Applying deep learning algorithm to maintain social distance in public place through drone technology

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Abstract

Purpose – The purpose of this paper is to inspect whether the people in a public place maintain social distancing. It also checks whether every individual is wearing face mask. If both are not done, the drone sends alarm signal to nearby police station and also give alarm to the public. In addition, it also carries masks and drop them to the needed people. Nearby, traffic police will also be identified and deliver water packet and mask to them if needed.

Design/methodology/approach – The proposed system uses an automated drone which is used to perform the inspection process. First, the drone is being constructed by considering the parameters such as components selection, payload calculation and then assembling the drone components and connecting the drone with the mission planner software for calibrating the drone for its stability. The trained yolov3 algorithm with the custom data set is being embedded in the drone's camera. The drone camera runs the yolov3 algorithm and detects the social distance is maintained or not and whether the people in public is wearing masks. This process is carried out by the drone automatically.

Findings – The proposed system delivers masks to people who are not wearing masks and tells importance of masks and social distancing. Thus, this proposed system would work in an efficient manner after the lockdown period ends and helps in easy social distance inspection in an automatic manner. The algorithm can be embedded in public cameras and then details can be fetched to the camera unit same as the drone unit which receives details from the drone location details and store it in database. Thus, the proposed system favours the society by saving time and helps in lowering the spread of corona virus.

Practical implications – It can be implemented practically after lockdown to inspect people in public gatherings, shopping malls, etc.

Social implications – Automated inspection reduces manpower to inspect the public and also can be used in any place.

Originality/value – This is the original project done with the help of under graduate students of third year B.E. CSE. The system was tested and validated for accuracy with real data.

Keywords Deep learning, Drone, Social distancing, Covid19, Novel corona virus, Drone unit

Paper type Research paper

1. Introduction

Covid 19 has affected many countries starting from Wuhan, a small place in China, and then it started spreading to many countries world-wide. The government introduced various measures to control the Covid-19 pandemic situation. But day by day, the virus infection increases in a consistent manner. Many organisations today is looking forward to adapt to automation, and many fields have changed their work lifestyle in an automated manner. There are many measures taken by the government to reduce the spread. The government

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has arranged various beds, ventilators and masks for the Covid-infected patients and implemented lockdown across the whole country. It allotted police in each area which was divided into separate zones and were kept in surveillance. The areas were being sprayed with disinfectants as well as insecticides. The areas affected by corona virus were sealed and people were warned not to come outside. Though government had framed various rules, many people violate the rules and do not follow the rules. During lockdown period, many people who violated the rules were arrested, and many cases were filed on many people and the vehicles were confiscated. Though the rules are being followed and some do not follow, the virus infection spread is being constantly increasing day by day. Many people do not follow social distancing and do not wear masks, and this leads to major problem. The government has instructed and framed a rule stating that people who go out to buy essential items should follow one-meter distance between other people and to wear a mask. As people violate the rules, the virus spread increases day by day. If this problem persists, then the measures taken by government as well as police will go in vain and lead to disastrous situation. To provide a solution to this, the proposed system uses an automated drone to perform the social distance inspection process in an automated manner. The drone uses a high-resolution camera which is used to detect people and measures the distance between them. If the distance between the people is less than one meter then the drone raises an alarm sound and alerts the people to maintain social distance at the spot itself. The drone is equipped with a box consisting of masks and a sanitizer. Then the drone detects the people who does not wear masks. If it detects the people without masks, it goes towards them and tells about the importance of wearing masks and tells about the importance of the social distancing between other people and then it instructs the people to pick a mask from the box in the drone and the drone also instructs the people to first use an sanitizer and then pick a mask. Then the drone detects for policemen, and it moves towards them and then it instructs the police to take the required eatables such as water bottle and snacks. The drone does all these activities in an automated manner. The drone performs these processes using a deep learning algorithm which performs object detection. The drone is operated by the drone unit. The drone unit consists of the controls for the drone and the automated control for the drone is being setup by the drone unit. The drone unit is maintained by drone operator. The drone is loaded with masks, eatable items in the drone unit. Then the drone's GPS module is being connected with the drone unit. The drone casts the live video detection to the drone unit where police people can view the live video through the live interface unit present in the drone unit or by installing the application and viewing the video. The drone flies to the fixed distance and then returns back to the drone unit. The proposed system uses deep learning algorithms and computer vision techniques to implement the above features inside the drone. The drone with the help of wi-fi module casts the live video to the drone unit. This helps in ensuring that the social distance is being maintained and makes sure that every people are wearing masks, and it also helps the policemen by providing them the required items needed by them. The proposed system can be applied in any place.

