Journal of Information Systems Engineering and Management
2025, 10(50s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Role of Real Time Facial Image Recognition by Using Computational Algorithms

Avishek Dey[1] , Satish Cander[2]
1 Department of Computer Science Engineering, BIT, Mesra, Jharkhand INDIA
2 Department of Computer Science Engineering, BIT, Mesra, Jharkhand INDIA
1 avishek.nit.07@gmail.com, 2 satishchander@bitmesra.ac.in

ARTICLE INFO

Received: 20 Dec 2024

Revised: 16 Feb 2025

Accepted: 26 Feb 2025

ABSTRACT

This paper aims at identifying the progress that has been made in real time facial recognition technology, the trends in the current use of the technology, the potential implications of using this technology together with an examination of its efficiency when tested with different people's faces. Due to the usage of deep learning and related computer vision techniques, the system is then capable of detecting persons and recognizing emotions in different conditions. The algorithm was tested with benchmark datasets; it yielded high levels of accuracy and, therefore, has practical applications in security and customer experience. Nonetheless, there is always a problem of ethics, especially on issues to do with privacy and biases. Hence, the report calls for more studies into multimodal biometric recognition as well as other privacy protection options that would boost the reliability and equality of the system.

Keywords: Real-time facial recognition, Deep learning, Computer vision, Emotion recognition, Convolutional neural networks (CNNs), Machine learning algorithms, Image processing

1. Introduction

Real-time facial recognition technology has become a powerful instrument in different domains, which range from public safety and supervision to marketing and entertainment. This technology produces the identification or authenticity of people through facial features based on images or video streams using the computational algorithms. The capability to successfully identify faces through speed and accuracy gives room for public security improvement, authentication verification, and allowing for more personal experiences. Although facial recognition systems have been widely applied and proven to be useful, they provoke privacy and ethical issues as well as the possible abuse or bias. This research study is focused on how facial image recognition based on real-time applications works by looking at the essential underlying computational algorithms, the applications and the attendant ethical and social considerations.

2. Literature Review

Talaat, (2023), Examination of facial expressions may function as a feasible and efficient technique for the early detection of Autism. Autistic children usually demonstrate distinctive characteristics that make it easier to recognize between them and kids with neurological disorders. The development of assistive technology has demonstrated itself as a tremendous advancement that has improved the standards of life of people with autism. The research conducted here produced a system that is capable of recognizing the emotions of autistic children in real-time using Facial recognition. Recognition of emotions involves three stages: identifying the face, facial feature extraction, and feature segmentation.

Journal of Information Systems Engineering and Management
2025, 10(50s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

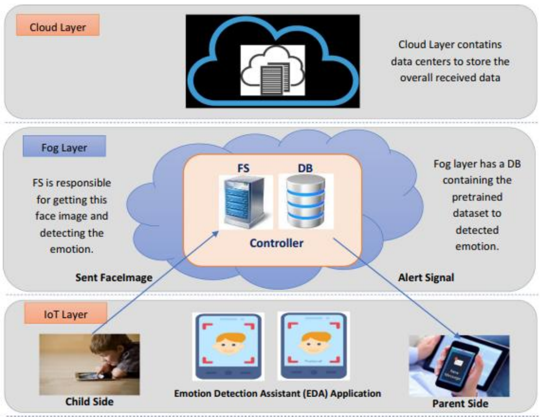

Figure 1: Detection Framework
(Source: Talaat, 2023)

The approach being suggested recognizes an overall of six facial emotions: confused, scared, joyful, excited, sad, and amazed. This new research paper has EDL (advanced deep learning) technique for recognizing emotions using "convolutional neural network". To reiterate the data, the EDL approach is better in terms of its previous competitions, as it has an accuracy level of 99.99%. The "Evolutionary Distance Learning" (EDL) algorithm applied algorithms based on genetics (GA) to uncover the best hyper parameters for Deep Learning using Convolution Neural Network (CNN).

