way for robust pattern recognition and classification. 2D Convolution and Max Pooling process, which are fundamental operations in Convolutional Neural Networks (CNNs) used for feature extraction and down-sampling.

2D Convolution, a cornerstone of CNNs. Imagine a pristine canvas representing our input image, brimming with pixels waiting to reveal their secrets. In the world of convolution, kernels—small, learnable filters—act as brushes, sweeping across the image to uncover distinctive patterns.

As the kernel traverses the image, it performs a dot product between its weights and the corresponding pixel values in each local region. This process yields a new value—a feature—that encapsulates the essence of the underlying structure within that region. With each stroke of the kernel, the canvas transforms, revealing hidden edges, textures, and shapes.

Max Pooling, like a magnifying glass, scans through the feature maps generated by convolution, selecting the most salient elements within localized regions. It achieves this by selecting the maximum value within each window, discarding irrelevant details and retaining only the most prominent features. Through this process, our canvas undergoes a subtle transformation, shrinking in size while amplifying the significance of its contents. A conceptual model of CNN is shown in Figure 1 [1]. Creating of feature extraction is shown in Figure 2 [2].

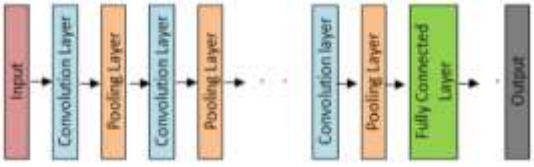

Figure 1. Conceptual model of CNN [1]

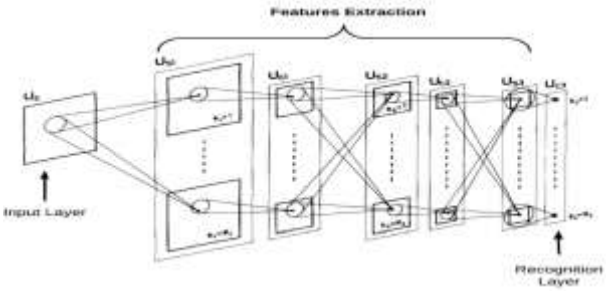

Figure 2. Schematic diagram illustrating the interconnections between layers in the neocognitron [2]

2. THE PROPOSED METHOD

The experimental method can be shown in Figure 3. A Camera is a device to capture the object(s) image. Then, the RGB input image is converted into grayscale. The contrast limited adaptive histogram equalization (CLAHE) is performed to the grayscale image to improve the image's contrast. This CLAHE image is filtered with a filter kernel in 2D convolution process, to express how the shape of the input image is modified by a filter. Finally, the max pooling is performed to reduce the spatial dimensions of an input volume.

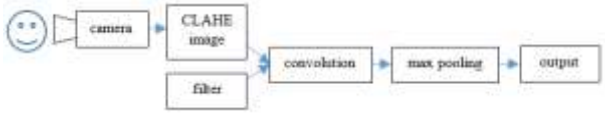

Figure 3. The experimental method

2.1 Contrast Limited Adaptive Histogram Equalization (CLAHE)

Adaptive histogram equalization (AHE) is a computer image processing technique used to improve contrast in images. It differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast and enhancing the definitions of edges in each region of an image [1][3][4].

International Journal of Computer Applications Technology and Research
Volume 13–Issue 06, 18 – 23, 2024, ISSN:-2319–8656
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However, AHE has a tendency to over amplify noise in relatively homogeneous regions of an image. A variant of adaptive histogram equalization called contrast limited adaptive histogram equalization (CLAHE) prevents this by limiting the amplification. The one implementation of CLAHE is used for improve the visibility level of foggy image or video [4].

In CLAHE, the contrast amplification in the vicinity of a given pixel value is given by the slope of the transformation function. This is proportional to the slope of the neighborhood cumulative distribution function (CDF) and therefore to the value of the histogram at that pixel value. CLAHE limits the amplification by clipping the histogram at a predefined value before computing the CDF. This limits the slope of the CDF and therefore of the transformation function. The value at which the histogram is clipped, the so-called clip limit, depends on the normalization of the histogram and thereby on the size of the neighborhood region. Common values limit the resulting amplification to between 3 and 4.

It is advantageous not to discard the part of the histogram that exceeds the clip limit but to redistribute it equally among all histogram bins [5-8].