2. Related work

Apostolopoulos and Mpesiana (2020) have made a study on the previously used convolutional neural networks and their classification methods for the pneumonia. Two data sets were taken. The first data set has 1427 X-ray images of Covid-19 patients and second data set has 224 images of Covid-19 patients and has classified it using deep learning method and obtained an accuracy of 96.78%.

Abbas *et al.* (2020) have proposed a system for Chest X-ray technique using the image processing technique. They have used convolutional neural networks CNN and a mechanism called Decompose, Transfer and Compose (DeTraC), for the classification of the chest X-ray images. The obtained experimental results had predicted accuracy results of 95.12%. Bennett (2020) has proposed a system Smart Xray (+CT) Scan based Covid-19 virus detection. The authors had used an artificial neural network to detect the strain of the Covid-19 and used other machine learning model types to detect the corona virus disease strain.

Dabh (2016) had compared the implementation and performance with geofencing technique using Geographic positioning system or RFID. The author had compared the technologies, merits and demerits of them. Karim and Singh (2013) had proposed a design for embedded system in vehicles to detect the vehicle in case of accidents and to provide immediate medical help to the affected people. Glass *et al.* (2006) had discussed about the significance of social distancing and how maintaining social distance will help in reducing the pandemic growth rate gradually. The authors had made an exhaustive study on this in both rural and urban communities to prove the reduction in growth rate.

These studies show that the various computing technologies were used in pandemic situation to control the situation. Hence, in this paper, drone-based deep learning technique is proposed to monitor the situation in a crowded place.

3. Proposed model

The proposed system is used to monitor the people to check whether they maintain social distancing, and it also detects whether the person is wearing mask. In addition to these, it also delivers the required essential items to the policemen. The proposed system uses the Deep learning, computer vision and drone technologies to implement the proposed ideas.

The proposed system uses drone technology to inspect whether the public maintain social distancing. This system has various features embedded in the system. The drone unit will send the drone for the inspection process by setting the distance area to be monitored. The masks count, essential items count, etc., are being set by the drone unit.

Figure 1 represents the components of drone and the required software to calibrate the drone. Each of the components mentioned in Figure 1 play a vital role in functioning of the drone in an effective manner.

Some of the major important components are:

- flight battery;
- propellers;
- brushless motors;
- platform frame;
- ESC;
- telemetry data;
- PCB;
- flight controller;
- RC transmitter;
- RC receiver;
- GCS (mission planner);
- Gimbal and camera;
- GPS Modules 1 and 2; and
- Mission planner software.

Source: https://lh3.googleusercontent.com/GoP9AJhsVvei5Nwu ZsyEj3Vbch6kTLqH_p_wZeOa52dnTOe98PWnS2i1tFaKsM2wc bC-yA = s120

Figure 1.
Drone components

These components are essential for the functioning of the drone. The drone consists of battery called as LIPO battery which is essential for the flight of the drone. The power from the battery goes to the Electronic Speed Controller (ESC) which is used to distribute the power to other parts of the drone and helps in controlling the speed of the drone. The propellers are designed in such a way that the flight of drone is stable and the length between each propeller is calculated in diameter. The Flight controller is considered to be the brain of drone, which is responsible for sending instructions to the drone components. It receives the instructions from the receiver and then it sends the instruction to other components.

The drone uses brushless motors for rotating the propellers and the drone has a camera which is used to capture video as well as images and it also consists of Global Positioning System (GPS) module for locating the drone. The Mission planner is the software which is used to calibrate the drone with the help of flight controller. These are various components which supports the flight of drone. To make the drone camera to detect people who maintain social distance as well as to detect whether each person wears masks or not, the proposed system uses deep learning algorithm and computer vision technique. The proposed system uses the You Only Look Once (YOLO-v3) Algorithm which is called as object detection algorithm to detect objects in an effective manner.

The YOLO-v3 algorithm is the latest version of the yolo algorithm. This algorithm has the most advanced version of convolutional neural network of deep networks which has 53 convolutional networks and termed as Darknet-53. Each network in convolutional layer follows batch normalization and has the Leaky Rectified Linear Unit (ReLU) activation function. The output of this algorithm will be a list of bounded boxes drawn over the images with a confidence score being mentioned. Yolo-v3 algorithm consists of three anchors and the parameters such as height and width of the image are being measured. It calculates the confidence score for the predicted image and object score. The algorithm only looks the image once at a time which requires forward propagation by the neural network to make the predictions in an accurate manner. There are totally three kinds of Yolo version algorithms, namely, Yolo-v1, Yolo-v2 and Yolo-v3. In the proposed system, Yolo-v3 algorithm is used (Figure 2).