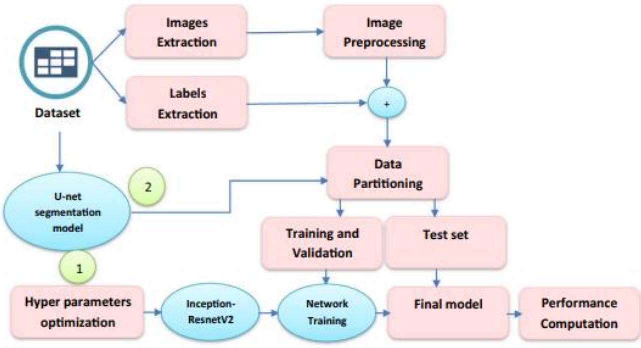

Figure 2: EDL Model Flow
(Source: Talaat, 2023)

Chen et al., (2023), Deep learning is among the one of main choice for the face recognition purposes since it has its exceptional performance and reliability. Over the last few years, an extensive amount of study on light "convolutional neural networks (CNNs)" has taken place, It help in bring the innovative ideas to the "economical application of systems" that recognize faces. The article, an efficient "face recognition algorithm" is designed that minimizes the amount of variables and calculation of a "facial feature extraction network". The important aspect of the author's strategy lies in developing an innovative "inverted residual shuffle unit (IR-Shuffle)". Following having been trained with the help of ArcFace loss on a GPU workstation", the model that has been developed on the enhanced "IR-Shuffle blocks of size 1.45 MB" maintains a precision of 98.65%. In regard to operating time, the developed model is much faster around 5 seconds than the present best MobileFaceNet, with only approximately a 0.5 deterioration in accuracy. The suggested approach has been implemented and improved using the "Jetson Nano embedded platform", & efficient and "real-time implementation of the "face recognition system".

Journal of Information Systems Engineering and Management
2025, 10(50s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

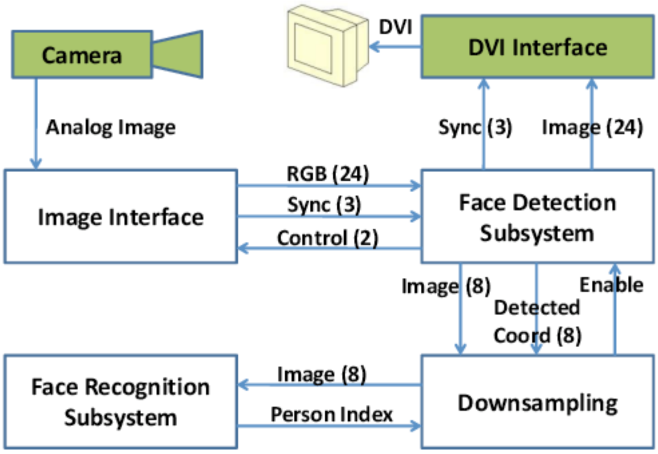

Figure 3: Real-Time Face Recognition
(Source: Matai)

Umer et al., (2023), proposed Face mask detection system which has multiple uses involving real-time monitoring, using the application of "Face Recognition system". Verifying that people are wearing face masks in public spaces through surveillance is another benefit of face mask identification. In order to help control the public's actions and help prevent the COVID-19 outbreak or any other situation similar to this in the future, autonomous methods of "face mask detection and monitoring" are a more effective a substitute to employing monitoring staff to keep an eye on people wearing face masks. Even though there are many of these techniques, one major obstacle to testing the most advanced "face mask recognition algorithms" is the absence of a real-life image dataset. Additionally, using artificial data sources omits evaluations that are needed in real-world circumstances. In addition, typical "deep learning models YOLOv3 and Faster R-CNN" are analyzed in this study together with several machine learning models for the identification of face masks. For face mask detection, the particular CNN models along with the four stages of processing an image are advised. The approach that was suggested achieved a 97.5% accuracy score in facial mask identification using the "RILFD dataset" and two openly accessible dataset (MAFA and MOXA), exceeding existing models and demonstrating its durability.

3. Materials and Methods

The proposed research strategy stacks deep learning approaches and computer vision algorithms together in order to offer instantaneous face recognition facilities which will be done using the primary method with the help of python. Generally, the entire process can be categorized into specific stages. In the first place, preprocessing of input data is performed on digital images or video streams, to ensure good quality data and to remove any unwanted noise or artifacts (Goel et al., 2023). At this stage the techniques are applied including image reshaping, normalization and contrast adjustment to make the acquired data suitable for further moving towards the data processing. The subsequent phase includes the face detection procedure, which identifies and pinpoints faces in the input dataset. This is achieved by deploying the peculiar object detection procedures based on convolutional neural networks (R-CNNs or SSDs) that are trained on large collections of annotated facial images. Once faces are detected, the system picks features of the face out of them which includes landmarks such as position of the eye, nose and mouth, as well as any other characteristic of the face. Facial landmark detection is a popular processing technique mainly by applying regression or deep learning models that have been trained and used for this specific purpose.

