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A NOVEL COMPUTER VISION BASED EFFECTIVE REALTIME DRIVER YAWN AND FATIGUE DETECTION APPROACH USING ML TECHNIQUES

[1]Dr. D. NAGA RAVI KIRAN, [2]B. PARDHAVI, [3]B. KARUN KUMAR, [4]A. NAGENDRA SAI

[1]Professor &HOD, Dept. of ECE, Chalapathi Institute of Technology, Mothadaka, Guntur, A.P, India

[2,3,4]B. Tech Students, Dept. of ECE, Chalapathi Institute of Technology, Mothadaka, Guntur, A.P, India

ABSTRACT: Due to the increasing of traffic accidents, there is an urgent need to control and reduce driving mistakes. Driver fatigue or drowsiness is one of these major mistakes. Drowsiness and Fatigue of drivers are amongst the significant causes of road accidents. Every year, they increase the amounts of deaths and fatalities injuries globally. Many algorithms have been developed to address this issue by detecting fatigue and alerting the driver to this dangerous condition. The major problem of the developed algorithms is their detection accuracy, as well as the time required to detect fatigue status and alert the driver. The accuracy and the time represent a critical condition that affects the reduction of traffic accidents. In recent years, with the progress of huge amount of data, computer vision technology and Machine Learning (ML) technology have been used in various applications due to their effectiveness and accuracy. Hence in this, A novel computer vision based effective real time driver yawn and fatigue detection approach using ml techniques is presented. The canny edge detection algorithm and sobel edge detector is employed to extract facial features such as eye closure and yawning. The ML algorithms such as K-nearest neighbour (KNN) and Support Vector Machine (SVM) are used to detect the driver fatigue and yawn in real time. This approach will achieve better results compared to earlier approaches.

KEYWORDS: Driver, Yawn, fatigue, Drowsiness, Machine Learning and Canny edge detection algorithm.

I. INTRODUCTION

Every human being needs sleep but a lot of people underestimate sleep and it is a recovery time for humans to gain energy and get back to work on a daily basis. Lack of sleep leads the body to work ineffectively and mind to a drowsy state.

Drowsiness is a leading cause of automobile collisions, with significant consequences for road safety. Driver fatigue is a significant factor in the large number of crashes. The World Health Organization (WHO) estimates that 1.22 million traffic accidents occur every day. If drowsy drivers are given adequate notice, several crashes can be avoided [4].

Driver's fatigue is a vital and primarily roots cause to reduce traffic accidents. Detection of driver fatigue (DDF) is based on behavioral measures through image processing and machine learning techniques. To detect DDF, there are many systems developed in the past. To measure the level of drowsiness, there are many authors used driver faces information to extract visual features. At most, the facial features include eye blinks, head movements and yawing [2]. Human factors in vehicle collisions or road accidents include drivers and other road users or roadside objects contributing to a crash or mishap. Examples include the behavior of drivers, visual and auditory clarity, quick decision-making ability, and quick response speed.

Fatigue means feeling abnormally sleepy, decreasing the typical efficiency of cognitive functions. Drowsy people may fall asleep in inappropriate situations or inconvenient times and make their surrounding situation highly critical. So, analyzing the problem statement, it is

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necessary to integrate modern technology to control road accidents due to drivers' drowsiness [3].

When driving for more than 8 or 9 hours in a row, the number of accidents climbs rapidly. The increasing death rates due to fatigued driving are quite alarming worldwide. Massive setbacks, wounds, and property harm brought about by drowsiness require critical strides in building up a robust framework that can identify drowsiness and make the right move before a mishap happens [5]. In fact, continuous fatigue can cause levels of performance impairment similar to those caused by alcohol. While driving, these symptoms are extremely dangerous since they significantly increase the probabilities of drivers missing road signs or exits, drifting into other lanes or even crashing their vehicle, causing an accident Monitoring the driver's level of vigilance and alerting them when he/she is not paying adequate attention while driving is essential to prevent driving accidents.

