



HELMET DETECTION USING MACHINE LEARNING

¹Chaitanya Srusti, ²Vibhav Deo, ³Dr. Rupesh C. Jaiswal

¹Student, ²Student, ³Professor

^{1,2,3}Department of Electronics and Telecommunication,

^{1,2,3}SCTR's Pune Institute of Computer Technology, Pune, India.

ABSTRACT: - In many nations, motorcycles are a common form of transportation. However, riding a motorcycle comes with a great risk when the correct safety equipment is not used. Therefore, wearing a helmet is highly recommended to promote safety while riding a bike. It is vital to build an autonomous helmet detection system that can identify the offenders on motorcycles in order to eliminate this manual dependency. Many riders choose not to wear helmets while riding two-wheelers or only do so when there are traffic police present. The goal of this study is to create a real-time autonomous system utilizing the YOLO deep learning method. A form of CNN called YOLO is suitable for real-time object detection.

1. KEYWORDS

CNN-Convolutional Neural Network, R-CNN-Region based CNN, YOLO-You Only Look Once, SVM-Support Vector Machine, IDE-Integrated Development Environment, CCTV-Closed Circuit Television

2. INTRODUCTION

In India majority of the vehicles owned are two-wheelers and people tend to ignore the safety gears while riding motorcycles. Consequently, most of the accidents caused in India are due to motorcycles, almost over 63% of accidents involve a motorcycle. These numbers seem more alarming as the reports suggest that every hour average of 67 accidents take place, where almost 20 people die in those 67 accidents. In order to reduce the fatality of these accidents, the government has mandated helmets while driving bikes. The manual strategies to catch violators have several drawbacks such as interrupting traffic flow, unpleasant weather conditions for police personnel, etc.

Many strategies have been proposed in recent years to handle the challenge of object detection. Background subtraction was utilized by A. Adam et al. [7] to identify and differentiate between moving vehicles. They used SVM to categorize helmets in this instance. Waranusat et al. [4] classified helmets using a technique to detect moving objects based on a k-NN classifier. The degree of precision that might be attained by these models, which were postulated based on statistical data from photographs, was constrained. With the evolution of neural networks and deep learning models there was further improvement in the accuracy of classification. A CNN-based technique for object recognition and classification was

introduced by Alex et al. A. Hirota et al. [6] classified riders using a CNN. Even when they employ CNN, the precision of their helmet detection is limited to coloured helmets and the number of riders on a single motorcycle.

Also, role of ML and ESPs [13-72] are becoming important in recent applications, recognition and control.

We develop our model using a CNN extension known as YOLO due of its remarkable feature extraction capacity. This paper walks you through the process of implementing an autonomous helmet identification model that is trained with the DarkFlow framework and flags riders who are not wearing helmets.

3. PROPOSED WORK

BLOCK DIAGRAM

I. Video Processing and Image Extraction

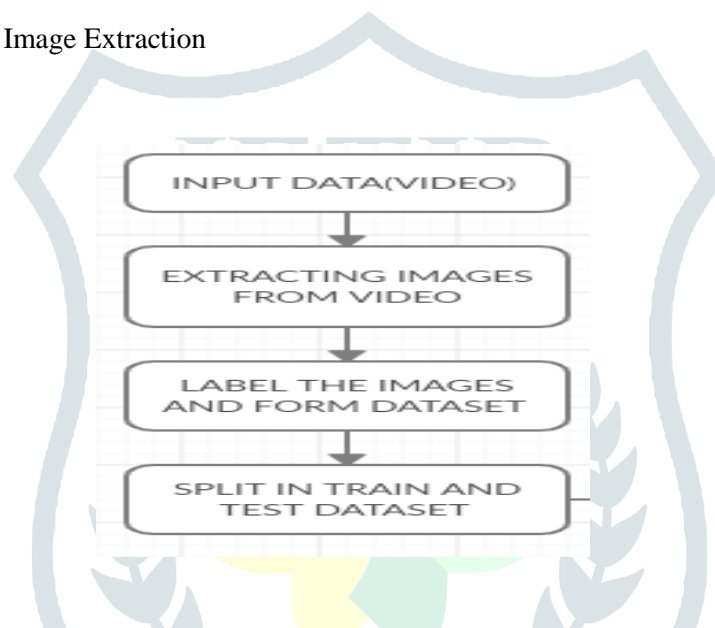


Fig.1. Video Processing and Image Extraction

In this stage, we create our own dataset of images with riders with and without helmet on a bike. The input video is from CCTV footages around our campus and societies. Using a Python script, the images are extracted at specific frames of the video which have people riding bike. This script also labels images as per our requirement into two groups (People wearing helmets and people not wearing helmet). After that, we split these images into train and test dataset in 4:1 ratio.

