Original Article

AUTONOMOUS VEHICLE TRAFFIC RECOGNITION BASED ON ARTIFICIAL INTELLIGENCE

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Abstract

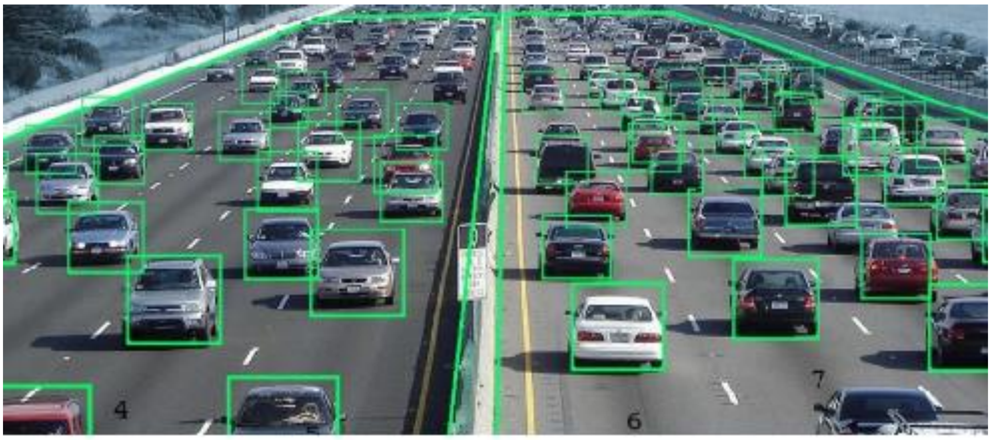
Self-driving vehicles, or self-driving cars, can navigate themselves without a driver because they are aware of their surroundings. Although it is one of the most intelligent features, lane-keeping assist sometimes fails in practical situations. In order to prevent this, the camera is firmly mounted on the hood. The video is then preprocessed and thus providing the masked area of the road to apply the Hough transform technique to detect traffic in the current lane of the motorway. An intelligent transportation system relies heavily on deeply integrated smart cars. The steering wheel is steered towards the designated lane using Arduino UNO. In spite of the great potential for vision-based autonomous driving, it remains difficult to assess complex traffic scenarios based on the data collected. In recent years, autonomous driving has been divided into a variety of individual tasks through the use of different models, such as object detection and intent recognition. This study presents a vision-based system for recognizing various objects in the traffic context, identifying them, and predicting pedestrian intentions. With this technique, most accidents can be prevented, and the trust of people is also increased.

Keywords: Automotive industry, Self driving car, Lane Departure Warning, Arduino UNO

1. Introduction

Radar, sensors, cameras, and artificial intelligence are used in self-driving automobiles to enable them to operate independently. Five steps need to be followed to get automated travel. When driving this car through these levels, ADAS is crucial [1]. This feature's lane keep assist, or the inability to recognise that lane, is one example. It chose to address this issue by mounting the camera above the hood. The camera's video will be destroyed after that. Pre-processing the video is then done using image processing. Enhancing image quality and providing associated information are two functions of image processing [2]. The three steps are to import the image using the OpenCV module, manipulate the image and then get the output image as a modified image. With these procedures in place, It will run the Hough transform algorithm, determine the magnitude of the line, and adjust the direction accordingly [3]. Rapid urbanization has revealed a number of issues, many of which are transportation-related, severely limiting travel and posing security hazards [4] as shown in figure 1. Even if object detection technology has advanced, there is still a chance of clashing elements since autonomous cars are surrounded by a range of common things, including some uncontrollable moving objects (pedestrians and automobiles) and stationary objects (traffic lights and signs) [5]. It is crucial to swiftly recognise different static components and correctly guess the function of moving items. It is inevitable that automation will take over all facets of life.

Figure 1 : Vehicle Detection in Traffic



There is a big potential for autonomous vehicles in the near future, and their numbers are rising dramatically. A smart car's effective driving direction and precise lane location can be determined based on the current driving lane [6]. The effectiveness and safety of automated driving are greatly enhanced by these features. The public's confidence in the transition toward autonomous vehicles will rise as a result of this effort. The main goal of this proposal is to realize the available space and traffic volume in the lane in which the vehicle is moving while maintaining lane compliance. Since the video that It will be using in real time is the same as the one from the hood camera, this video is taken from an online source [7]. The OpenCV module will be used to pre-process the video in order to obtain the necessary images for identification purposes. After preprocessing, road size, lane orientation and space are calculated respectively using Hough's transform technique and Canny's edge detection.