Three major techniques are being used to create a robust and effective fatigue detection system. These techniques are classified as behavioral-based, vehicle-based, and physical-based techniques [1]. Various systems exist for this purpose which makes use of physiological features, behavioural patterns and vehicle-based features. Physiological features considered here are Electroencephalogram (EEG), Electrooculogram (EOG), Electrocardiogram (ECG), heartbeat, pulse rate etc. Behavioural patterns considered here are visual behaviours of drive like eye blinking, eye closing, yawning, head bending etc. Vehicle based features are metrics like wheel movement, acceleration, vehicle speed, brake pattern, deviation from lane pattern etc. Most of these methods are time consuming and expensive [6].

The limitation of drowsiness identification processes using the physiological method is that the diver needs to contain electrodes on their body. There is a substantial restriction based on vehicle-based drowsiness identification, such as they are prone to forces connected to drivers and vehicles, road situations.

Machine learning (ML) is the study of computational methods for improving performance by mechanizing the acquisition of knowledge from experience. As a modern data-driven optimization and applied regression methodology, ML aims to provide increasing levels of automation in the knowledge engineering process, replacing much time-consuming human activity with automatic techniques that improve accuracy and/or efficiency by discovering and exploiting regularities in training data.

Hence, in this work, A novel computer vision based effective real time driver yawn and fatigue detection approach using ml techniques is presented. The rest of the work is organized as follows: The section II describes the literature survey. The section III presents A novel computer vision based effective real time driver yawn and fatigue detection approach using ml techniques. The section IV evaluates the result analysis. Eventually the work is concluded in section V.

II. LITERATURE SURVEY

Md. Tanvir Ahammed Dipu, Syeda Sumbul Hossain, Yeasir Arafat, Fatama Binta Rafiq et. al., [7] describes Real-time Driver Drowsiness Detection using Deep Learning. A methodology based on Convolutional Neural Networks (CNN) is presented that illustrates drowsiness detection as a task to detect an object. It will detect and localize whether the eyes are open or close based on the real time video stream of drivers. The MobileNet CNN Architecture with Single Shot

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Multibox Detector is the technology used for this object detection task. A separate algorithm is used based on the output given by the SSD_MobileNet_v1 architecture. A dataset that consists of around 4500 images was labeled with the object's face yawn, no-yawn, open eye, and closed eye to train the SSD_MobileNet_v1 Network. The proposed approach is to ensure better accuracy and computational efficiency.

Qaisr Abbas et. al., [8] describes FatigueAlert A real-time fatigue detection system using hybrid features and Pre-train mCNN model" The proposed FatigueAlert system pre-trained many convolutional neural network (mCNN) models on different driver's eyes, ears and mouths datasets. Three online datasets such as closed eyes in the wild (CEW), yawing dataset (YAWDD) and Columbia gaze dataset (CAVE-DB) were utilized to train and evaluate the proposed FatigueAlert system. On average, the FatigueAlert DDF system achieved 93.4% detection accuracy on different real-time driver's datasets.

Pranay Sharma, Naveksha Sood et. al., [9] describes Application of IoT and Machine Learning for Real-time Driver Monitoring and Assisting Device. A driver monitoring and assisting device is described which employs IoT sensors, like alcohol sensor and air pressure sensor for sobriety check and machine learning algorithms to detect micro-sleep and frequent yawns for drowsiness detection. The device turns on and asks the driver to blow into the mouthpiece. After a clean and proper blow, the driver is allowed to switch the ignition on. Thereafter, the device constantly monitors the driver using a camera for signs of fatigue, and uses the vehicle's sound system or a buzzer to alert the drowsy driver. The goal of our work is to develop and deploy a device that will curb drunk and drowsy driving mishaps and inculcate responsible driving behavior among drivers.

Ratna Kaavya M1, Ramya V, Ramya G Franklin et. al., [10] describes Alert System For Driver's Drowsiness Using Image Processing. The proposed system here uses the Raspberry Pi and various sensors like Gas Sensor, Vibration Sensor for the detection of the type of drowsiness. The driver is been monitored by placing a camera which captures the vital sign. If the eye is closed for a longer period of time then the image of the person is sent. The accident is detected using a vibration sensor and the server is notified by sending latitude and longitude. The location of the car is sent by the IOT modem which is embedded in the car. If the driver consumed alcohol it is sensed by the gas sensor and the server is notified by a message. The motor of the car is continuously running can be stopped or cut-off if the server side is notified about the driver that the person is not in a situation to drive the car. By this, the accident rate is reduced and the risk of customer life is decreased.

