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Realtime Implementation of Odd-Even Traffic Control Formula Using Arduino

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ABSTRACT

In context to smart city vision accomplishment by the Indian government to different cities of the nation, various environment awareness approaches to traffic formula has been designed for controlling traffic, eyeing to mitigate air and sound pollution and to reduce oil consumption. We have designed an Arduino based automated system, based on an Odd-Even formula to control traffic. Odd- Even formula stated that vehicle with odd numbers license plate will ply on odd dates and those with even numbers license plate will ply on even dates. The system is acting like one of the node points in the targeted highway area, where it detects the passing by vehicle's license plate number and send the faulty vehicle information to the sink via the transceiver. The performance of the system has been demonstrated which includes pre-image processing, finding Region of Interest (RoI) and matching the templates using standard image processing algorithm followed by faulty vehicle detection which is controlled by graphical user interface using MATLAB tool called GUIDE and to alarm fault indication and send fault information to the sink, We have been interfaced camera, LCD, alarm , radio transceiver with Arduino UNO.

Keywords: *Odd-Even formula, OE-TCM RoI, GUIDE, Arduino*

1. INTRODUCTION

With the advent of new Smart cities like Bhubaneswar, it has become very necessary to control the urban air pollution, save oil consumption and increase traffic demand with existing road capacity.Hence an artificial restriction for road is required.ANPR is a method that detect, recognize and track vehicle over a large sequence of images acquired by CCD TV camera. Its utility can be seen in access control systems supervising car traffic in the restricted areas[1], electronic toll collection system [2] [3] etc. As number of vehicle increase day by day, it implies swipe rise in air pollution, smog, and also increased traffic due to unavailability of wide roads. To surmount the current issue an Arduino based automated system has been designed to implement odd even rule in the most populated cities of Odisha.

Arduino UNO is an open source project used for building electronic projects. It consists of both a physical programmable circuit (microcontroller) and a piece of software called IDE (integrated development environment). Unlike most previous programmable circuit board, the Arduino does not need a separate piece of hardware in order to load new code onto the board, simply we can use a USB.

Arduino board operates on an external power of 6 to 20 Volts. The popularity of Arduino is because of its wiring platform, lighter weight, and low-cost version.Viewing to traffic congestion, many research works has been developed for automatic number plate detection but all the developed algorithms are for a particular country or state. If any foreign vehicle enters to the particular area then the algorithm fails to

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detect that vehicle license plate. Recently an algorithm is developed for license plate detection and recognition based on Hough lines using Hough transformation and template matching [4], which can detect only the Islamabad (Pakistan) license plate and fails to recognize Odisha (India) license plate due to the difference in license plate format. An interesting algorithm has been designed for automatic recognition of characters written on Italian license plate placed on rear-side of motor vehicles [5].Using this algorithm the recognition rate is closer to 91%, although the technique is time-consuming. The license plate can be detected in a normal environment but Eyeing to weather condition, a system has been designed that can detect in the smoggy and rainy environment using image restoration technique [6].AmrBadr [7] proposed the model in four steps: First Preprocessing, second license plate localization, third charter segmentation, and fourth character segmentation. Hao Chen et al [8] proposed the method in two steps. First, based on texture information number plate is extracted. Second, auto-correlation of the binary image and applying projection algorithm to verify the true candidate plate. Heo [9] proposed the number plate detection algorithm using a group of lines formed by the rectangular plate boundary. Wang et al [10] used connected component analysis for character segmentation. Mei yu et al[11] proposed vertical edge detection followed by size, shape filter for edge area and edge matching technique based on plate model. Farhad Faradji et al first used Sobel vertical edge detection on the image. Presently, several methods have been developed for number plate recognition such as pattern matching, neural network character recognition, and image processing technology.But these techniques are again time-consuming and use of artificial neural networking involves large training data and complex mathematics.

1.1. ODD_EVEN Formula

To control traffic and the pollution in the city, Delhi government has started an Odd-Even formula which stated that vehicle with odd numbers license plate will ply on odd dates and those with even numbers license plate will ply on even dates. In that way, they could able reduce the traffic and air pollution by 40 percent as per the media data report. Which is a huge success in terms of reducing pollution and to reduce consumption of fossil fuels and to provide a healthy environment to the locality. Now this has been a real challenge to implement and surveillance of the rule implementation. Our proposed model is based on that, which detect and send the faulty vehicle information to the sink.