The proposed system is divided into four modules such as:

(1) building custom data set;

(2) training Yolov3 algorithm with custom data set;

(3) testing Yolov3 algorithm; and

(4) drone unit initialization and drone inspection process.

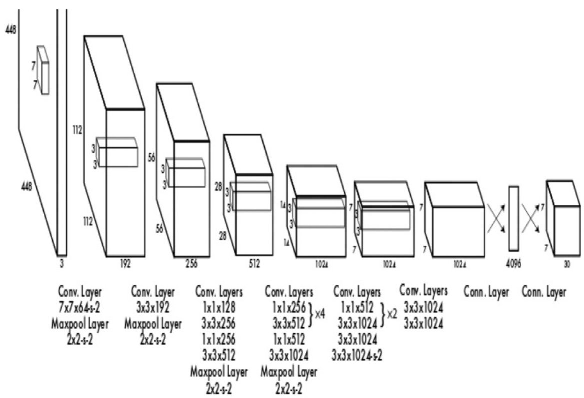
3.1 Building custom data set

The proposed system makes a custom data set which consists of the social distancing imaging and mask images which are labelled. The automatic detection of checking the social distance maintenance and checking whether people are wearing masks is done by the yolov3 algorithm.

The algorithm works based on the training data set which is provided to it. Before the images are to be labelled, the data set is being split into training data set and testing data set. The Training data set should consist of 75% images to train the algorithm efficiently and for prediction accuracy.

The Testing data set should consist of 25% images for testing the algorithm's prediction accuracy. The images in the training data set are labelled by a software tool called Microsoft Vott tool which is used to label the images with *n* number of tags. After labelling, the images can be exported to various formats such as .csv,.json formats based on the user's requirements (Figure 3).

When creating project in Vott tool, the project name should be given and the source connection and target connection should be mentioned in the settings tab. Then the tags should be added before the project starts. The tags which the proposed system uses is Mask,



Source: https://lh3.googleusercontent.com/u09BWEEhn UAKqFLfDI-rgIppkXCeKCn_EcGhvfx8FTqOym-g HSRSiDqzJD6eHon-pW7FXA = s157

Figure 2. Yolov3 algorithm architecture

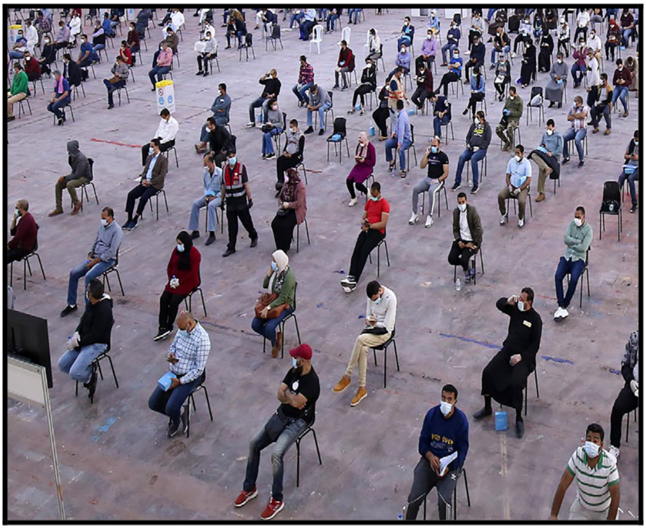


Figure 3.
Image for social distancing and wearing mask

Source: https://lh3.googleusercontent.com/UOi0vMTBzo-X_NCFvLJ_MZmVnDtQMorbNxVSRFfmz_NfWdOtUjgVhfa45dqfURD6OV_ZjAk = s134

Non mask, social distance, No social distance. After adding tag names, the project is started. The images are being loaded from the source connection, then the labelling process starts the rectangular box can be drawn over the image and then add a suitable tag name for it.

After labelling all images in the data set, the export settings are viewed and the format is to be selected as .csv format and then the labelled images with annotations.csv file will be exported to the target connection file as in Figure 4. The labelled images are stored in target connection. The file consists of annotations for the labelled images. The annotated values have to be converted into yolov3 format.