III. A NOVEL COMPUTER VISION BASED EFFECTIVE REALTIME DRIVER YAWN AND FATIGUE DETECTION APPROACH

A novel computer vision based effective real time driver yawn and fatigue detection approach using ml techniques is presented. The use of color information has been introduced to the face-locating problem in recent years, and it has gained increasing attention since then. Color information is typically used for region rather than edge segmentation. The region segmentation is divided into two general approaches, as illustrated in Fig. 1 One approach is to employ color as a feature for partitioning an image into a set of homogeneous regions The other approach, however, makes use of color as a feature for

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identifying a specific object in an image. In this case, the skin color can be used to identify the human face. This is feasible because human faces have a special color distribution that differs significantly from those of the background objects. Hence this approach requires a color map that models the skin-color distribution characteristics.

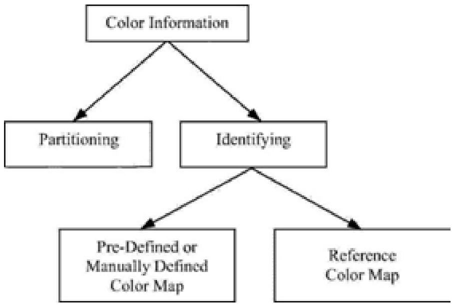

Fig. 1: The use of color information for region segmentation

In another approach, the skin-color map can be designed by adopting histogram technique on a given set of training Therefore, this individual color feature can simply be defined by the presence of Cr values within, say, 136 and 156, and Cb values within 110 and 123. Using these ranges of values, we managed to locate the subject's face in another frame of Foreman and also in a different scene (a standard test image called Car phone).

An image can be presented in a number of different color space models like RGB (Red Green Blue), HSV (Hue Saturation Value) and YCbCr (luminance (Y), chroma blue (Cb) and chroma red (Cr)). However in this analysis YCbCr is used. The Y value reprensents the luminance (or brightness) component, while the Cr and Cb values, also known as the color difference signals, represent the chrominance component of the image.

The skin color segmentation in applied to YCbCr color space. So first of all, RGB color space is converted to YCbCr color space. Y represents the luminance and Cb and Cr represents chrominance. The RGB color space is converted to YCbCr color space using the following equation:

$$Y = 0.299R + 0.587G + 0.114B$$
$$C = (B - Y) * 0.564 + 12$$
$$Cr = (R - Y) * 0.713 + 128 \ (1)$$

The skin color segmentation is used to classify the pixel as skin pixel or non-skin pixel. As or hand is connected component made of skin pixels we will get the hand after skin color segmentation. The skin segmentation process is as follows: The first step in skin color segmentation to specify the range for the skin pixels in YCbCr color space.

$$[R_{cb} R'_{cb}] = [77, 127]\&$$
$$[[R_{cr} R'_{cr}] = [133, 173] \quad (2)$$

Next, find the pixels (p) that are in the range defined above: is lower and upper bound for Cb component.

$$R_{cb} \leq pixel\ value\ (Cb(i,j) \leq R'_{cb}$$

$$R_{cr} \leq pixel\ value\ (Cr(i,j) \leq R'_{cr} \ (3)$$

The Canny edge detection algorithm is known to many as the optimal edge detector. The canny edge detection algorithm block diagram is shown in Fig. 2.