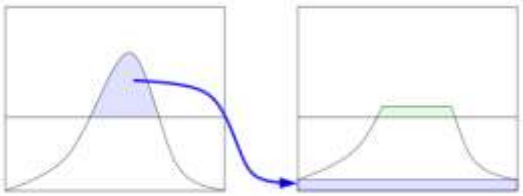

Figure 4. The histogram distribution in CLAHE [5]

The redistribution will push some bins over the clip limit again (region shaded green in the Figure 4), resulting in an effective clip limit that is larger than the prescribed limit and the exact value of which depends on the image. If this is undesirable, the redistribution procedure can be repeated recursively until the excess is negligible.

The CLAHE algorithm has three major parts: tile generation, histogram equalization, and bilinear interpolation. The input image is first divided into sections. Each section is called a tile. Histogram equalization is then performed on each tile using a pre-defined clip limit. Histogram equalization consists of five steps: histogram computation, excess calculation, excess distribution, excess redistribution, and scaling and mapping using a cumulative distribution function (CDF). The histogram is computed as a set of bins for each tile. Histogram bin values higher than the clip limit are accumulated and distributed into other bins. CDF is then calculated for the histogram values. CDF values of each tile are scaled and mapped using the input image pixel values. The resulting tiles are stitched together using bilinear interpolation, to generate an output image with improved contrast.

To increase image contrast, use the CLAHE algorithm as below. Grayscale and color photos can both be processed using this approach.

CLAHE algorithm steps are as follows [9]:

Step 1: Input image
Step 2: Segment input images into tiles
Step 3: Compute histogram for each tiles
Step 4: Apply TFM to compute clip limit
Step 5: Limit the contrast based on computed clip limit
Step 6: Check for enhanced image
Step 7: Enhanced image

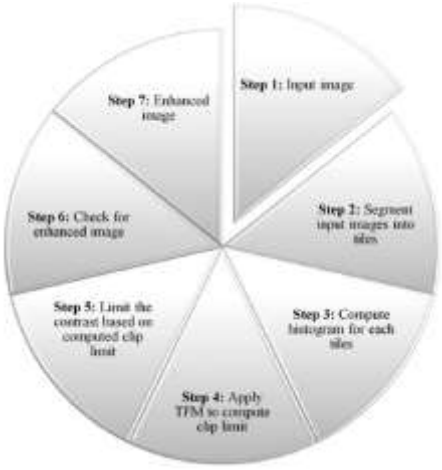

Figure 5. Steps followed in CLAHE algorithm [9].

Figure 5 illustrates the steps to be followed in the CLAHE algorithm. Prior to creating a histogram for each context region, a given input image is first separated into context regions. So that various portions of the image may be easily linked, a mapping function is used to produce an image mapping. The image noise is subsequently reduced using an interpolation approach. This enables us to lessen the noise in particular regions of the image. Although the method denoises the image, it does not do so fully.

2.2 Filter Kernel

A filter kernel, often simply referred to as a kernel or a filter, is a small matrix of weights used in convolutional operations, particularly in image processing and computer vision tasks. The kernel acts as a window or a template that is systematically applied to an input image to perform operations such as feature extraction, blurring, sharpening, edge detection, and more.

Key characteristics of a filter kernel include:

1. **Size**: The size of the kernel determines the spatial extent of the features it detects or the type of operation it performs. Common sizes include 3x3, 5x5, and 7x7 kernels, although larger or smaller kernels can also be used depending on the specific task.
2. **Weights**: Each element in the kernel matrix represents a weight that determines the contribution of the corresponding pixel in the input image to the output result. These weights are often learned during the training process in neural networks or manually defined for specific image processing tasks.
3. **Center**: The center element of the kernel matrix is typically aligned with the pixel being processed in the input image during convolution operations. The weights of the kernel are applied to the surrounding pixels in the input image to compute the output value for that pixel.
4. **Functionality**: The values in the kernel matrix define a mathematical operation that is applied to the input image. For example, in edge detection, the kernel may be designed to highlight areas of rapid intensity change, while in blurring, the kernel may apply a smoothing effect by averaging neighboring pixel values.

Examples of commonly used filter kernels include:

1. **Identity Kernel**: A 3x3 kernel with a center value of 1 and all other values set to 0. It preserves the original image without any modification.

2. **Gaussian Kernel**: A 2D Gaussian distribution used for blurring or smoothing images. It assigns higher weights to central pixels and lower weights to surrounding pixels, resulting in a blur effect.
3. **Sobel Kernels**: A pair of 3x3 kernels used for edge detection. One kernel highlights vertical edges, while the other highlights horizontal edges.
4. **Laplacian Kernel**: A 3x3 kernel used for edge detection and image sharpening by emphasizing regions of rapid intensity change.

Filter kernels are versatile tools that enable a wide range of image processing and feature extraction tasks, playing a crucial role in the success of convolutional operations in various computer vision applications. Some of filters are shown in Figure 6 [10].