2. Related work

Safety system features, functions and driver assistance systems are detailed in the 2015 issue of Herman Winner, Stephan Hakuli, Felix Lotz and Christina Singer, "The Handbook of Driver Assistance Systems" [8].They have helped provide readers with insights into the most recent technological advancements. This provides insight into the basic ideas behind these systems. The most important step is to compile the relevant ADAS systems. It enhances knowledge of autonomous vehicle safety systems and provides insight into image processing.

According to John Ball and Bo Tang in their 2019 publication [9] , "Machine Learning and In-Car Computing in Advanced Driver Assistance Systems," machine learning and in-vehicle computing are the two key components that enable cars to Self-driving. ADAS can distinguish objects, pedestrians, other vehicles, etc. through complex machine learning algorithms and embedded computing. While it has a lot of functionality, one major flaw is that it lacks edge detection, which is required for autonomous vehicles and makes parking assist systems a necessity.

According to the study by Lentin Joseph and Amit Kumar Mondal on "Advanced Driving Assistance Systems and Autonomous Driving (ADAS)" [10] , published in 2021, the testing process developed based on the test results. and verify jobs including sensor position, sensor association, camera alignment, algorithm performance, synthesis, and computer vision. Here, it mainly explains that current technology, such as lane-keeping assist, is ineffective in the presence of weather-related factors such as rain. Instead of using lane keeping assist, It will integrate traffic recognition and lane detection which can solve the current problem.

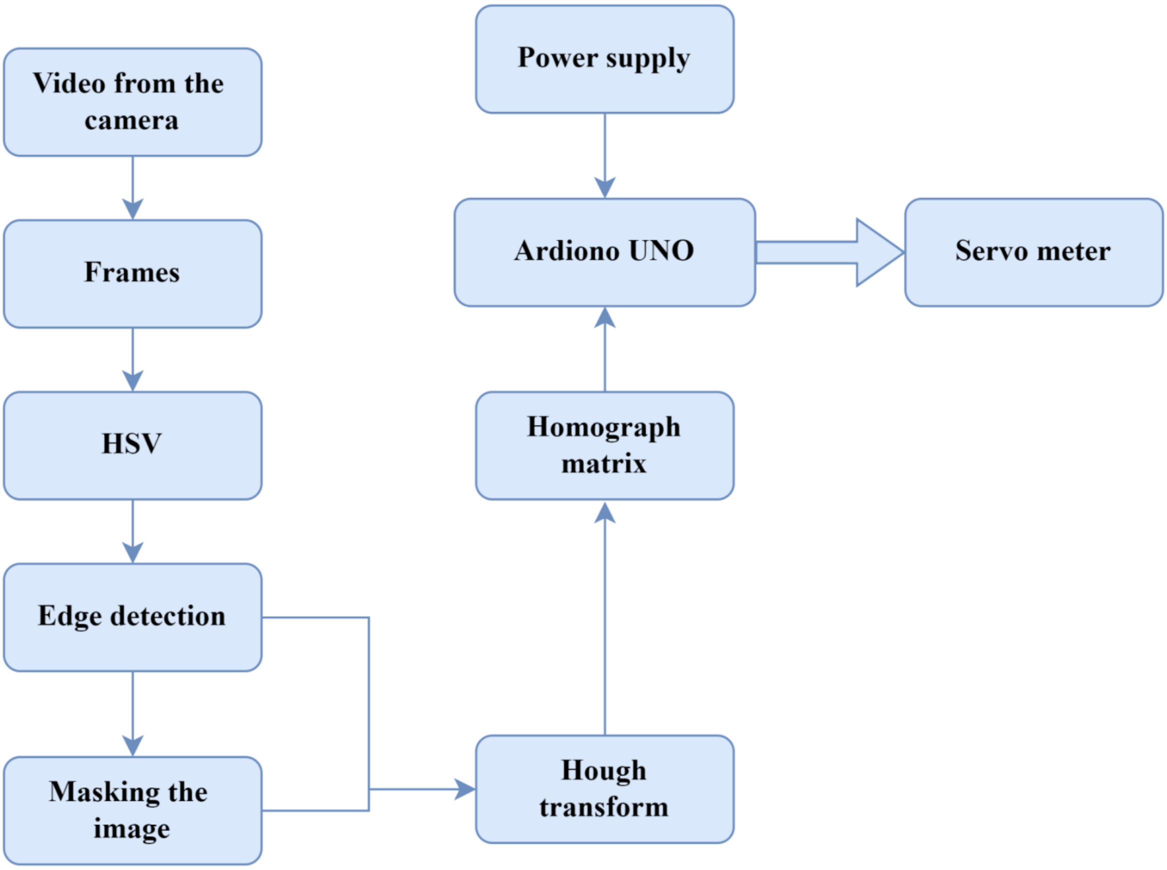
According to Richard Romano and David Maggie's study [1]] and research on "the impact of misplaced lane-keeping assist cameras on driver behavior", the lane-keeping assist system has a bias ranging from -0.66 m to 0.66