II. Model Training

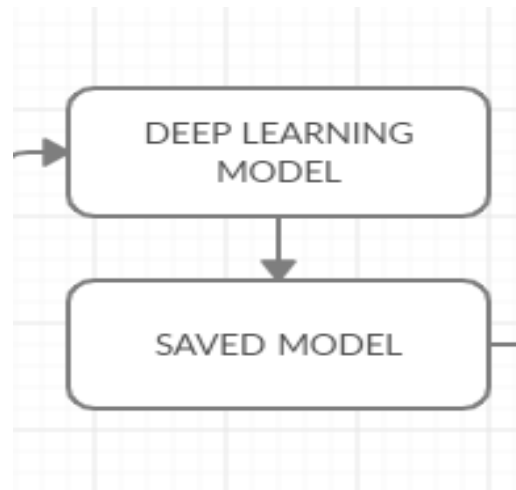


Fig.2. Model Training Process

In this stage, a major concern was training a completely new model on our dataset, which would have costed us a lot of compute resources (heavy GPUs), to avoid this expensive affair we adopted the approach of “Transfer Learning” where a pre-trained model used to detect simple objects using YOLO algorithm was used as our base. On top of that, we used the custom-made dataset to train this model so as it would work in the situation we desire. The essence of Transfer Learning is to tweak the weights of the end layers to work as per our need.

III. Helmet Detection (using YOLO)

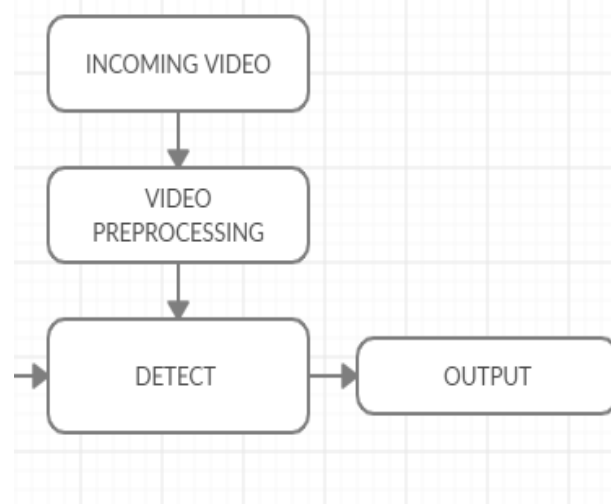


Fig.3. Process of Helmet Detection

Here, the incoming video is imported into the model using the OpenCV library of Python. The video is split into frames which are passed on to the model for detection. These frames are fed to the model, which was trained on the custom-made dataset to detect people wearing helmets and red flag the violators. A key thing to note here is, the YOLO algorithm only propagates through many layers of the neural network only once for each image (frame) to detect the violators. This greatly increases the speed by which the model works.

4. RESULTS AND ANALYSIS



Fig. 4 Accurate prediction on pre-recorded video



Fig. 5 Accurate prediction in a real time video input.

The proposed work successfully detects helmets on riders, Figure 5 shows us that our model ignores the pedestrians on road while detecting the rider wearing helmet which is desirable. Also, Figure 6 shows us that our model can easily discriminate among riders wearing and not wearing helmets in a single frame.