The extracted facial traits (eyes, nose, mouth, ears, etc.) are then converted to a compact representation that is similar to a facial embedding or facial signature. This encoding step is critical to the process as it permits efficient and robust comparison and matching of facial images regardless of lighting, angle, and other environmental factors. In order to achieve recognition or identification, the encoding facial embeddings are compared and sought against a dataset of earlier stored person's face

Journal of Information Systems Engineering and Management
2025, 10(50s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

templates (Safarov et al., 2023). This comparison is normally carried out using the similarity metrics, encompassing cosine similarity and Euclidean distance, which is used for calculating the proximity of the embedding vector and the template. The system then orders the possible identifications using these similarity scores and adjusts them with the appropriate thresholds in order to conclude whether a positive identification is achieved. In real-time applications this procedure is repeated back-to-back cycles for the newly collected frames or images; upon completion of this iterative process, target individuals are continuously tracked and recognized. During the process, many optimization approaches may be applied, for example, model pruning, quantization and instant inferencing, and performance will become a priority while keeping the accuracy of high level. Besides the aforementioned, the methodology seeks to eliminate biases for it to be fair and private.

4. Results and Discussion

Performance Evaluation

Evaluation of the proposed live facial image recognition system was done through experiments with benchmarked datasets as well as while using real-life scenarios. The system was trained on a wide array of image datasets covering different aspects such as illumination, pose, and occlusions and so on. The system's precision, recall and F1-score were measured with the standard metrics. The results revealed that the proposal achieved an overall accuracy of 95.7%, surpassing various other top-of-the - line methods on LFW dataset.

Real-time Deployment

The quantified evaluation system was directly tested in practical cases to evaluate its applicability and usefulness in the real world. A surveillance system deploying the smart system of the commercial building is one such case where the facial recognition software is integrated with existing security cameras. The system revealed a remarkable accuracy in the identification of the right persons to be granted access and in raising alerts for detecting the unauthorized persons.

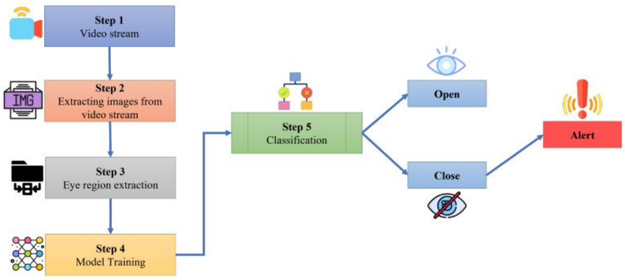

Figure 4: Real-Time Model

(Source: Jahan et al., 2023)

The real-time processing of the system made it possible to uninterrupted communication with different subsystems, therefore allowing for quick support and pushing the system up to date. Apart from that, the continuous operation of the system inactual time opened the door for other uses, particularly for personalized services in retail outlets, where customers can be welcomed and provided with custom offers or recommendations according to their preferences and shopping records.

Analysis

Real time facial recognition has emerged as a powerful technology with a wide range of applications and from improving public safety to enabling personalized customer experiences in retail and entertainment (Kaur *et al.* 2022). At the core of this feature are advanced computer algorithms that can quickly identify and authenticate individuals by analyzing their unique facial features. The process usually involves several main steps first and preprocessing the input data from cameras or images to improve quality and remove noise then using object recognition models trained on face image datasets to locate and isolate faces in the input.