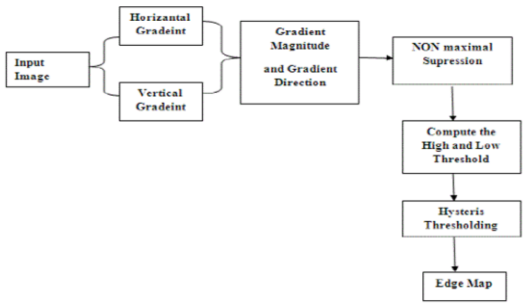

Fig. 2: Block Diagram of the Canny edge Detection Algorithm

Canny edge detection is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed. It has been widely applied in various computer vision systems. Canny has found that the requirements for the

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application of edge detection on diverse vision systems are relatively similar. Thus, an edge detection solution to address these requirements can be implemented in a wide range of situations. The general criteria for edge detection include:

Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image as possible. The edge point detected from the operator should accurately localize on the center of the edge. A given edge in the image should only be marked once, and where possible, image noise should not create false edges

To satisfy these requirements Canny used the calculus of variations – a technique which finds the function which optimizes a given functional. The optimal function in Canny's detector is described by the sum of four exponential terms, but it can be approximated by the first derivative of a Gaussian. Among the edge detection methods developed so far, Canny edge detection algorithm is one of the most strictly defined methods that provides good and reliable detection. Owing to its optimality to meet with the three criteria for edge detection and the simplicity of process for implementation, it became one of the most popular algorithms for edge detection.

The process of Canny edge detection algorithm can be broken down to five different steps: the input image is divided in to vertical and horizontal gradients. Apply Gaussian filter to smooth the image in order to remove the noise, Find the intensity gradients of the image. Apply gradient magnitude thresholding or lower bound cut-off suppression to get rid of spurious response to edge detection. The gradient magnitude is used to measure how strong the change in image intensity is. The gradient magnitude is a real-valued number that quantifies the “strength” of the change in intensity. The gradient orientation is used to determine in which direction the change in intensity is pointing. Non Maximum Suppression is a computer vision method that selects a single entity out of many overlapping entities (for example bounding boxes in object detection). The criteria is usually discarding entities that are below a given probability bound. Next threshold values are compared. Apply double threshold to determine potential edges and Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

In case of Sobel Edge Detection there are two masks, one mask identifies the horizontal edges and the other mask identifies the vertical edges. The mask which finds the horizontal edges that is equivalent to having the gradient in vertical direction and the mask which computes the vertical edges is equivalent to taking in the gradient in horizontal direction.

By passing these two masks over the intensity image the gradient along x direction (Gx) and gradient along the y direction (Gy) can be computed at the different location in the image. Now the strength and the direction of the edge at that particular location can be computed by using the gradients Gx and Gy. The gradient of an image $(x,)$ at location (x,y) is defined as the vector.

$$\nabla f = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix} \quad (4)$$

Where Gx is the partial derivative of f along x direction and Gy is the partial derivative of f along the y direction. Computation of the magnitude of the gradient involves squaring the two components Gx and Gy adding them and takes the square root of this addition.

$$\nabla f = mag(\nabla f) = [G_x^2 + G_y^2]^{1/2} \quad (5)$$

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The approximation of this is taken as magnitude of the gradient to be sum of magnitude of Gx gradient in the x direction plus magnitude of Gy in the y direction.

$$|G_x| + |G_y| \quad (6)$$

The magnitude tells the strength of the edge at location (x, y), it does not tell anything about the direction of the edge. To compute the direction of the gradient f, let $(x,)$ represent the direction angle of the vector ∇f at $(x,)$, then

$$\propto (x, y) = tan^{-1}\left(\frac{G_y}{G_x}\right) \quad (7)$$

Sobel Edge Operator gives an averaging affect over the image, so effect due to the presence of spurious noise in the image is taken care of some extent by the Sobel operator. Sobel operator also gives a smoothing effect by which we can reduce the spurious edge that can be generated because of the noise present in the image.

Sobel filter Analysis: Filtering is the process of applying masks to images and the application of a mask to an input image produces an output image of the same size as the input image. There are three steps of convolution are given which is necessary for filtering. i) For each pixel in the input image, the mask is conceptually placed lying on that pixel; ii) The values of each input image pixel under the mask are multiplied by the value of the corresponding mask weights; iii) The result is summed together to yield a single output value that is placed in the output image at the location of pixel being processed on the input.