5. PERFORMANCE EVALUATION

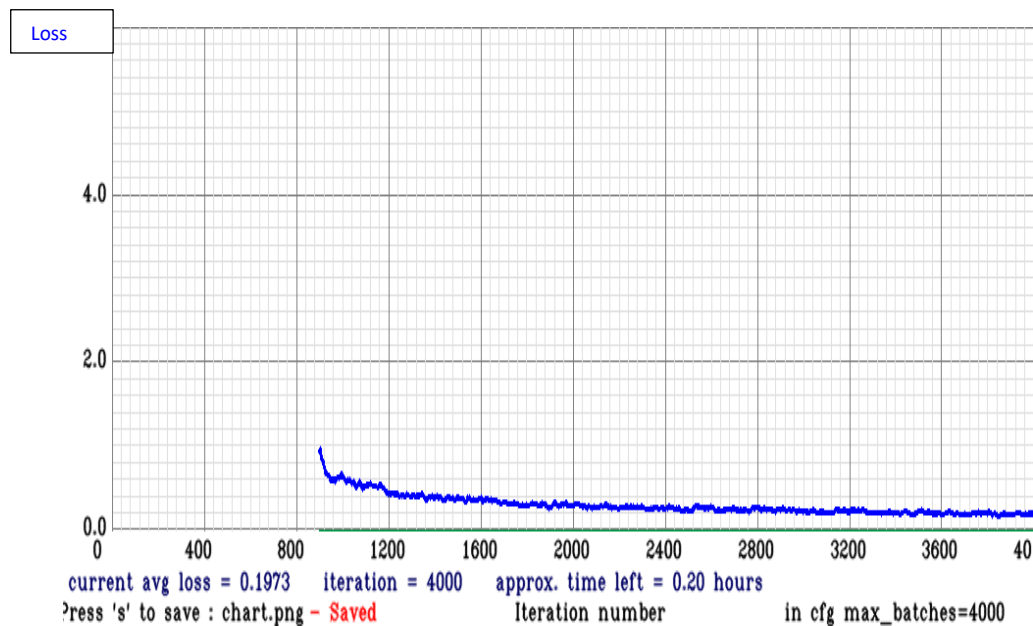


Fig.6. Model Average Loss Vs Iteration

```

calculation mAP (mean average precision)...
Detection layer: 82 - type = 28
Detection layer: 94 - type = 28
Detection layer: 106 - type = 28
836
detections_count = 1545, unique_truth_count = 1063
class_id = 0, name = helmet, ap = 98.31%      (TP = 619, FP = 22)
class_id = 1, name = noHelmet, ap = 94.03%   (TP = 405, FP = 27)

for conf_thresh = 0.25, precision = 0.95, recall = 0.96, F1-score = 0.96
for conf_thresh = 0.25, TP = 1024, FP = 49, FN = 39, average IoU = 73.52 %

IoU threshold = 50 %, used Area-Under-Curve for each unique Recall
mean average precision (mAP@0.50) = 0.961723, or 96.17 %
Total Detection Time: 533 Seconds

```

Fig. 7 mAP (Model Average Prediction) for Test Images

Figure 6 Shows us the model had a final average loss of 0.197 after training the model through 4000 iterations. Figure 7 Calculates the mAP of the model. mAP is a metric to find the accuracy of the model to detect a particular object. It compares the original bounding box value with the detected bounding box and returns a score, hence higher the mAP higher the accuracy. We can see from the Figure 8 that our model depicts accuracy of about 96% and an average detection time of 1.35 seconds, which is impressive for real time scenarios.

CONCLUSION

A reliable method to identify and flag motorcycle riders who are not wearing helmets is provided by the model described in this research. The ingenious approach to train the neural network using Transfer Learning technique along with the usage of open-source libraries in the code allows for the development of a cost-effective system to assist personnel to catch violators. YOLO algorithm used in our model shows us promising results, demonstrating its applicability in real-world situations. The outcome of this study can be utilized as the foundation for integrating this technology with fully autonomous systems, such as drones, to enable their operation in a wholly independent manner.

ACKNOWLEDGEMENT

We would like to thank all the members who have helped me in completing this research work and paper. We express our heartiest gratitude to Dr. Rupesh Jaiswal Sir for providing me all guidance to complete our research work. Finally last but not least we would like to thank all our friends and family members and other all members who have directly or indirectly contributed in successful completion of this research work.