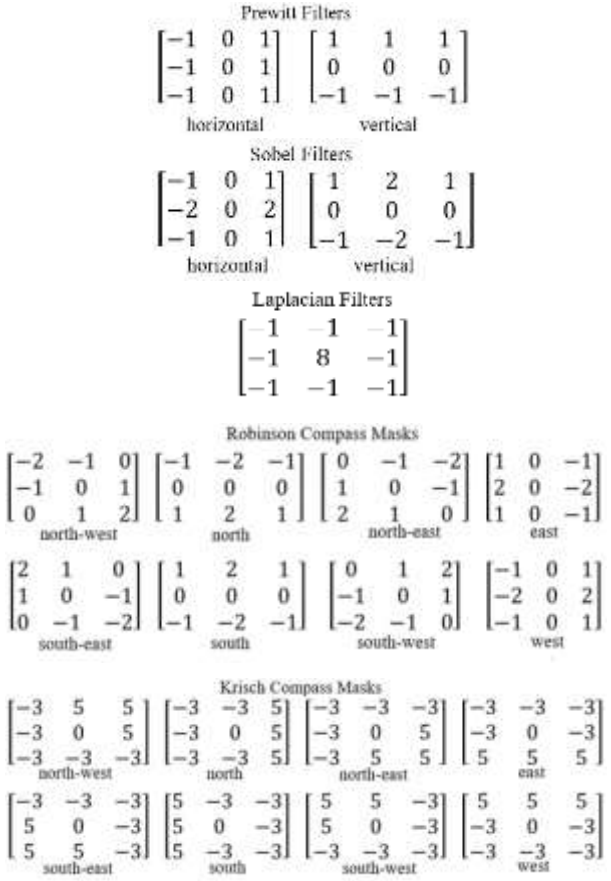

Figure 6 Some of filter kernel [10].

2.3 2D Convolution

2D convolution is a fundamental operation in image processing and computer vision, widely used in Convolutional Neural Networks (CNNs) for feature extraction. It involves applying a filter, also known as a kernel or a mask, to an input image to produce a feature map that highlights specific patterns or features.

Here's how 2D convolution works:

1. **Input Image**: The process begins with an input image represented as a two-dimensional grid of pixels, where each pixel contains grayscale intensity values or color channels (e.g., red, green, blue).
2. **Filter or Kernel**: A filter or kernel is a small matrix of weights that slides over the input image. The size of the kernel determines the spatial extent of the features it detects. For example, a 3x3 kernel captures local features, while larger kernels capture more global patterns.
3. **Convolution Operation**: The kernel is convolved with the input image by sliding it over the image and computing the element-wise multiplication between the kernel and the corresponding pixel values in the image patch covered by the kernel. These products are summed up to produce a single value, which becomes the corresponding pixel value in the output feature map.
4. **Stride and Padding**: The kernel moves across the input image with a specified step size called the stride. Padding may also be applied to the input image to preserve its spatial dimensions during convolution, ensuring that the output feature map has the same spatial dimensions as the input image.
5. **Output Feature Map**: As the kernel slides over the input image, it computes the convolution operation at each position, generating a new grid of values known as the output feature map. Each value in the feature map represents a local feature or pattern detected in the corresponding region of the input image.

The convolution operation captures various types of features such as edges, textures, and shapes present in the input image. By learning appropriate filter weights during training, convolutional layers in CNNs can automatically extract hierarchical representations of visual features, enabling the network to perform tasks like image classification, object detection, and segmentation.

2D convolutions, a convolution generalized to matrices, are useful in computer vision for a variety of reasons, including edge detection and convolutional neural networks. Their exact usage will not be discussed here, and instead we will discuss an efficient way to calculate a 2D convolution with the FFT we have already developed. We have a “data” matrix, representing an image, and we have a kernel matrix, which is the matrix we imagine sliding over the image. This is also known as a filter [11][12][13].

For 2D convolutions, the result is slightly ambiguous depending on how one defines it. We will use scipy’s definition, where to calculate the value of the convolution at a particular point, we imagine the bottom right corner of the kernel placed over that point.

We define the 2D convolution between an image x of size $M \times N$ and a kernel h of size $H \times W$ as follows (similar to the 1D case, we assume both matrices are padded with 0’s):

$$(x * h)[i,j] = \sum_{k=0}^{i} \sum_{l=0}^{j} x[k][l]h[i-k][j-l] \quad (1)$$

This operation is also symmetric, so what we call the image and the kernel is essentially arbitrary (by convention, the kernel is the smaller matrix). The resulting matrix is going to be of size $(M + H - 1) \times (N + W - 1)$ from the same logic as the 1D case. Thus, the time it takes to compute the convolution is $O(MNHW)$. We can, however, take advantage of a trick if the kernel has a certain property.