The Sobel operator is used commonly in edge detection. The Sobel operator is a classic first order edge detection operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Sobel operator is the corresponding norm of this gradient vector. The Sobel operator only considers the two orientations which are 0°and 90°convolution kernels.

The operator uses the two kernels which are convolved with the original image to calculate approximations of the gradient. As given above, the gradients are calculated along with the magnitude. Read the text file generated by the MATLAB into the memory and store it into theRAM, then extract the raster window. Two 3 x 3 windows are shown in figure 5.8. Next, scan the text file with the window and find out the values of center pixel, north, south, east, west, south east, south west, north east and north west pixel for whole binary image row wise and column 38 wise, this completes the horizontal and vertical scanning. The process of raster scanning is shown in Fig. 3.

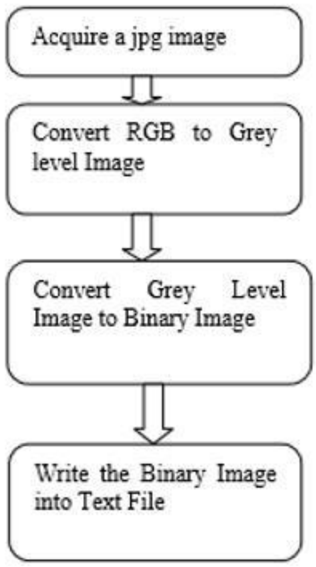

Fig. 3: Process flow of Raster window scanning

Feature extraction is achieved using feature-based techniques or holistic techniques. In some holistic techniques we can make use of dimensionality reduction before classification. We compared the results of different holistic approaches used for feature extraction and

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classification in real time scenario Normally the textures may be random but with the consistent properties. Such Textures can be described by their statistical properties. Moment of intensity plays a major role in describing the Texture in a region. Suppose in a region we construct the histogram of the intensities then the moments of the 1-D (one dimensional) histogram can be computed. The mean intensity which we have discussed is the first moment. The variance describes how similar the intensities are within the region then this variance is the second central moment and they mainly do statistics for the first order, second-order and third-order moment of each color component. For image retrieval, the color moment is a simple and effective representative method of color features. Such color moment as first-order (mean) and second (variance) and third-order (gradient), is proved to be very effective in presenting color distribution of images.

After feature extraction the data is applied to ML models for driver state detection. KNN and SVM are used which are as follows: K -Means algorithm is used for classification in this research because it is the simplest machine learning algorithm and it is very easy to implement. It is a technique based on the closest training samples in the feature space. When the test sample is given, the distance between the test sample and all the training samples are first calculated using Euclidean distance. Then, the 'k' nearest neighbors which have minimum distance are determined. Once the nearest neighbors are found, the test sample is classified according to the majority votes.

In machine learning, support vector machines are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high dimensional feature spaces. When data are not labeled, supervised learning is not possible, and an unsupervised learning approach is required, which attempts to find natural clustering of the data to groups and then map new data to these formed groups. The clustering algorithm which provides an improvement to the support vector machines is called support vector clustering and is often used in industrial applications either when data is not labeled or when only some data is labeled as a preprocessing for a classification pass. Finally these machine learning techniques are effectively detected the driver state and drowsiness.

IV. RESULT ANALYSIS

A novel computer vision based effective real time driver yawn and fatigue detection approach using ml techniques is implemented using python. Computer vision algorithms are used to extract facial features such as eye closure and yawning and machine learning techniques are used to effectively detect driver state. The result analysis evaluates that the different stages of drowsy and active states that may cause to particular person while driving. Red color indicates the driver is in drowsiness condition. Green color indicates the driver is in active state so it can be real time even during the driving conditions. In this project the video will be recorded continuously. The Fig. 4 shows the fatigue detection.