REFERENCES

- [1] K. Dahiya, D. Singh, and C. K. Mohan, "Automatic detection of bikeriders without helmet using surveillance videos in real-time," in Proc. Int. Joint Conf. Neural Networks (IJCNN), Vancouver, Canada, 24–29 July 2017, pp. 3046–3051.
- [2] R. V. Silva, T. Aires, and V. Rodrigo, "Helmet detection on motorcyclists using image descriptors and classifiers," in Proc. Graphics, Patterns and Images (SIBGRAPI), Rio de Janeiro, Brazil, 27–30 August 2016, pp. 141–148.
- [3] A. H. M. Rubaiyat, T. T. Toma, M. Kalantari-Khandani et al., "Automatic detection of helmet uses for construction safety," in *Proceedings of the 2016 IEEE ACM International Conference on Web Intelligence Workshops (WIW)*, ACM, Omaha, NE, USA, October 2016.
- [4] R. Waranusast, N. Bundon, V. Timtong, C. Tangnoi, and P. Pattanathaburt, "Machine vision techniques for motorcycle safety helmet detection," in *Proceedings of the Image & Vision Computing New Zealand*, IEEE, Wellington, New Zealand, November 2013.
- [5] "TensorFlow Lite- Deploy machine learning models" <https://www.tensorflow.org>.
- [6] Atsushi Hirota, Nguyen Huy Tiep, Le Van Khanh and Natsuki Ok, "Classifying Helmeted and Non-helmeted Motorcyclists" ISSN 2017
- [7] A. Adam, E. Rivlin, Shimshoni and D. Reintiz "Robust Real Time Unusual Event Detection", March 2008
- [8] L. Ding, W. Fang, H. Luo, P. E. D. Love, B. Zhong, and X. Ouyang, "A deep hybrid learning model to detect unsafe behavior: integrating convolution neural networks and long short-term memory," *Automation in Construction*, vol. 86, pp. 118–124, 2018.
- [9] Z. Q. Zhao, P. Zheng, S. T. Xu and X. Wu, "Object Detection with Deep Learning: A Review", *IEEE Trans. Neural Networks Learn. Syst.*, vol. 30, no. 11, pp. 3212-3232, 2019.
- [10] R. L. Galvez, A. A. Bandala, E. P. Dadios, R. R. P. Vicerra and J. M. Z. Maningo, "Object Detection Using Convolutional Neural Networks", *IEEE Reg. 10 Annu. Int. Conf. Proceedings/TENCON*, vol. 2018, pp. 2023-2027, October 2019.
- [11] J. Redmon and A. Farhadi, *YOLOv3: An Incremental Improvement*, 2018.
- [12] http://cs231n.stanford.edu/slides/2017/cs231n_2017_lecture11.pdf.
- [13] Jaiswal R.C. and Lokhande S.D., "Systematic Performance Analysis of Bit-Torrent Traffic", *Helix Vol. 9 (2)*: pp. 4858- 4863, DOI 10.29042/2019-4858-4863, April 2019.
- [14] Jaiswal R.C. and Aishwarya Gaikwad, "Experimental Analysis of Bit torrent Traffic based on Heavy-Tailed Probability Distributions", *International Journal of Computer Applications*, ISSN No. (0975 – 8887), Impact Factor .3.1579(2016), Volume 155 – No 2, December 2016.