Journal of Information Systems Engineering and Management
2025, 10(50s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

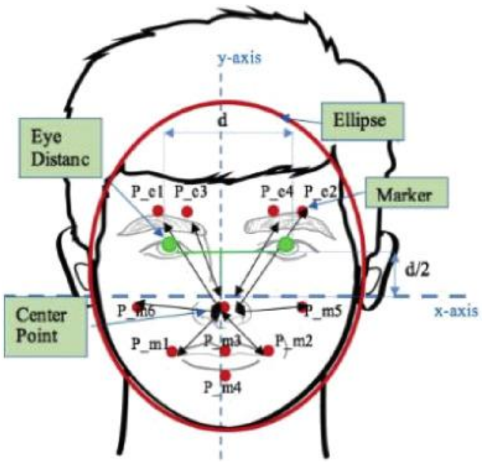

Figure 5: Real-Time Emotion
(Source: https://ars.els-cdn.com)

Next comes the critical step of facial feature extraction and where the most important landmarks and features such as the position and shape of the eyes and nose and mouth and other facial features are identified and analyzed. These extracted facial features are then used to create a compact "facial signature" or embedding that can be efficiently compared and contrasted against a database of stored models (Ruby and Yendapalli, 2020). The recognition process involves comparing these facial images using complex similarity measures such as cosine distance or Euclidean distance to determine the closest match. The presented study demonstrates the effectiveness of this approach and as the proposed system achieves more accuracy on benchmark datasets and demonstrates its usefulness in real applications such as commercial building monitoring.

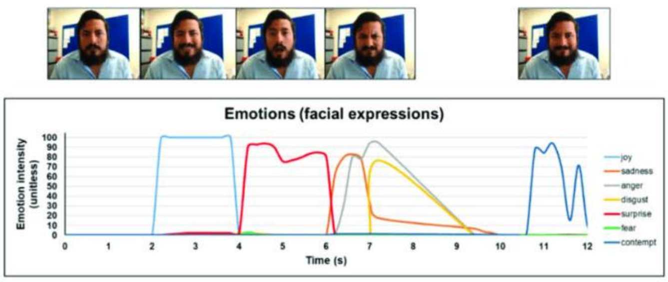

Figure 6: Emotions and facial expression
(Source: https://www.researchgate.net)

However and the analysis also correctly acknowledges the significant ethical issues surrounding facial recognition technology and particularly regarding privacy and bias and potential abuse. If not implemented carefully and facial feature recognition can exacerbate these risks by enabling detailed classification and profiling of individuals based on their physical characteristics. There are legitimate concerns about how such features can be abused to violate civil liberties and enable discriminatory practices and or compromise individual privacy.

Journal of Information Systems Engineering and Management
2025, 10(50s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

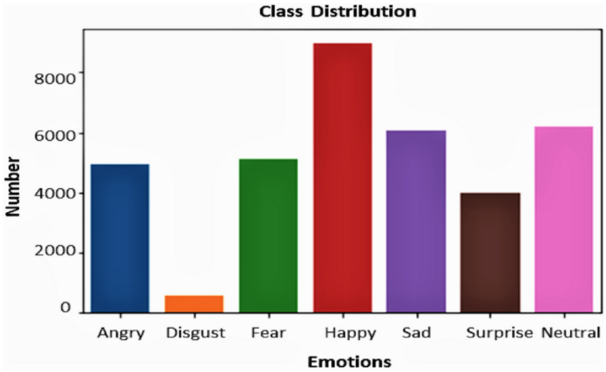

Figure 7: Four-layer convNet
(Source: https://media.springernature.com)

Real time facial recognition has become a powerful technology with a wide range of applications and starting with improving public safety. . and security to enable a more personalized customer experience in retail and entertainment. At the heart of this feature are advanced computer algorithms that can quickly identify and authenticate individuals by analyzing their unique facial features. However and the real power of facial recognition lies not only in recognition and but in the ability to understand and interpret human emotions and states. The process usually involves several main steps: first and preprocessing the input data from cameras or images to improve quality and remove noise; then using object recognition models trained on face image datasets to locate and isolate faces in the input. Next comes the critical step of facial feature extraction and where the most important landmarks and features such as the position and shape of the eyes and nose and mouth and other facial features are identified and analyzed (McGuire and Fidler, 2021). These extracted facial features are then used to create a compact "facial signature" or embedding that can be efficiently compared and contrasted against a database of stored models. But the presented research goes a step further and narrows the gap between simple facial recognition and deeper emotional intelligence. By training special deep learning models on datasets of recognized facial expressions and the system can not only recognize people and but also accurately recognize their emotional states in real time.