m. This assessment was done on two highways. The car's camera alignment was also problematic, leading to frequent steering wheel swings. As a result, the driver struggles to maintain the vehicle's position in the lane. The quality of the lane-keeping assist, the driving experience, and the results were all examined in this study, along with camera sensor bias.

3. Proposed System

Lane keeping assist is one of the many features found in self-driving cars. While this is one of the smartest features, it frequently fails in real life due to weather conditions and when driving on hills. This proposal will circumvent this problem. Here, road detection from a single image can be used to find the way within an image so that it can be used as part of an autonomous driving system to move the vehicle to the right path. Given an image captured by a camera mounted on a moving vehicle on the road, where the road captured may or may not be well graded, has clearly delineated edges, or has known patterns, the route detection from a single image can be used to find a route within an image. The Hough transform can be used for this. Our model is trained using tens of thousands of different road images and is therefore able to identify the road in a newly processed car image.

Figure 2 : Design



A camera is used in this proposal to capture video from a car. In addition, after video pre-processing, the size of the line is determined using Canny detection and the lines are detected using the Hough transform as shown in figure 2. The Python compiler is used to perform these procedures. Thonny, a very user-friendly Python compiler, is used here. Also, the Arduino UNO is connected via a serial wire and the Arduino IDE is used to upload the servo motor control code to the Arduino UNO. To process the code in real time, a stepper motor is attached to the flywheel and the Raspberry Pi acts as the CPU. The first video was shot with a camera mounted in the center of the car's bonnet. Convert each frame after separating audio and video. The frames are then converted to HSV format. Once the threshold value of the lane in which the car will move has been determined, edge detection is used. The mask is then used on the converted image. Finding the slope of the track requires the Hough transform. Next, a homograph matrix is used to determine the angle of inclination of the track so that the steering can be directed in that direction. The Arduino UNO will control the servo motor after receiving the guide angle.

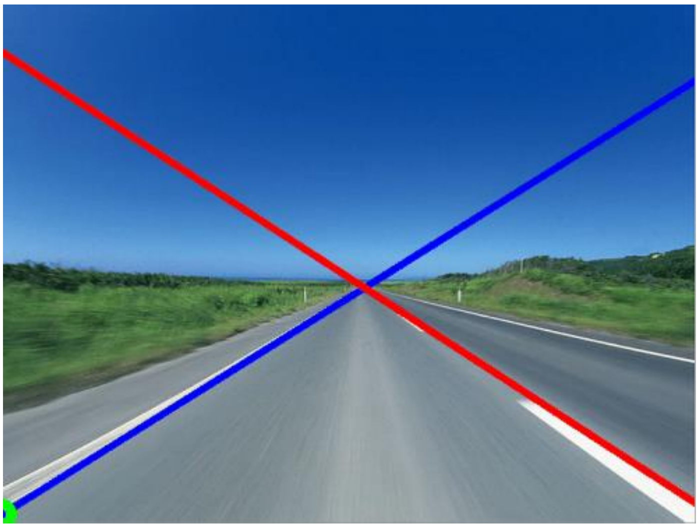
3.1. Modeling

In terms of the modeling component, we'll develop a system that can recognise and locate floor symbols. A model developed using tens of thousands of photos can even be used with a brand-new self-driving car to achieve our level of accuracy. It can determine the direction and the lane the car is traveling in. The Arduino UNO is then programmed with the code necessary to direct the car. It can be used by autonomous vehicles to assist in making turns safely.