- [15] Jaiswal R.C. and Lokhande S.D., "Evaluation of Effect of Seeds and downloaders on the Performance of Bit Torrent Network using Markov Chain Modelling", *Journal of Communication Engineering & Systems*, Volume 6, Issue 1. (ISSN: 2321-5151 (print version), ISSN: 2249-8613 (electronic version) IF (2016): 0.709).
- [16] Jaiswal R.C. and Lokhande S.D., A. Ahmed, P. Mahajan, "Performance Evaluation of Clustering Algorithms for IP Traffic Recognition", *International Journal of Science and Research (IJSR)*, volume-4, Issue-5, May-2015, pp. 2786-2792. (ISSN (Online): 2319-7064, Index Copernicus Value (2013): 6.14|Impact Factor (2013):4.438
- [17] Jaiswal R.C. and Lokhande S.D., Gulavani Aditya "Implementation and Analysis of DoS Attack Detection Algorithms", *International Journal of Science and Research (IJSR)*, volume-4, Issue-5, May-2015, pp. 2085-2089. (ISSN (Online): 2319-7064, Index Copernicus Value (2013): 6.14 | Impact Factor (2013):4.438
- [18] Jaiswal R.C. and Lokhande S.D., "Performance Analysis for IPv4 and IPv6 Internet Traffic", *ICTACT Journal on Communication Technology*, September 2015, volume: 06, issue: 04, pp. 1208-1217. (Print: ISSN: 0976-0091, Online ISSN:2229-6948 (Impact Factor: 0.789 in 2015).
- [19] Jaiswal R.C. and Lokhande S.D., "Performance Evaluation of Wireless Networks", *Coimbatore Institute of Information Technology International Journal*, volume-7, Issue-8, July-2015, pp. 1237-1242. (Print: ISSN 0974 – 9616 |Impact Factor: 0.572)
- [20] Jaiswal R.C. and Lokhande S.D., "A Novel Approach for Real Time Internet Traffic Classification", *ICTACT Journal on Communication Technology*, September 2015, volume: 06, issue: 03, pp. 1160-1166. (Print: ISSN: 0976-0091, Online ISSN:2229-6948 (Impact Factor: 0.789 in 2015).
- [21] Jaiswal R.C. and Lokhande S.D., "Measurement, Modeling and Analysis of HTTP Web Traffic", *IMCIET-International Multi Conference on Innovations in Engineering and Technology-ICCC-International Conference on Communication and Computing -2014*, PP-242-258, ISBN:9789351072690, VVIT, Bangalore.
- [22] Jaiswal R.C. and Lokhande S.D., "Comparative Analysis using Bagging, Logit Boost and Rotation Forest Machine Learning Algorithms for Real Time Internet Traffic Classification", *IMCIP-International Multi Conference on Information Processing –ICDMW- International Conference on Data Mining and*