3.2 Training Yolov3 algorithm with custom data set

When the custom data set is developed, the custom data set is used to train the yolov3 algorithm as in Figure 5. The custom data set is loaded into the project directory, then the algorithm is being trained based on the labeled images.

Before training starts, the algorithm converts the labeled images into yolov3 format. It downloads pretrained yolo weights for making the algorithm's prediction efficiency in an accurate manner. After downloading the pretrained weights, the algorithm is now ready to be trained with both the yolov3 weights and the annotated images custom data set.

3.3 Testing the algorithm

Figure 6 represents the testing of the yolo algorithm. The trained custom data set and the pretrained weights are given to the algorithm and it is trained. Then the algorithm should be tested for its prediction accuracy. The test data set is provided to the algorithm. The algorithm then runs and applies the detection results over the test images. It displays a bounding box with mask, non- mask, social distance, non-social distance on the testing image.

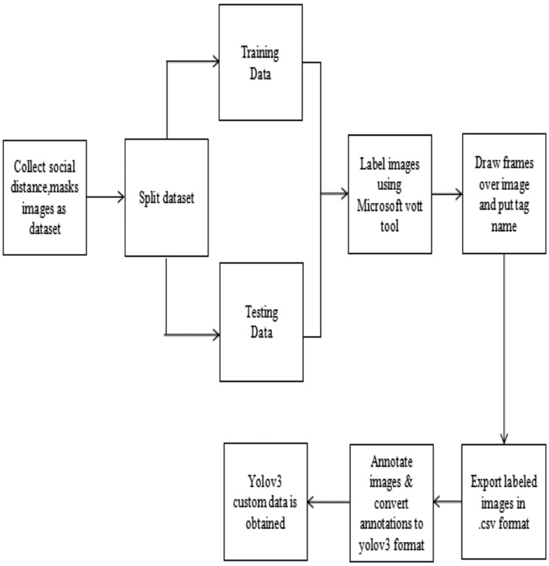


Figure 4.
Building custom data set

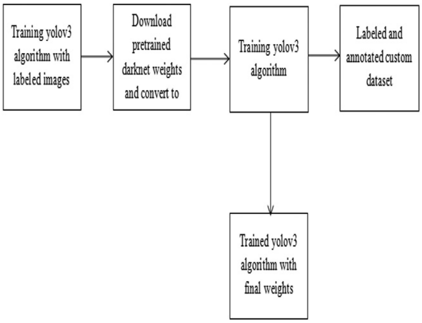


Figure 5.
Training Yolov3 algorithm with custom data set

3.4 Drone unit initialization and drone inspection

The proposed system uses an automated drone which is used to perform the inspection process. First, the drone is being constructed by considering the parameters such as components selection, payload calculation and then assembling the drone components and connecting the drone with the mission planner software for calibrating the drone for its stability.

The trained yolov3 algorithm with the custom data set is being embedded in the drone's camera. The drone camera runs the yolov3 algorithm and detects the social distance is maintained or not and whether the people in public is wearing masks. This process is carried out by the drone automatically.

As in Figure 7, the drone unit is the main unit which performs all the automation process. The drone unit consists of drone, drone unit, drone control unit, database, live interface video unit. The drone control unit is responsible for setting the drone's flight time, distance, box consisting of mask and sanitizer. The drone's camera is connected with the live interface unit present in the drone unit. The drone and the database unit are connected and as soon as drone starts video interfacing, it sends the location details and video details to the drone unit.

The officials and police can view the live video interfacing through mobile phone by installing the application or they can view the live video in the live video interface unit present in the drone unit.

The drone is set by the drone control unit by the drone operator. The automatic controls are now being setup. The GPS module is connected with the drone unit and starts sending the location details. The drone initializes and starts live video interfacing to the drone unit.