1.2. Our Contribution

We have implemented whole design model by integrating two platforms including the capturing element. The capturing element captured the moving vehicle photo which is processed and control by using Matlab and Arduino Uno. For the first time in India as per our knowledge we are implementing this formula using Arduino Uno and eyeing to implement the smart city vision in India. It has been for the first time we are going to implement this protocol in Odisha.

2. SYSTEM OVERVIEW

The module has been designed to locate standardized Odisha vehicle license number plate. Odisha license number plate contains nine character. It consists of characters with four provinces. The left most two character are String that represents from which state the vehicle is belong the next two character represents Integer followed by a character which represents the model of vehicle; and the rightmost four character are Integer that identifies each registered vehicle.

The number plate extraction process follows like this.

In order to track vehicle license plate , a module has been designed which is placed on the highway. The module is controlled by graphical user interface(GUI), designed by using MATLAB tool called GUIDE. Basically, GUI is a type of interface that allows the user to interact with electronic devices through the

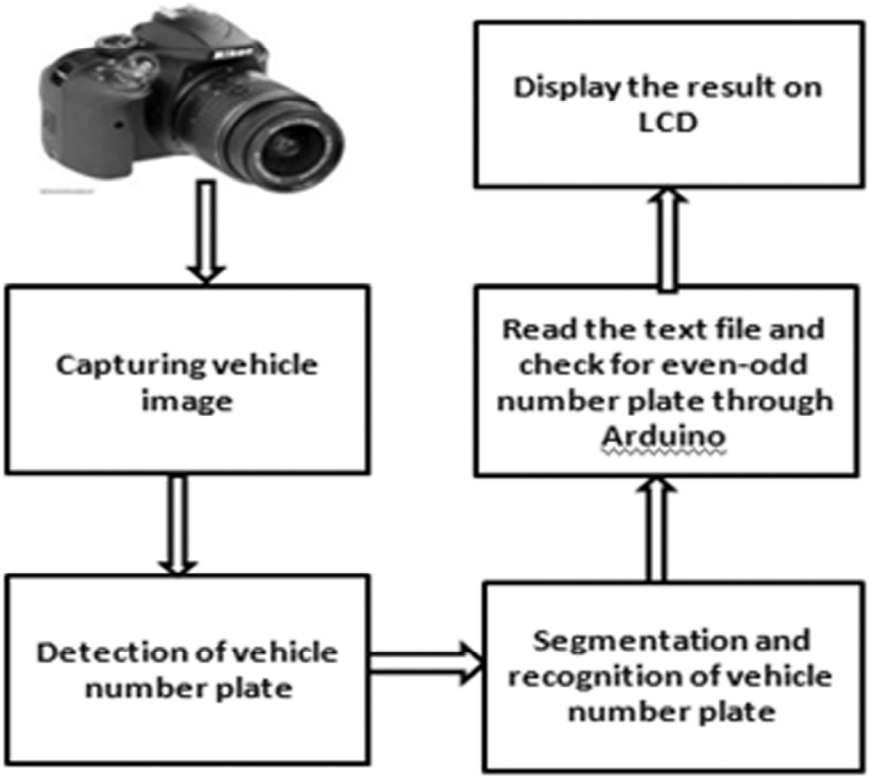

Figure 1: Block diagram of proposed model AE-TCM.

graphical icon. When the vehicle is moving on the road, the camera connected to the module will capture the image of moving vehicle allowing it for further processing , to extract the vehicle license plate. The extraction of license plate number from the entire image is a challenging task. So to overcome this problem the pre-processing algorithm is applied. After extraction of the license plate, the characters from the license plate is stored in a text file and check for odd-even number formulation. The Arduino will fetch the characters from the text file and show in the LCD. It beeps for faulty image and send to sink via the transceiver.