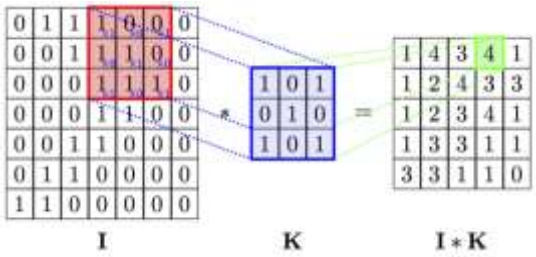

Figure 7. A convolution process [11]

In summary, 2D convolution plays a crucial role in extracting meaningful features from input images, providing the foundation for advanced computer vision algorithms and applications. Its ability to capture local patterns and spatial relationships enables machines to perceive and interpret visual information with remarkable accuracy and efficiency.

2.4 Pooling Layer

The pooling layers are used to sub-sample the feature maps (produced after convolution operations), i.e. it takes the larger size feature maps and shrinks them to lower sized feature maps. While shrinking the feature maps it always preserve the most dominant features (or information) in each pool steps. The pooling operation is performed by specifying the pooled region size and the stride of the operation, similar to convolution operation [1].

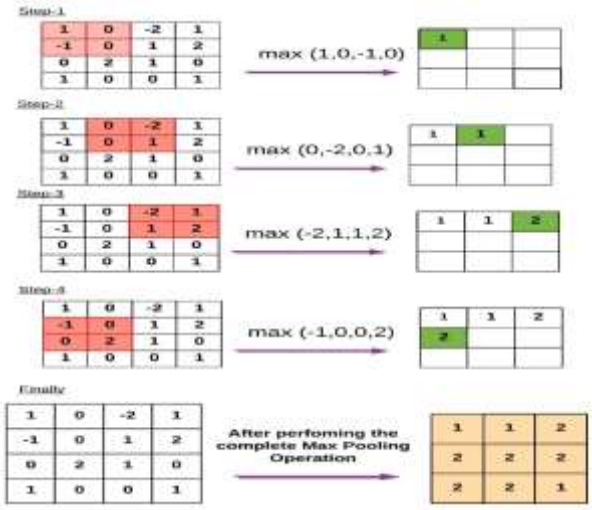

Figure 8. Illustrating the max pooling process [1]

There are different types of pooling techniques are used in different pooling layers such as max pooling, min pooling, average pooling, gated pooling, tree pooling, etc. Max Pooling is the most popular and mostly used pooling technique.

The main drawback of pooling layer is that it sometimes decreases the overall performance of CNN. The reason behind this is that pooling layer helps CNN to find whether a specific feature is present in the given input image or not without caring about the correct position of that feature [1].

Typically, the size of the pooling window is 3×3, and the stride with which the window is moved is also 2 pixels, as shown in Figure 7. This setup reduces the size of the input by half, both in height and width, effectively reducing the total number of pixels by 75%.

Max pooling offers several benefits in the context of CNNs [8]:

Feature Invariance: Max pooling helps the model to become invariant to the location and orientation of features. This means that the network can recognize an object in an image no matter where it is located.

Dimensionality Reduction: By down sampling the input, max pooling significantly reduces the number of parameters and computations in the network, thus speeding up the learning process and reducing the risk of overfitting.

Noise Suppression: Max pooling helps to suppress noise in the input data. By taking the maximum value within the window, it emphasizes the presence of strong features and diminishes the weaker ones.

3. THE EXPERIMENTAL RESULT

In this section, we explain our experimental result. We use an input image captured by a camera. The image size is 640×480 pixels. This experiment is performed using programming language C++ and openCV library.

The programming code to convert the RGB input image into grayscale is:

```
cvtColor(imgOriginal,imgGrey,COLOR_BGR2GRAY);
```

The programming code to convert the grayscale image into CLAHE image with clip limit 4, are:

```
Ptr<CLAHE> clahe = createCLAHE();
clahe->setClipLimit(4);
clahe->apply(imgGrey,imgClahe);
```

To create the filter kernel 3×3 is as follows:

```
kernelPFH = (Mat_<int>(3,3) << -1, 0, 1, -1, 0, 1, -1, 0, 1);
  //Prewitt filter horizontal
```

Then the convolution process is performed in filter2D(src,dst,ddepth,kernel,anchor,delta,BORDER_DEFAULT) as:

```
filter2D(imgClahe,output, -1 , kernel, Point(-1, -1), 0, 4);
```

where the arguments denote:

- *src* : source image.
- *dst* : destination image.
- *ddepth* : the depth of *dst*. A negative value (such as -1) indicates that the depth is same as the source.
- *kernel* : the kernel to be scanned through the image.
- *anchor* : the position of the anchor relative to its kernel. The location *Point(-1,-1)* indicates the center by default.
- *delta* : a value to be added to each pixel during the correlation. By default it is 0.
- *BORDER_DEFAULT* : we let this value by default.