3.2. Hough Transform

This idea uses the Hough Transform method, which is essential for route determination. To extract features from images, the Hough transform algorithm is used in computer vision, image processing, and digital image processing. A classic Hough transform method for locating lines in an image is to draw them. In 1972, Peter Hart and Richard Duda came up with this idea. Pattern recognition by automatic digital image monitoring is challenging. To get image pixels from image points, edge detection can be used. This has inaccuracies due to the lack of curvatures and image offsets. On the other hand, the Hough transform can solve this problem by grouping the edge points as shown in figure 3. Create a model and edge finder together for the best level of accuracy.

Figure 3 : Lane detection with Hough transform



3.3. Edge Detection

Edge detection is one of the most widely used techniques in image analysis. Because of this, edges define an object's outline as shown in figure 4 and 5. An edge is the line that divides an object from its surrounds and symbolizes the division between items that overlap. This implies that all objects in the image can be found, and fundamental characteristics like area, perimeter, and form may be measured. It depends on correctly identifying the image's edges. Since computer vision focuses on the identification and categorization of features in an image, edge detection is a crucial tool.

Figure 4 : Edge detection for vehicle

Figure 5 : Detected Cars

4. Result and discussion

As well as assessing the model's learning performance, the learning curve serves as a diagnostic tool in machine learning for algorithms that learn gradually from a training dataset. A model can be tested against training and holdout validation datasets after each update during training, and graphs can be generated of its performance. A lane departure will result in the cars being directed accordingly on top left of the video, according to the traffic recognition system conditions. When lane departures occur, green spaces will allow vehicles to traverse them.

Figure 6 : Left turn

This is the result of the rail turning to the left and being transmitted to the Arduino UNO microcontroller. It will tilt to the left if the value is less than 90, because the Arduino UNO, which is responsible for controlling the servo, will turn it in that direction. In this case, the lane moves in a straight line, without deviations, as shown in figure 7. In order to steer the lane straight, the Arduino adjusts the steering to tilt toward the center because the value is 90. Due to the lane's right turn and the fact that the value is greater than 90, the Arduino UNO microcontroller receives it in figure 8. As the servo motor is driven by the Arduino UNO, a value greater than 90 will cause the servo motor to tilt to the right until the lane points to the right.

Figure 7 : Go Straight

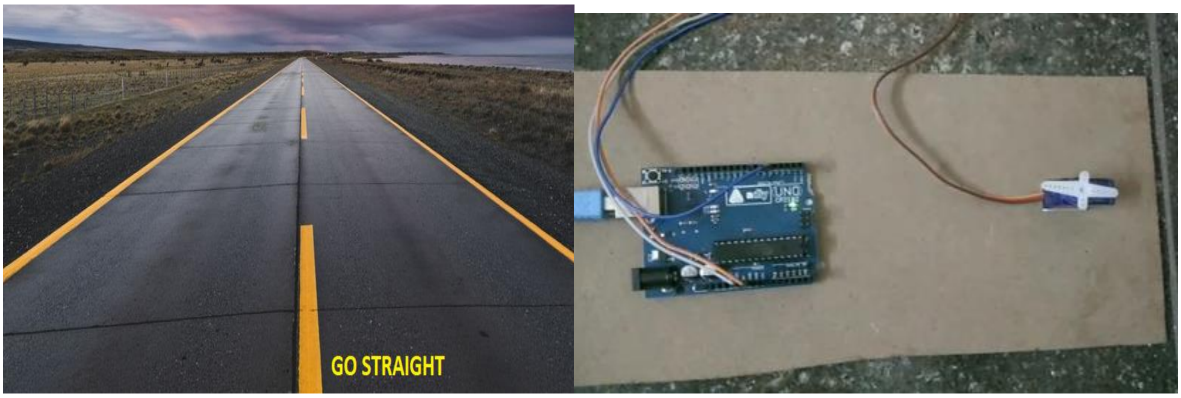
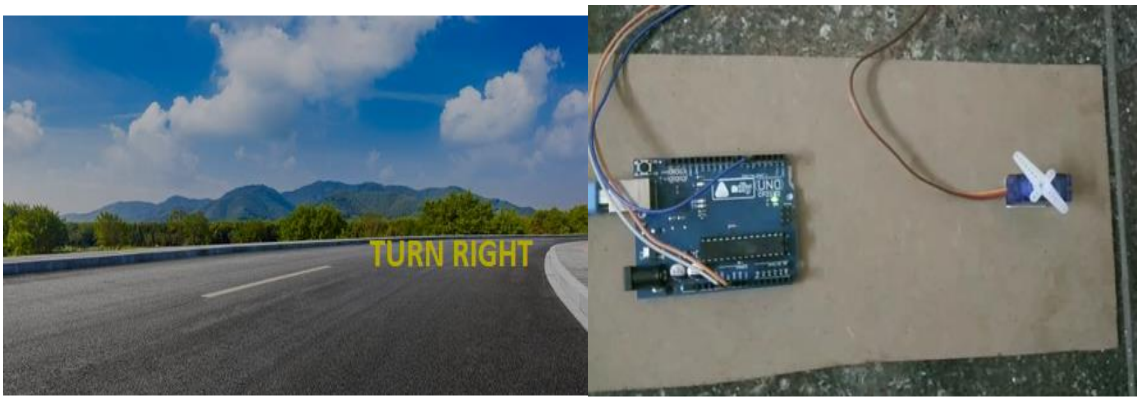