3. METHODOLOGY

When the vehicle moves towards the deployed station, the camera freezes the image of moving the vehicle when it is about 20 meter from the deployed station. The picture stability and enhancement technique is applied to identify the source image. After identification of source image, the image is resized which is 400*400 scale times of the source image. Then the RGB image is converted to a grayscale image by eliminating the hue and saturation information while retaining the luminance.

In order to reduce noise and to preserve the edges the gray scale image is fed to median filter. Each output pixel contains the median value in the m-by-n neighborhood around the corresponding pixel in the input image. After denoising, the next task is to detect the edges of grayscale Image. Edge detection involves three steps.

- A structural element of rectangular shape is created.
- The structural element dilates the grayscale image returning the dilated image. If the gray scale image is logical and the structural element is flat then binary dilation is performed, otherwise, grayscale dilation is performed. And also, the structural element erodes the gray scale image by returning the eroded image. if the gray scale image is logical and the structural element is flat then binary erosion performed, otherwise, grayscale erosion is performed.
- Each element of the eroded image is subtracted from the dilated image to get the morphological gradient for edge detection, i.e detected gray scale image DGS.

Then the detected gray scale image convert to intensity image for normalization where IDGS hold the output matrix contains a value from 0(black) to 1(white). also converts to double from class.The two-dimensional convolution of matrix has been done where one matrix is IDGS another is [1 1;1 1] , if one of the above matrices describes a two-dimensional FIR filter then the other is filtered in two dimensions,the size of returning matrix is determined as follows:

$$\text{If } [ma, na] = \text{size}(A) \quad \text{and}$$
$$[mb, nb] = \text{size}(B) \quad \text{and}$$
$$[mc, nc] = \text{size}(C) \quad \text{then}$$
$$mx = max([ma + mb - 1, ma, mb]) \quad \text{and}$$
$$nc = max([na + nb - 1, na, nb])$$

Convolution of double image is done for brightening the image. Then conversion of class from double to binary is performed. The returning value is an array that can be used for logical indexing. To get the edges of the license plate, the Horizontal line is removed from the output of image grow by subtracting the eroded image with structural element 'line' shape and parameter, having length 50 and inclined horizontally with a null degree.

The next step is filling all the regions and holes of the binary scale image, where hole is a set of background pixel that cannot be reached by filling up the background from the edge of image i.e filling a region of dark pixels surrounded by lighter pixel that is defined by connectivities, to form a fixed binary scale (FBS).The binary image then undergo a morphological operation, it removes pixel, so that an object without holes shrinks to minimally connected stroke, and an object with holes shrinks to a connected ring halfway between each hole and the outer boundary, this operation preserves the Euler number, FBS1. For image thinning the following two operations are used [1]. In the first suboperation, delete the pixel p, if and only if the conditions G1, G2 and G3 are all satisfied. In the second suboperation, delete the pixel p, if and only if the conditions G1, G2 and G3 compliment are all satisfied.

- Condition $G1$

$$XH(P) = 1$$

Where,

$$XH(P) = bi$$
$$bi = 1, if\ x2i - 1 = 0$$

And $$(x2i = 1\ or\ x2i + 1 = 1)$$
$$0, \quad otherwise$$

$X1, X2, \ldots X8$ are the values of eight neighbors of p starting from the east neighbor and numbered in the counter-clockwise order.

- Condition G2

$$2 \le min\{n1(p), n2(p)\} \le 3$$

Where

$$N1(p) = x2k - 1\ x2k,$$
$$N2(p) = x2k - 1\ x2k + 1$$

- Condition G3

$$(x2\ x3\ x8)x1 = 0$$

- Condition G3 compliment:

$$(x6\ x7\ x4)x5 = 0$$

Then region of the area are selected that are having pixels area more than 100. from the FBS2(erode the image of FBS1 with parameter 3 in length and degree 90 degree).The properties of ROI by bounding boxes in matrices of the order number of boxes are measured.