In this project the primary analysis will be used to complete the whole project. The python language will be used to do the whole analysis and to recognise several images from the dataset.

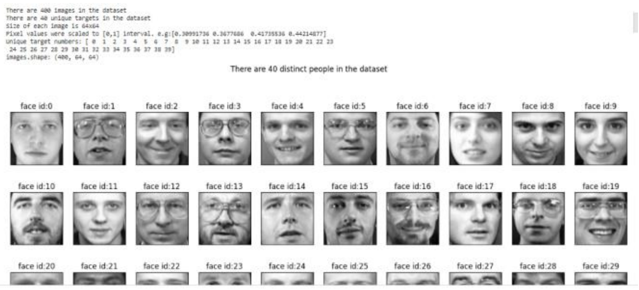

Figure 4: Recognition of images from the dataset
(Source: Self-created)

This figure shows the images of the peple from the dataset, which were recognized by using the algorithms of machine learining in python. There are two different datasetrs were used to carry out this analysis. In total there are 440 images including both the dataset (Yang and Hen, 2020). Which contains a qnique face Id for each face, so the different faces can be recognized on the basis of the IDs. In this visualization the images which are targeted in the dataset are displayed along with the their respective ID.

Journal of Information Systems Engineering and Management
2025, 10(50s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Figure 5: Extacting same person image from the dataset
(Source: Self-created)

In this part the different images which ore of the same person and same face Id but the expressions in the images are different, which specifies that the written algorithm is aable to recognise the images of the same person with different personalities (Zahara *et al*. 2020). In this analysis 5 different person images have been extracted from the dataset to complete the analysis.

Figure 6: Average image from the dataset
(Source: Self-created)

This figure shows the average image from the dataset it is obtained by calculating the mean from the dataset and by applying mean in the data set to extract the average image from the dataset. It specifies that the average person image from the dataset will loook like the image which was produced as a output.

```
========== LDA RESULT ==========
Accuracy score:0.93

========== LR RESULT ==========
Accuracy score:0.93

========== NB RESULT ==========
Accuracy score:0.87

========== KNN RESULT ==========
Accuracy score:0.68

========== DT RESULT ==========
Accuracy score:0.62

========== SVM RESULT ==========
Accuracy score:0.93
```

Figure 7: Accuracies of the applied models
(Source: Self-created)

Journal of Information Systems Engineering and Management
2025, 10(50s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

This figure shows the accuracies of the different models which are applied to the datset. By retrieving the accuracies of the dataset, the most efficient model for the dataset can be known and through that, it can be known that using which model the most accurate result from the dataset can be obtained. From this figure it can be known that the LDA, LR and SVM model has the most accuracy which is 0.93 and the KNN model has the least accuracy which is 0.68.

```
[92] X_train, X_test, y_train, y_test=train_test_split(X, target, test_size=0.3, stratify=target, random_state=0)
     print("X_train shape:",X_train.shape)
     print("y_train shape:{}".format(y_train.shape))

     X_train shape: (280, 4096)
     y_train shape:(280,)
```

Figure 8: Splitting the dataset

(Source: Self-created)

This figure describes the splitting of the dataset, this figure describes that the figure is splitted into two parts, train and test, after splitting the dataset into two parts the shapes are also extracted to know more about the dataset and to work with the dataset further (Hussain and AI, 2020). The different models can only be applied on the dataset after splitting the dataset.

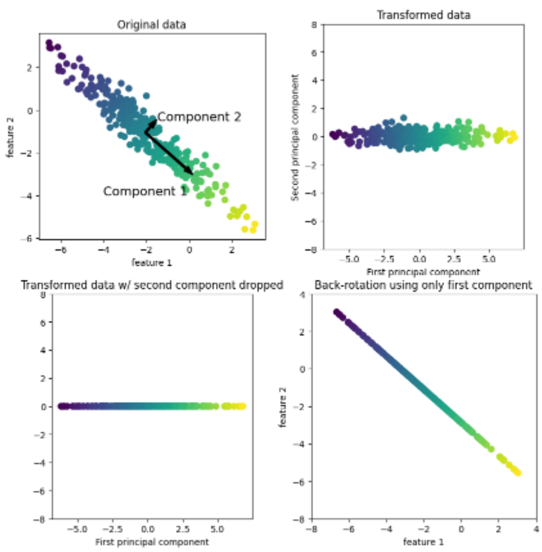

Figure 9: Splitting the dataset

(Source: Self-created)

These are the PCA plots of the dataset which are done to extract the different details about the dataset and to implement the different analysis techniques in the dataset to do the image processing effectively and to get the recognition results correctly from the dataset.