Figure 8 : Right turn



5. Conclusion

Automobiles are oriented by lines on the road that mark the lanes. An algorithm will be used to identify distinct road markers automatically for the development of a self-driving vehicle. It is best to be flexible when choosing the region of interest (ROI) for traffic analysis. As the horizon moves upward or downward, frame size no longer matters. This approach is mostly based on image processing and road recognition in self-driving cars, which will be a promising development in the future. As a result of the specific algorithms used throughout the implementation, self-driving cars are safe and increasingly safe, even though their perception has not changed. It has been observed that self-driving cars are a key advance in transportation technology.

References:

1. Kotsi, A.; Mitsakis, E.; Tzanis, D. Overview of C-ITS Deployment Projects in Europe and USA. In Proceedings of the 23rd IEEE International Conference on Intelligent Transportation Systems, Rhodes, Greece, 20–23 September 2020.
2. Kim, J. A Study on the R&D of the Operating System and Transportation Infrastructure for Road Driving of Self-Driving Cars; The Road Traffic Authority: Wonju-si, Korea, 2018.
3. Jung, J.; Yoon, I.; Lee, S.; Paik, J. Object Detection and Tracking-Based Camera Calibration for Normalized Human Height Estimation. J. Sens. 2016, 2016, 1–9.
4. Yang, I.; Jeon, W.; Lee, J.; Park, J. Development of an Integrated Traffic Object Detection Framework for Traffic Data Collection. J. Korea Inst. Intell. Transp. Syst. 2019, 18, 191–201.
5. N.Nandan, R.Sagar and H.S.R Allu - Consumer Electronics, "Flexible Wide Dynamic Range(WDR) processing in image signal processor, Jan 2015.
6. S.Dabral, U.Batur, V.Appia and M.Mody - Circuits and Systems, "Trends in camera based Automotive Driver Assistance System", Aug 2014.
7. Ham, S.; Im, J.; Kim, M.; Cho, K. Construction and Verification of a High-Precision Base Map for an Autonomous Vehicle Monitoring System. ISPRS Int. J. Geo-Inf. 2019, 8, 501.
8. Herman Winner, Felix Lotz, Stephan Hakuli and Christina Singer – "Handbook of Driver Assistance Systems", 2015.
9. John Ball and Bo Tang – "Machine learning and Embedded Computing in Advanced Driver Assistance Systems", 2019.
10. Lentin Joseph and Amit Kumar Mondal – "Autonomous Driving and Advanced Driver Assistance System, 2021.
11. Yang, I.; Jeon, W.; Lee, J.; Park, J. Development of an Integrated Traffic Object Detection Framework for Traffic Data Collection. J. Korea Inst. Intell. Transp. Syst. 2019, 18, 191–201.
12. Seo, H.; Kim, E. Estimation of Traffic Volume Using Deep Learning in Stereo CCTV Image. J. Korean Soc. Surv. Geod. Photogramm. Cartogr. 2020, 38, 269–279
13. Kim, B. Design of Image Tracking System Using Location Determination Technology. J. Digit. Converg. 2016, 14, 43–148.
14. Kumar, D.; Raut, S.; Shimasak, K.; Senoo, T.; Ishii, I. Projection-mapping-based object pointing using a high-frame-rate cameraprojector system. Robomech. J. 2021, 8, 1–21.