Finally, the desired ROI is extracted from the total bounding boxes and selected bounding boxes are compared with the pre-stored templates and a correlation algorithm is fed to it. After which the letters are extracted from the bounding boxes with maximum matched templates letters and stored the letters in the text file and check for even-odd formulation for vehicle license plate. The module is interfaced with the Arduino UNO board and this Arduino will read the text file and display whether the vehicle license number is even or odd. The result is displayed on the LCD, the LED beeps for the faulty output, and send a message to the sink (center with the detail of the number plates with location) . Then the process will continue to detect the license plate of next vehicle which is shown in figure 2.

4. ODD-EVEN TCM

Odd –Even Traffic Control Model(OE-TCM) that we have proposed in this paper. Here our prime goal is to reduce the traffic congestion by implementing Odd- an Even formula which needs to identify the faulty vehicles on the road and do send the information to the base station so that necessary action could be taken against that. The pseudo code for our model is:

4.1. Pseudo Code

- Captured the raw image RI
- Preprocess the RI, source image formation(S)

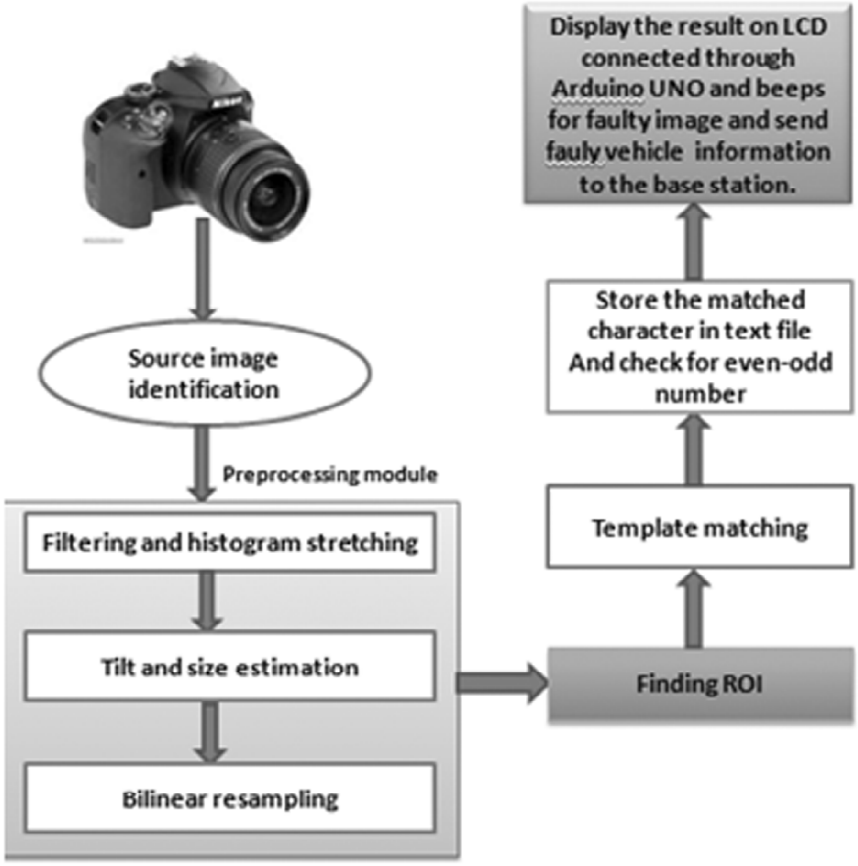

Figure 2: Number plate detection and Odd-Even protocols implementation

- ✓ Freeze the image of moving vehicle coming closer to 20 meters of the deployed station
- ✓ Enhance picture stability and quality
- ✓ Identification of the source image

- Resize the source image to 400*400, RS
- Convert the cropped RS to grayscale, GS
- Use median filter to remove the noise from the MGS
- Edge detection of GS
  - ✓ Finding the structural element using steel(),SE
  - ✓ Using SE dilate the image and erode the MGS image
  - ✓ Subtract the eroded image from the dilated image to get the morphological gradient for edge detection, DGS
- Convert the DGS to the intensity image [normalization]
- Two-dimensional convolution of the image
- Convert the double class to binary, BS
- Horizontal line removal
- Filling of holes, FBS
- The binary image then undergoes morphological operation,FBS1
- Selecting the region of interest (ROI)
- Measure the properties of ROI by bounding boxes in matrices of order number of boxes
- Extract the number of desired ROI from the total bounding boxes
- Selected bounding boxes
- Store the extracted letter in a txt file
- Read the txt file from the interfaced Arduino board
- Check for the odd and even formulation
- Display the result in LED , beeps for the faulty output, send an msg to the sink (center with detail of the number plates with location)
- 20. Process continue (infinite loop)