- Warehousing-2014, PP113-124, ISBN: 9789351072539, University Visvesvaraya College of Engg. Department of Computer Science and Engineering Bangalore University, Bangalore.
- [23] Jaiswal R.C. and Lokhande S.D, "Statistical Features Processing Based Real Time Internet Traffic Recognition and Comparative Study of Six Machine Learning Techniques", IMCIP- International Multi Conference on Information Processing-(ICCN- International Conference on Communication Networks-2014, PP-120-129, ISBN: 9789351072515, University Visvesvaraya College of Engg. Department of Computer Science and Engineering Bangalore University, Bangalore.
- [24] Jaiswal R.C. and Lokhande S.D, "Analysis of Early Traffic Processing and Comparison of Machine Learning Algorithms for Real Time Internet Traffic Identification Using Statistical Approach", ICACNI-2014-International Conference on Advanced Computing, Networking, and Informatics), Kolkata, India, DOI: 10.1007/978-3-319-07350-7_64, Volume 28 of the book series Smart Innovation, Systems and Technologies (SIST),Page:577-587.
- [25] Jaiswal R.C. and Lokhande S.D, "Machine Learning Based Internet Traffic Recognition with Statistical Approach", INDICON-2013-IIT Bombay IEEE Conference. Inspec Accession Number: 14062512, DOI: 10.1109/INDCON.2013.6726074.
- [26] Jaiswal R. C. and Manasi Satpute, "Machine Learning Based Car Damage Identification", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 10 pp. b684-b690, October 2022.
- [27] Jaiswal R.C. and Aryan Bagade, "Metaverse Simulation Based on VR, Blockchain, and Reinforcement Learning Model", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.538, Volume 10 Issue X, pp. 67-75, October 2022.
- [28] Jaiswal R. C. and Atharva Agashe, "A Survey Paper on Cloud Computing and Migration to the Cloud", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 10 pp. a258-a265, October 2022.
- [29] Jaiswal R. C. and Taher Saraf, "Stock Price Prediction using Machine Learning", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 9 pp. e33-e41, September 2022.
- [30] Jaiswal R. C. and Ritik Manghani, "Pneumonia Detection using X-rays Image Preprocessing", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 9 pp. c653-c662, September 2022.
- [31] Jaiswal R. C. and Apoorva Ushire, "Real Time Water Monitoring System Using NodeMCU ESP8266", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 9 pp. c1-c8, September 2022.
- [32] Jaiswal R. C. and Firoz Saherawala, "Smart Glasses", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 8 pp. f393-f401, August 2022.
- [33] Jaiswal R. C. and Asawari Walkade, "Denial of Service Detection and Mitigation", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 5 pp. f108-f116, May 2022.
- [34] Jaiswal R. C. and Fiza Shaikh, "Augmented Reality based Car Manual System", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 5 pp. c326-c332, May 2022.
- [35] Jaiswal R. C. and Tejveer Pratap, "Multiparametric Monitoring of Vital Signs in Clinical and Home Settings for Patients", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 5 pp. a701-a705, May 2022.
- [36] Jaiswal R. C. and Sahil Nahar, "Recognition and Selection of Learning Styles to Personalize Courses for Students", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 2 pp. b235-b252, February 2022.
- [37] Jaiswal R. C. and Rushikesh Karwankar, "Demand Forecasting for Inventory Optimization", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 12 pp. 121-131, January 2022.
- [38] Jaiswal R. C. and P. Khore, "Exo-skeleton Arm", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 12 pp. 731-734, December 2021.
- [39] Jaiswal R. C. and Shreyas Nazare, "IoT Based Home Automation System", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 11 pp. 151-153, November 2021.
- [40] Jaiswal R. C. and Prajwal Pitlehra, "Credit Analysis Using K-Nearest Neighbours' Model", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 5, pp. 504-511, May 2021.
- [41] Jaiswal R. C. and Rohit Barve, "Energy Harvesting System Using Dynamo", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 5, pp. 278-280, May 2021.
- [42] Jaiswal R. C. and Sharvari Doifode, "Virtual Assistant", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 10, pp. 3527-3532, October 2020.
- [43] Jaiswal R. C. and Akshat Kaushik, "Automated Attendance Monitoring system using discriminative Local Binary Histograms and PostgreSQL", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 11, pp. 80-86, November 2020.
- [44] Jaiswal R. C. and Danish Khan, "Arduino based Weather Monitoring and Forecasting System using SARIMA Time-Series Forecasting", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 11, pp. 1149-1154, November 2020.
- [45] Jaiswal R.C. and Param Jain, "Augmented Reality based Attendee Interaction at Events", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.429, Volume 8 Issue VI, pp. 1578-1582, June 2020.
- [46] Jaiswal R.C. and Akash Pal, "Cosmetics Application Using Computer Vision", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 6, pp. 824-829, June 2020.
- [47] Jaiswal R.C. and Jaydeep Bhoite, "Home Renovation Using Augmented Reality", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 6, pp. 682-686, June 2020.
- [48] Jaiswal R.C. and Aashay Pawar, "Stock Market Study Using Supervised Machine Learning", International Journal of Innovative Science and Research Technology (IJISRT), Open Access, Peer Reviewed and refereed Journal, ISSN: 2456-2165; IC Value: 45.98; SJ Impact Factor:6.253, Volume 5 Issue I, pp. 190-193, Jan 2020.
- [49] Jaiswal R.C. and Deepali Kasture, "Pillars of Object-Oriented System", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.177, Volume 7 Issue XI, pp. 589-591, Nov 2019.
- [50] Jaiswal R.C. and Yash Govilkar, "A Gesture Based Home Automation System", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.177, Volume 7 Issue XI, pp. 501-503, Nov 2019.
- [51] Jaiswal R.C. and Onkar Gagare, "Head Mounted Display", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.177, Volume 7 Issue XI, pp. 535-541, Nov 2019.
- [52] Jaiswal R.C. and Nehal Borole, "Autonomous Vehicle Prototype Development and Navigation using ROS", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.177, Volume 7 Issue XI, pp. 510-514, Nov 2019.