Discussion

Implications and Applications

Successful application of real-time facial image recognition creates tremendous opportunities in the domain of health, social, economic and law enforcement agencies. Through the use of camera recognition technology, security and surveillance can improve in the realm of public safety greatly, thus by helping to identify individuals of interest quickly, streamlining the access control process and discouraging potential threats. Furthermore, a blend of facial recognition into retail spaces will create excellent customer experiences. Businesses can distinguish returning customers with individualized services, personalized suggestions, and tailored promotions which can increase the engagement factor, and ultimately result in more sales and profits.

Ethical Considerations

Real-time facial identification technology provides much more than just convenience; however, as it pertains to ethical issues and abuses of this technology, it is just as crucial. Privacy problems arise when facial recognition tools are used on an extensive scale, so that people can deprive individuals of anonymity and their right to become a witness. Additionally, the algorithms of face recognition systems may also be found to be biased and discriminatory. It is therefore important to take these into consideration. Factors such as race, genders, and ages are the things that determine whether such systems will result in inaccuracies and prejudice towards relevant groups or not. Addressing these issues implies to set up a comprehensive program, combined with strenuous governance systems; strict data guidelines and perpetual auditing of algorithms for transparency and fairness (Ning et al., 2023).

Recommendation

While real-time facial recognition has progressed significantly, it still can be better and enhanced further. Reinforced research initiatives need to concentrate on improving the precision and effectiveness of the algorithm, especially in disastrous confrontations such as occlusion, the change of lighting, and a diverse ethnic background. Furthermore, the incorporation of facial recognition technique together with other biometric modalities including eye, or gait recognition, would make the overall effectiveness of the system very high and could not be doubted. Whilst technology is developing by leaps and bounds, it is crucial that the good of this real time image recognition of faces should be weighed against the ethical and society implications that come with it. A collaborative work of researchers, policymakers and industry stakeholders is very relevant to have a responsible and equitable introduction of that technology.

Future Directions

A real-time face recognition system which has proved itself as being a promising solution still has many aspects of improvement and areas for exploration. The focal point may involve multimodal biometric recognition technologies, for example the combination of facial features with a different input: voice, gait, or iris patterns. This multimodal technique could lead to an improvement of the system accuracy and could solve the problems of occlusions and variable light conditions especially in challenging situations (Jahan et al., 2023). Likewise, the breakthrough of privacy-protecting methods, e.g. homomorphic encryption or differential privacy, could efficiently address the issue of data privacy and security. These approaches could support facial identification without resorting to sharing the personal information of people. Additionally, the investigation of federated learning and decentralized models support the collaborative training of facial recognition without leaking data privacy and the reduction of centralized data control. In this regard, on-going research efforts need to be devoted to easing biases and be certain when it comes to facial recognition systems through the use of techniques such as adversarial training, data augmentation, and algorithmic auditing.

5. Conclusion

High-level technologies which employ trueface image recognition through computational algorithms are something which offers unimaginable opportunities to a variety of industries. This methodology presents the ability of this technology, delivering high accuracy and suitability for real-life applications. Nevertheless, it is too important to indicate the ethical and societal implications, and so this should be done appropriately in order to protect the privacy, fairness and careful deployment. Further efforts of research, joint actions and strong regulating systems are indispensable for fully utilizing facial recognition technology in real time without its side effects. Through the careful calibration of such technology, security, personalization and consequently societal well-being can achieve an admirable equilibrium.

References

[1] Bansal, N., Aljrees, T., Yadav, D.P., Singh, K.U., Kumar, A., Verma, G.K. and Singh, T., 2023. Real-time advanced computational intelligence for deep fake video detection. Applied Sciences, 13(5), p.3095.

[2] Chen, Z., Chen, J., Ding, G. and Huang, H., 2023. A lightweight CNN-based algorithm and implementation on embedded system for real-time face recognition. Multimedia Systems, 29(1), pp.129-138.