5. IMPLEMENTATION AND RESULTS

Odisha license number plate contains nine characters with four provinces. The leftmost two characters are a string that represents from which state the vehicle belongs. the next two character represents Integer followed by a character which represents the model of vehicle, and the rightmost four characters are Integer that identifies each registered vehicle. There are nodes in the highway having OE-TCM module deployed, the distance between two consecutive nodes is Km. for analysis purpose we have consider and analysis the working of one of the module of whole system. Our proposed model OE-TCM is following the following steps to extract license plates by considering the module to be kept at a particular node.

5.1. Source Image Identification

When the vehicle moves towards the node, the sensor senses the vehicle coming that initialize the camera which is situated in the deployed station actuates and starts freezing images of the vehicle. Among all the images, the module will identify the source image by enhancing the stability and hue, so that the number plate can be read by the module efficiently. A sample image is shown in figure number 3.

5.2. Pre-Processing image module

This module contains several steps.like, resize image, conversion of image, different image de-noising filter. After source image identification, the image is resized to 400*400 pixel and then converted to a grayscale image by eliminating the hue and saturation information while keeping the luminance. In order to reduce noise and to preserve the edges the gray scale image is fed to the median filter, the output pixel contains the median value in the m-by-n neighborhood around the corresponding pixel in the input image.

5.3. Edge Detection

After de-noising the next task is to segment and detect the edges of gray scale image. The segmented image is shown in the upper part of the fig. 5. And the lower part of the same figure is for edge detected image which involves basically three steps. First, the creation of structural elements having a rectangular shape. Second, the structural element dilates the gray scale image returning the dilated image, after that each element of the eroded image obtained using the same structural element is subtracted from the dilated image to produce a morphological gradient for edge detection.

Figure 3: A sample source Image identification.

Figure 4: Top one is the resize image , lower left one is the grayscale image and lower right image comes after denoising

5.4. Region of Interest finding (RoI)

After edge detection, the image is normalized, that enhances the intensity of the previous image and our main required interested image identification is carried out by several processes. First, in the region filling, the holes are filled with the binary image. Which then undergo a morphological operation by removing pixel apart from the filled area from the binary image, then thinning of the image is carried out.

From the previous output thinning image the region which is having pixel more than the required is selected, here we have taken this barrier as 100 pixel, selected region then undergo bounding boxes and the bounding boxes regions are then compared with the desired input scale and the number of output region, here we required 9 characters to read from the whole image. All the graph has been shown in figure 5.

5.5. Template matching

The out of the bounding box is simulated for template matching, we are having a set of templates design for Odisha number plate, which will select the character or number that it found the highest percentage of correlation, shown in fig 7.

5.6. Arduino Uno based fault detection

The matched template number plate data is then stored in a .txt file which then fetch by Arduino UNO and the odd or even license number plate is detected and display in the LED . According to the Odd-Even protocol, the faulty information is sent to the sink node for future necessary action that to is taken off.

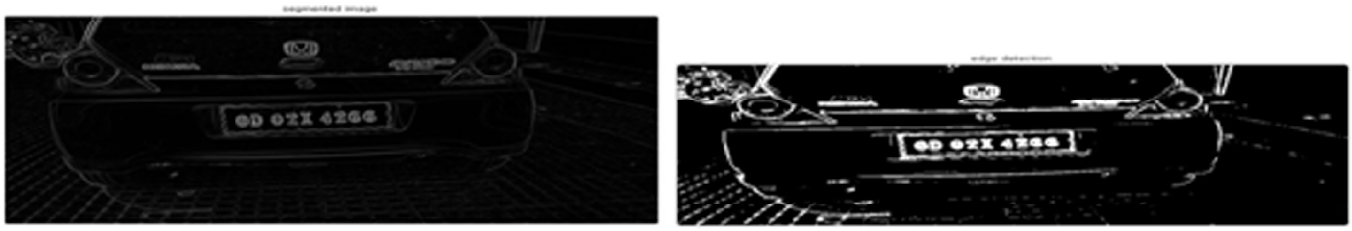

Figure 5: The upper one is the segmented image and the lower one is the edge detected an image of the source image.