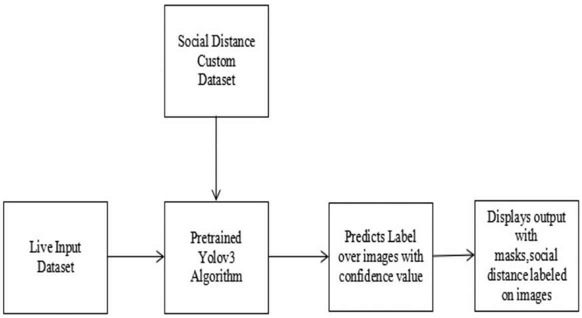


Figure 6.
Testing the algorithm

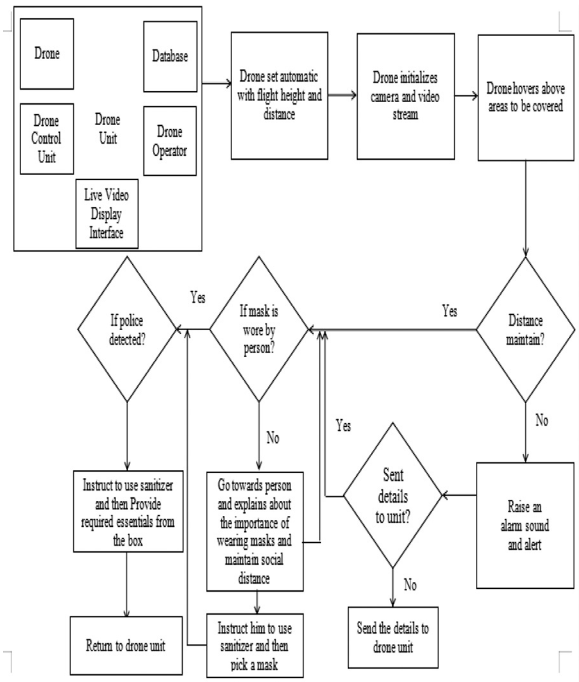


Figure 7.
Drone unit initialization and inspection process

Then the drone starts flying to the fixed level of flight and it starts applying the yolov3 algorithm and detects the person not following social distancing.

If the distance is being maintained by the people, then it checks whether people are wearing masks. If not, then the drone hovers towards the respective person and tells the importance of wearing mask and social distancing. Then it also instructs the user to use a sanitizer which is kept in the box, and then it tells the user to pick a mask and wear it. If social distance is not maintained, then the drone raises an alarm sound and instructs the people to maintain social distance. The drone simultaneously sends the location details as well as sends the video and image details to the database in the drone unit.

If police are detected, then the drone goes toward the police and asks whether they are in need of essential items. If yes, then it instructs the user to use sanitizer and then pick the required essential items. If not in need, the drone flies until the fixed distance is met and performs inspection process. If required distance is over, then it returns back to the drone unit.

4. Results and discussions

The proposed system thus starts from the collection of custom data sets and then it splits the data set into training data set and testing data set. Then the training dataset is being labelled by using the Microsoft vott tool which is used to label the images. The tags such as mask, non-mask, social distance, non-social distance is added as tags for the training data set. Then the labelled images are stored in a separate file and then that file is loaded to the project directory. Then the pretrained yolo weights are downloaded and then the images are annotated and then the algorithm is trained. The trained algorithm is now tested based on the test data set.

The trained yolo algorithm is embedded into the drone camera and then the drone unit sets the required flight time, distance to be travelled and the number of masks and the essential items are counted before putting into the box. Then the drone initializes and connects with the drone unit and initializes video stream, casts the video to live video interface and then the location details are sent to the drone unit and then the details are being stored in the database.

The proposed system is implemented by using python 3.6 language with deep learning and computer vision algorithm Yolov3 algorithm. The algorithm uses computer vision's package for image as well as video detection called OpenCV package. The algorithm is implemented using python. The drone's flight controller is optimized using software called Mission planner software.

The test images are being drawn with a bounding box with the tag name and the confidence score which is specified at the top of the box. The test images were detected with the mask, non-mask, social distance, non-social distance labelled by frames with confidence scores being displayed as in Figure 8. The proposed system works in an automated manner and helps in making the social distance inspection process automatically. The system detects the social distance and masks with an accuracy score of 0.95 with confidence score.

Figures 9 and 10 show the result of scanning the input images with the algorithm. Figure 9 shows the result after detecting the mask in the images. Figure 10 shows the result of detecting social distancing that is maintained in a public place. If mask is not seen in the faces and if social distance is not maintained, then the drone creates an alarm signal.