The result images are depicted in Figure 9 and 10. Figure 9 is processing of static image, to compare the convolved image with grayscale input and CLAHE input. It is shown in Figure 9(e) more texture than (b). Figure 10 is processing of the real time frame that captured by a camera, with the image size of 640×480 pixels. It shows the convolved and pooled image.

4. CONCLUSION

2D convolution serves as a powerful tool for capturing spatial patterns and extracting hierarchical features from input images. By convolving learnable filter kernels across the image grid, convolutional layers effectively detect edges, textures, shapes, and other visual motifs, enabling the network to learn rich representations of the input data. Through the process of convolution, raw pixel values are transformed into higher-level features that encode essential information about the underlying structure of the input image.

On the other hand, max pooling serves as a selective down-sampling mechanism that preserves the most salient features while discarding irrelevant details. By systematically scanning through feature maps and retaining only the maximum values within localized regions, max pooling effectively reduces the spatial dimensions of the input data, making subsequent layers more computationally efficient and robust to variations in input size and position.

The experiment has been conducted to observe the result of convolution and max pooling process in real time. The experiment results show the pooled image still has a similar pattern to the input image, i.e. the convolved image. The pooled image becomes an object's feature to be fed to the classifier.

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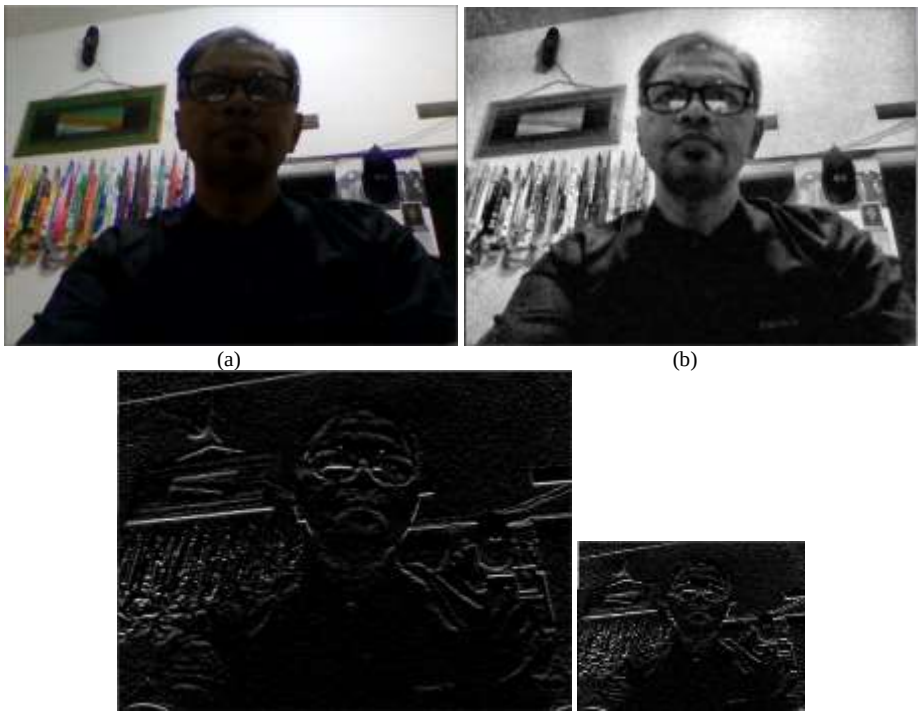
(a) (b) (c)

International Journal of Computer Applications Technology and Research
Volume 13–Issue 06, 18 – 23, 2024, ISSN:-2319–8656
DOI:10.7753/IJCATR1306.1003

(d) (e)

Figure 9. Original and convolved images (a) the original image (b) grayscale image (c) the convolved output of (b) (d) CLAHE image (e) the convolved output of (d)



(a) (b)

(c) (d)

Figure 10. Processing of real time frame (a) original image, size of 640×480 pixels (b) CLAHE image (c) convolved image (d) max pooled image of (c), size of 320×240 pixels