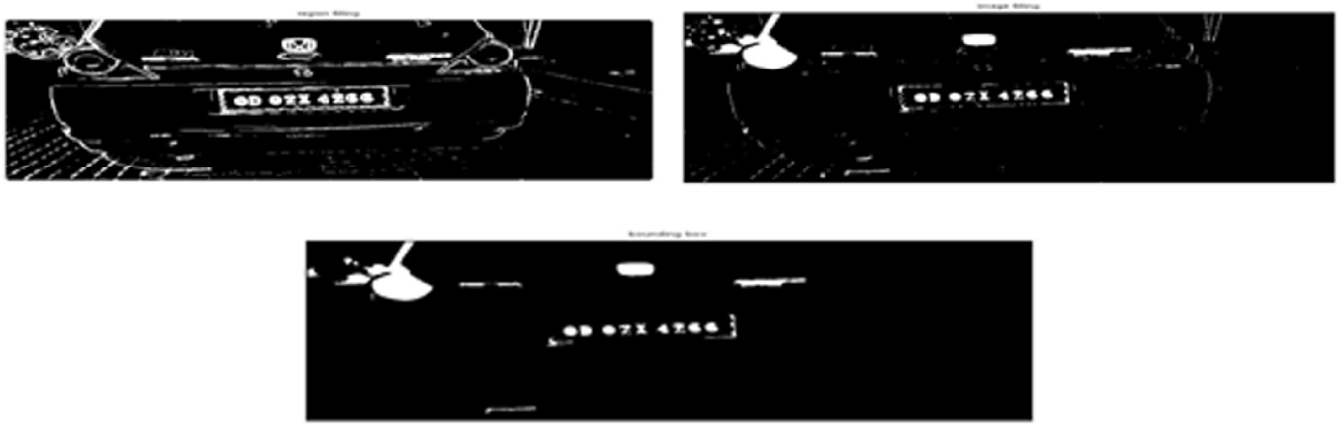

Figure 6: The top one is the region filling, middle one is image filling and the last one is the bounding box outcome graph

Figure 7: The extracted bounded box filled RoI in top which is correlated with the store template, shown in the bottom for the corresponding character

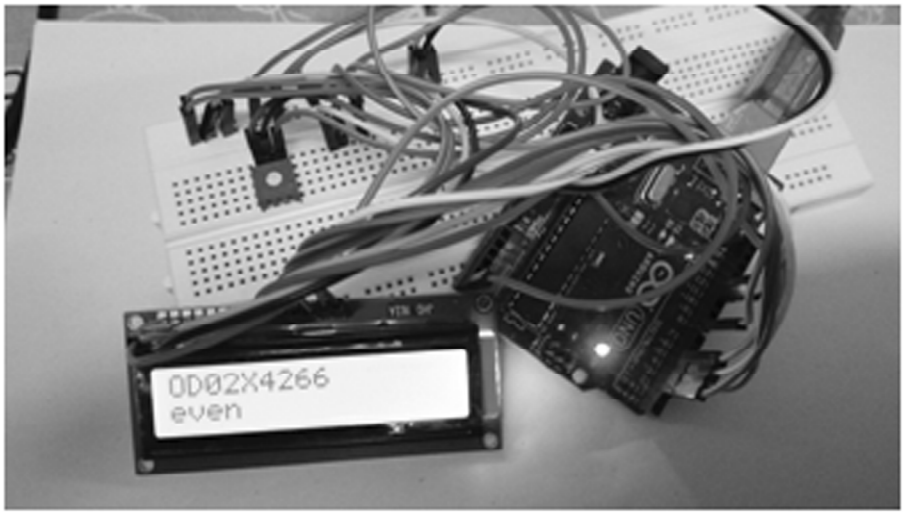

Figure 8: Arduino UNO interfaced with Matlab showing result in LED and beeping red LED as the day of testing is an odd day (3-3-2016)