- [53] Jaiswal R.C. and Vaibhav Pawar, "Voice and Android Application Controlled Wheelchair", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Volume 6, Issue 6, pp. 635-637, June 2019.
- [54] Jaiswal R.C. and Shreya Mondhe, "Waste Segregation & Tracking", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.429, Volume 8, Issue 5, pp. 2085-2087, May 2019.
- [55] Jaiswal R.C. and Shreya Mondhe, "Stock Market Prediction Using Machine Learning & Robotic Process Automation", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Volume 6, Issue 6, pp. 926-929, February 2019.
- [56] Jaiswal R.C. and Samruddhi Sonare, "Smart Supervision Security System Using Raspberry Pi", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162, Volume 6, Issue 4, pp. 574-579, April 2019.
- [57] Jaiswal R.C. and Manasi Jagtap, "Automatic Car Fragrance Dispensing System", International Journal of Research and Analytical Reviews (IJRAR), ISSN-2349-5138, Volume 6, Issue 1, pp. 315-319, March 2019.
- [58] Jaiswal R.C. and Sumukh Ballal, "Scalable Healthcare Sensor Network", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162, Volume 6, Issue 2, pp. 350-354, February 2019.
- [59] Jaiswal R.C. and Samruddhi Sonare, "Multiple Camera Based Surveillance System Using Raspberry Pi", International Journal of Research and Analytical Reviews (IJRAR), ISSN-2348-1269, Volume 6, Issue 1, pp. 1635-1637, February 2019.
- [60] Jaiswal R.C. and Reha Musale, "Application of Digital Signature to Achieve Secure Transmission", International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887, Volume 7 Issue II, pp. 150-153, February 2019.
- [61] Jaiswal R.C. and Himanshu Mithawala, "Automatic Gate Monitoring System", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162, Volume 5, Issue 1, pp. 88-94, January 2019.
- [62] Jaiswal R.C. and Bernard Lewis, "Dynamic Runway and Gate Terminal Allocation for Flights", Journal of Emerging Technologies and Innovative Research (JETIR), UGC approved Journal, ISSN-2349-5162, Volume 5, Issue 12, December 2018.
- [63] Jaiswal R.C. and Sakshi Jain, "Text Search Engine", Journal of Emerging Technologies and Innovative Research (JETIR), UGC approved Journal ISSN-2349-5162, Volume 5, Issue 11, November 2018.
- [64] Jaiswal R.C. and Arti Gurap, "Design of Different Configurations of Truncated Rectangular Microstrip Patch Antenna For 2.4 GHz And 1.6 GHz", Journal of Emerging Technologies and Innovative Research (JETIR), UGC Approved Journal, ISSN-2349-5162, Volume 5, Issue 10, October 2018.
- [65] Jaiswal R.C. and Atharva Mahindrakar, "Mine Warfare and Surveillance Rover", International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887, Volume 6 Issue III, March 2018.
- [66] Jaiswal R.C. and Saloni Takawale "Multi-Client Server Communication Enhancement through Intranet", International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; UGC approved Journal, IC Value: 45.98; SJ Impact Factor :6.887, Volume 6 Issue 1, January 2018.
- [67] Jaiswal R.C. and Nikita Kakade, "Skin disease detection and classification using Image Processing Techniques", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162; UGC approved Journal:5.87, Volume 4, Issue 12, December 2017.
- [68] Jaiswal R.C. and Nikita Kakade, "OMR Sheet Evaluation Using Image Processing", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162; UGC approved Journal:5.87, Volume 4, Issue 12, December 2017.
- [69] Jaiswal R.C. and Swapnil Shah, "Customer Decision Support System", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056; p-ISSN: 2395-0072; UGC approved Journal, SJ Impact Factor:5.181, Volume: 04 Issue: 10 | Oct -2017.
- [70] Jaiswal R.C. and Ketan Deshpande, "IOT Based Smart City: Weather, Traffic and Pollution Monitoring System", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056; p-ISSN: 2395-0072; UGC approved Journal, SJ Impact Factor:5.181, Volume: 04 Issue: 10 | Oct -2017.
- [71] Jaiswal R.C. and Vipul Phulphagar, "Arduino Controlled Weight Monitoring With Dashboard Analysis", International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; UGC approved Journal, IC Value: 45.98; SJ Impact Factor:6.887, Volume 5 Issue XI November 2017.
- [72] Jaiswal R.C. and Siddhant Sribhashyam, "Comparison of Routing Algorithms using Riverbed Modeler", International Journal of Advanced Research in Computer and Communication Engineering (IJARCCCE), ISSN: (Online) 2278-1021; online) 2278-1021 ISSN (Print) 2319 5940; UGC approved Journal, Impact Factor 5.947 Vol. 6, Issue 6, June 2017.