15. Schiopu, I.; Cornelis, B.; Munteanu, A. Real-Time Instance Segmentation of Traffic Videos for Embedded Devices. Sensors 2021, 21, 275
16. Fernandes, S.; Duseja, D.; Muthalagu, R. Application of Image Processing Techniques for Autonomous Cars. In Proceedings of the Engineering and Technology Innovation, Online, 17 December 2020; Volume 17, pp. 1–12.
17. Guerna, A.; Bitam, S.; Calafate, C.T. Roadside Unit Deployment in Internet of Vehicles Systems: A Survey. Sensors 2022, 22, 3190.
18. Kiela, K.; Barzdenas, V.; Jurgo, M.; Macaitis, V.; Rafanavicius, J.; Vasjanov, A.; Kladovscikov, L.; Navickas, R. Review of V2X-IoT Standards and Frameworks for ITS Applications. Appl. Sci. 2020, 10, 4314.
19. Krishnamoorthy, R., Soubache, I.D. &Farmani, A. Exploring surface plasmon resonance ring resonator structure for high sensitivity and ultra-high-Q optical filter with FDTD method. Opt Quant Electron 54, 75 (2022). https://doi.org/10.1007/s11082-021-03449-y
20. NattappanAnbuchezhian, GanesanSuganyaPriyadharshini, ThiagarajanVelmurugan, RanganathanKrishnamoorthy, Design of automation control thermal system integrated with parabolic trough collector based solar plant, Thermal Science 2022, 26,2 PP: 947-954 https://doi.org/10.2298/TSCI201113218N
21. Krishnamoorthy, R., Desai, A., Patel, R. et al. 4 Element compact triple band MIMO antenna for sub-6 GHz 5G wireless applications. Wireless Netw 27, 3747–3759 (2021). https://doi.org/10.1007/s11276- 021-02734-8
22. Anbuchezhian, N., Velmurugan, T., Priyadharshini, G., Krishnamoorthy, R., Novel Design of Hybrid Steam Turbine Reflector Based Controller for Solar Power Plant, (2020) International Review of Mechanical Engineering (IREME), 14 (9), pp. 572-578. https://doi.org/10.15866/ireme.v14i9.19510
23. R. Krishnamoorthy, S. L. Prathapa Reddy, Ambresh P. Ambalgi& M. Amina Begum (2021) Design of Higher-Order Circular Array Antenna with Multiple Patch Elements Based on Angular Momentum, Fusion Science and Technology, 77:5, 366-372, https://doi.org/10.1080/15361055.2021.1903783
24. Krishnamoorthy, R. & Soubache, I.D. & Jain, Shafali. (2021). Wireless Communication Based Evaluation of Power Consumption for Constrained Energy System. Wireless Personal Communications. https://doi.org/10.1007/s11277-021-08402-6
25. N. Anbuchezhian, S. Srinivasan, T. Velmurugan, G. SuganyaPriyadharshini, R. Krishnamoorthy "Comparative Study of Neural Network and Tree-Based Models in Solar Irradiance Prediction"International Review of Mechanical Engineering (IREME) Vol 15, No 6 (2021), PP:307-316https://doi.org/10.15866/ireme.v15i6.21170

26. Dr.R.Krishnamoorthy ,Dr.V.Balajivijayan , Sowmiya , Dr.R.Thiagarajan , Dr.S.Arun,” Cyber Attack Detection on IOT Using Network Traffic Mechanism by Neural Network Predictive Approach”, European Journal of Molecular & Clinical Medicine, Volume 07, Issue10 , 2020, PP:3690-3697.
27. N. Anbuchezhian, T. Velmurugan, G. SuganyaPriyadharshini, R. Krishnamoorthy” Novel Design of Hybrid Steam Turbine Reflector Based Controller for Solar Power Plant, International Review of Mechanical Engineering (I.RE.M.E.), Vol. 14, N. 9 September 2020,PP: 572- 579.