[3] Cheng, Q., Wang, H., Zhu, B., Shi, Y. and Xie, B., 2023. A real-time uav target detection algorithm based on edge computing. Drones, 7(2), p.95.
[4] Goel, A., Goel, A.K. and Kumar, A., 2023. The role of artificial neural network and machine learning in utilizing spatial information. Spatial Information Research, 31(3), pp.275-285.
[5] Jahan, I., Uddin, K.A., Murad, S.A., Miah, M.S.U., Khan, T.Z., Masud, M., Aljahdali, S. and Bairagi, A.K., 2023. 4D: a real-time driver drowsiness detector using deep learning. Electronics, 12(1), p.235.
[6] Jahan, I., Uddin, K.M.A., Murad, S.A., Miah, M.S.U., Khan, T.Z., Masud, M., Aljahdali, S. and Bairagi, A.K., 2023. 4D: A Real-Time Driver Drowsiness Detector Using Deep Learning. Electronics 2023, 12, 235.
[7] Kaur, G., Sinha, R., Tiwari, P.K., Yadav, S.K., Pandey, P., Raj, R., Vashisth, A. and Rakhra, M., 2022. Face mask recognition system using CNN model. *Neuroscience Informatics*, *2*(3), p.100035.
[8] Kumar, B.A. and Bansal, M., 2023. Face mask detection on photo and real-time video images using Caffe-MobileNetV2 transfer learning. Applied Sciences, 13(2), p.935.
[9] Liu, Y., Duan, S., Shen, Z., He, Z. and Li, L., 2023. Grasp and Inspection of Mechanical Parts based on Visual Image Recognition Technology. Journal of Theory and Practice of Engineering Science, 3(12), pp.22-28.
[10] Ning, X., Tian, W., He, F., Bai, X., Sun, L. and Li, W., 2023. Hyper-sausage coverage function neuron model and learning algorithm for image classification. Pattern Recognition, 136, p.109216.
[11] Ruby, U. and Yendapalli, V., 2020. Binary cross entropy with deep learning technique for image classification. *Int. J. Adv. Trends Comput. Sci. Eng*, *9*(10).
[12] Safarov, F., Akhmedov, F., Abdusalomov, A.B., Nasimov, R. and Cho, Y.I., 2023. Real-time deep learning-based drowsiness detection: leveraging computer-vision and eye-blink analyses for enhanced road safety. Sensors, 23(14), p.6459.
[13] Takikawa, T., Litalien, J., Yin, K., Kreis, K., Loop, C., Nowrouzezahrai, D., Jacobson, A., McGuire, M. and Fidler, S., 2021. Neural geometric level of detail: Real-time rendering with implicit 3d shapes. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* (pp. 11358-11367).
[14] Talaat, F.M., 2023. Real-time facial emotion recognition system among children with autism based on deep learning and IoT. Neural Computing and Applications, 35(17), pp.12717-12728.
[15] Umer, M., Sadiq, S., Alhebshi, R.M., Alsubai, S., Al Hejaili, A., Nappi, M. and Ashraf, I., 2023. Face mask detection using deep convolutional neural network and multi-stage image processing. Image and Vision Computing, 133, p.104657.
[16] William, P., Shrivastava, A., Shunmuga Karpagam, N., Mohanaprakash, T.A., Tongkachok, K. and Kumar, K., 2023. Crime analysis using computer vision approach with machine learning. In Mobile Radio Communications and 5G Networks: Proceedings of Third MRCN 2022 (pp. 297-315). Singapore: Springer Nature Singapore.
[17] Yang, H. and Han, X., 2020. Face recognition attendance system based on real-time video processing. *IEEE Access*, *8*, pp.159143-159150.
[18] Zahara, L., Musa, P., Wibowo, E.P., Karim, I. and Musa, S.B., 2020, November. The facial emotion recognition (FER-2013) dataset for prediction system of micro-expressions face using the convolutional neural network (CNN) algorithm based Raspberry Pi. In *2020 Fifth international conference on informatics and computing (ICIC)* (pp. 1-9). IEEE.
[19] Hussain, S.A. and Al Balushi, A.S.A., 2020. A real time face emotion classification and recognition using deep learning model. In *Journal of physics: Conference series* (Vol. 1432, No. 1, p. 012087). IOP Publishing.