This Arduino based automated system can be used in normal work condition. The system was tested over 300 vehicles. Among the tested vehicle number plate images, some are unrecognized number plates. The unrecognized vehicles are the foreign vehicle entering to the area. Out of 300 vehicle number plate images, 279 vehicle number plate images were detected successfully implying that 93% of the total vehicle number plate were recognized successfully and 21 vehicle number plate images remained unrecognized. It means that only 7% of the total vehicle number plate were not recognized. Hence, this Arduino based automated system has good efficiency, approaches to 93%.

Table 1 is holding the successfully number plate detected data after simulating our model, in an average one-thirteenth failure is happening in our proposed model due to the anomaly between some characters which has been plotted and simulated in Matlab, the figure 8. is showing the corresponding graph of table 1.

Table 1
The number plate successfully detected for the different district of Orissa using EV-TCM

Sl. No	*Districts of Odisha*	*Rto no.*	*Successfully detected number plates out of 10 samples*
1	Angul	OD19-X-XXXX	9
2	Bargarh	OD17	9
3	Bhadrak	OD22	9
4	Balasore	OD01	10
5	Balangir	OD03	9
6	Boudh	OD27	10
7	Cuttack	OD05	8
8	Deogarh	OD28	10
9	Dhenkanal	OD06	9
10	Gajapati	OD20	10
11	Ganjam	OD07	10
12	Jagatsinghput	OD21	9
13	Jajpur	OD34	9
14	Jharsuguda	OD23	9

(*contd...*)

(*Table 1 contd...*)

Sl. No	*Districts of Odisha*	*Rto no.*	*Successfully detected number plates out of 10 samples*
15	Kalahandi	OD08	10
16	Kandhamal	OD12	10
17	Kendrapara	OD29	9
18	keonjharh	OD09	10
19	Khurda	OD02	8
20	Koraput	OD10	9
21	Malkangiri	OD30	10
22	Mayurbhanj	OD11	10
23	Nuapada	OD 26	9
24	Nabarangpur	OD24	10
25	Nayagarh	OD25	9
26	Puri	OD13	8
27	Rayagada	OD18	10
28	Sambalpur	OD15	9
29	Subarnapur	OD31	10
30	sundargarh	OD16	8

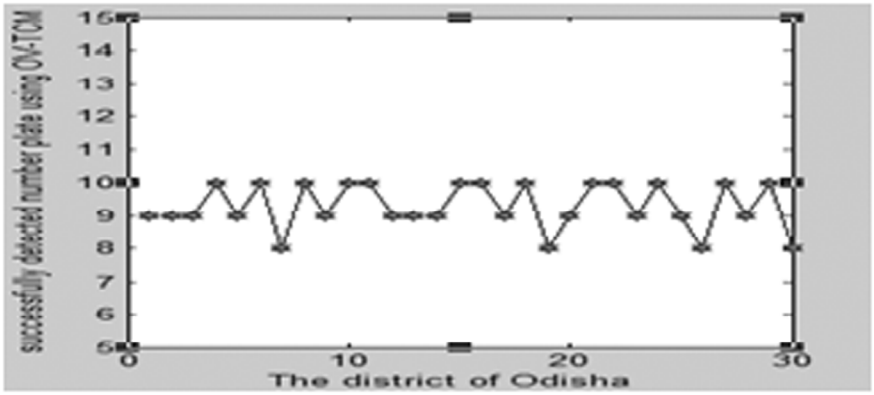

Figure 9: Graph showing the successfully detected number plate out of 10 for all district of Odisha using OE-TCP

6. CONCLUSION

We have implemented the whole proposed model to implement even-odd formula in one of the leading upcoming smart city of the nation, taking all the possible number-plate of the state with every possibilities of captured image, where we have found a high efficiency in detecting the number plate i.e 93 % and we have succeeded in detecting the faulty number plate in order to pursue odd- even protocol. Hence, on simulation basis the even-odd formula implementation in Bhubaneswar is found successful.

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