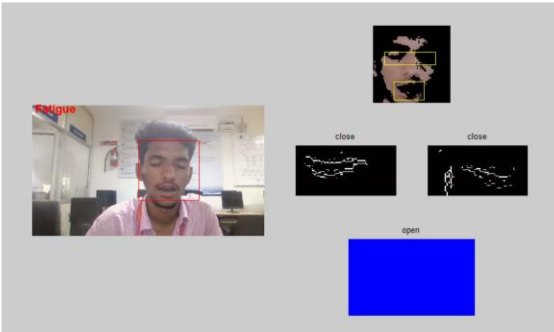

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Fig. 4: Fatigue Detection

Apart from the raising alarm the usage of color-based alertness is done each and every color has their own representation of alertness. In fig. 4, the persons left eye and right eye are closed and the mouth is open the system identify that the person is in drowsiness condition and it is indicated in red color as Fatigue. The Fig. 5 shows the non-fatigue detection. In figure the persons left eye and right eye are open and the mouth is closed then the system identify that the person is in active state that means non fatigue state and it is indicated in green color.

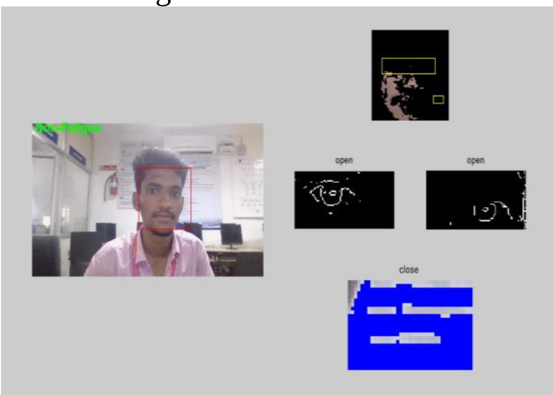

Fig. 5: Non-Fatigue Detection

The Fig. 6 shows the detection of fatigue.

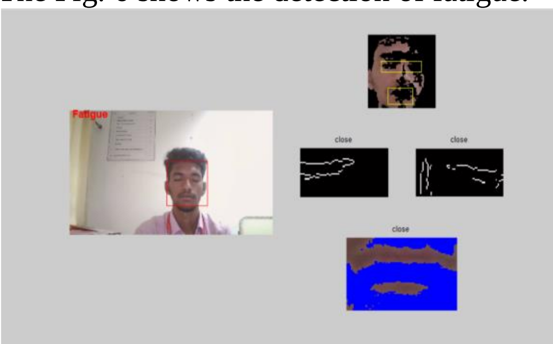

Fig. 6: detection of fatigue

In the figure 6, the person both eyes are closed and mouth is also closed then the system identify that the person is in drowsiness state and it is indicated in red color as fatigue. In addition, this system achieves an overall accuracy of 94.58% in test cases, which is highest in comparison to the recent methods.

V.CONCLUSION

In this work, A novel computer vision based effective real time driver yawn and fatigue detection approach using ml techniques is presented. This project presents the real time implementation of drowsiness detection which is invariant to illumination and performs well under various lighting conditions. Correlation coefficient template matching provides a super-fast way to track the eyes and mouth. This system achieves an overall accuracy of 94.58% in test cases, which is highest in comparison to the recent methods. A high detection rate and reduced false alarms makes sure that this system.

can efficiently reduce the number of fatalities every year. During the monitoring, the system is able to detect if the eyes are closed or open. When the eyes have been closed for a specified period of time, the system issues an alarm. Our system also implements the detection of yawn. If the yawn count has crossed a predefined number, the system sends an alert message to the owner of the car indicating the chances of the driver falling asleep. The system implemented in real time gave highly accurate results and promises a reliable fatigue detection.

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Dr.D.Naga Ravi Kiran is currently working as Professor and HOD in Chalapathi Engineering College, Mothadaka, Guntur, Andhra Pradesh, India

Bollineni Pardhavi is currently Pursuing B. tech Final year in the stream of ECE in Chalapathi Engineering College, Mothadaka, Guntur, Andhra Pradesh, India.

Bollepalli Karun Kumar is currently Pursuing B. tech Final year in the stream of ECE in Chalapathi Engineering College, Mothadaka, Guntur, Andhra Pradesh, India.

Allamsetty Nagendra Sai is currently Pursuing B. tech Final year in the stream of ECE in Chalapathi Engineering College, Mothadaka, Guntur, Andhra Pradesh, India.

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