5. Conclusion

The proposed system delivers masks to people who are not wearing masks and tells importance of masks and social distancing. Thus, this proposed system would work in an

Figure 8.
Input image for detection

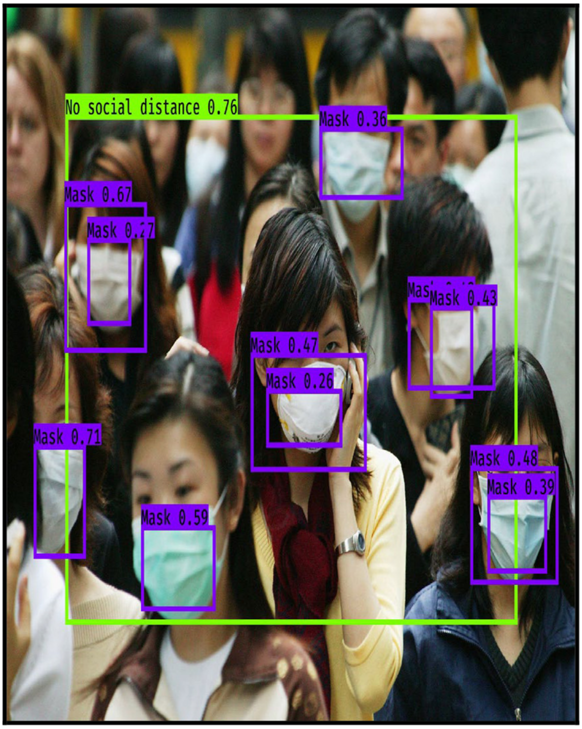


Figure 9.
Detecting mask in public place

Figure 10. Detecting social distance in public place

efficient manner after the lockdown period ends and helps in easy social distance inspection in an automatic manner. The algorithm can be embedded in public cameras and then details can be fetched to the camera unit same as the drone unit which receives details from the drone location details and store it in database. Thus, the proposed system favours the society by saving time and helps in lowering the spread of corona virus.

References

Abbas, A., Abdelsamea, M. and Gaber, M. (2020), "Classification of COVID-19 in chest X-ray images using DeTrac deep convolutional neural network", Medrxiv, doi: 10.1101/2020.03.30.20047456.

Apostolopoulos, I.D. and Mpesiana, T.A. (2020), "Covid-19: automatic detection from X-ray images utilizing transfer learning with convolutional neural networks", *Physical and Engineering Sciences in Medicine*, p. 1, doi: 10.1007/s13246-020-00865-4.

Bennett, J. (2020), "Smart AI CT scan based Coronavirus2019/Covid19 detector", available at: www.researchgate.net/publication/339300393_Smart_Ai_ct_sca

Dabh, M.D. (2016), "Geofencing: a generic approach to real- time location based tracking system", *IRACST – International Journal of Computer Networks and Wireless Communications*, Vol. 6 No. 6.

Glass, R.J., Glass, L.M., Beyeler, W.E. and Min, H.J. (2006), "Targeted social distancing design for pandemic influenza", *Emerging Infectious Diseases*, Vol. 12 No. 11, pp. 1671-1681.

Karim, D. and Singh, J. (2013), "Development of automatic geofencing and accidental monitoring system based on GPS technology", *International Journal of Computer Science, Engineering and Applications*, Vol. 3 No. 4.

Further reading

Eikkenberry, S.E., Mancuso, M., Iboi, E., Phan, T., Eikkenberry, K., Kuang, Y., Kostelich, E. and Kumel, A.G. (2020), "To mask or not to mask: modeling the potential for face mask use by the general public to curtail the COVID-19 pandemic", *Infectious Disease Modelling*, Vol. 5, pp. 293-308.

Mohite, S.P., Nair, A. and Shaikh, N. Mr. (2016), "Geofencing and location based reminder services", *International Journal of Advance Engineering and Research Development*, Vol. 3 No. 10.

Rahate, S.W., Dr. and Shaikh, M.Z. (2016), "Geo-fencing infrastructure: location based service", *International Research Journal of Engineering and Technology*, Vol. 3 No. 11.

Streed, O.J., Cliquet, G. and Kagan, A. (2015), "Optimizing geofencing for location-based services: a new application of spatial marketing", in Kubacki K. (Ed.), *Ideas in Marketing: Finding the New and Polishing the Old. Developments in Marketing Science: Proceedings of the Academy of Marketing Science*, Springer, Cham.

Suganthi, D., John, S.P.R., Shamil, J.S. and Patel, D.G. (2018), "Vehicle tracking with geo fencing on android platform", *International Journal of Engineering Science and Technology*, Vol. 8 No. 4.

Suyama, A. and Inoue, U. (2016), "Using geofencing for a disaster information system", *IEEE/ACIS 15th International Conference on Computer and Information Science (ICIS)*, Okayama, 2016, pp. 1-5, doi: 10.1109/ICIS.2016.7550849

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