IoT Based Road Traffic Control System for Bangladesh

Tushar Deb Nath

***Abstract:** The existing traffic administration policy is not worthy enough to tackle the density of movement in Bangladesh. This study proposes an advanced Internet of Things (IoT) based road traffic administration system to resolve the problem. All the smart lamp posts of road crossings handle four factors, i.e., number of cars, activation time, waiting time, and emergency signal of each lane. This research uses an automatic video processing method to count the number of cars on the road. In order to process the video mask, R-CNN is used, which is a combination of the faster R-CNN that performs object detection (class + bounding box), and Fully Convolutional Network (FCN) results into a pixel border. Modern statistical methods are also used, such as multiple regression analysis, cluster analysis, and factor analysis. For handling emergency traffic situations, a new activation function was proposed and named the RT activation function. Factor analysis with principal component analysis (PCA) allowed in reducing the number of variables from elevens to five. The linear regression explains 90.2% of the variance in the data. This research considers R, R-square, adjusted R-square with 0.950, 0.902, and 0.409, values respectively. The results analysis ensures that the performance of the proposed schema is good enough to apply in the road of Bangladesh.*

***Keywords:** traffic jam, IoT, traffic system, video processing*

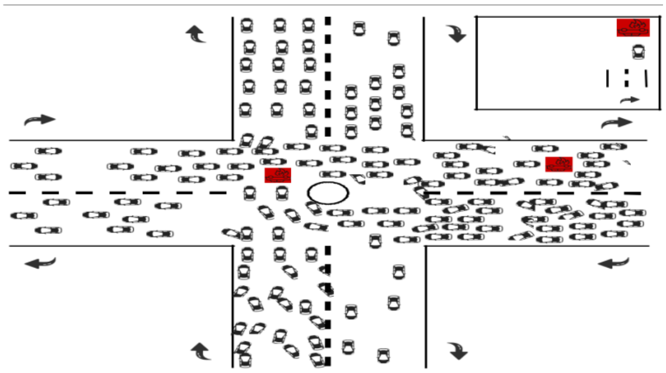

Fig. 1 Current situation of traffic System in Bangladesh

I. INTRODUCTION

Traffic jam is the most common and intolerable problem for all densely populated countries like Bangladesh. Drivers are careless about the traffic signals due to the lack of adequate traffic systems, which results in severe accidents and massive traffic jams. In 2019, at least 5,227 people were killed, while 6,953 injured in 4,702 road accidents across the country[1].

Fig.1 represents the present road traffic scenarios of Bangladesh. From Fig.1, we can see that; passengers don't have any respect for the traffic system, and vehicles from all lanes are passing willingly, which results in various major and minor accidents. In Bangladesh, traffic police solve this situation manually, and it costs an extra 2-3 hr for every passenger on that road. Traffic jam in the Dhaka city has turned daily trips into nightmares. The World Bank reported on the traffic condition of Dhaka and claimed that the speed has dropped from 21 kilometers per hour (kmph) to 7 kmph on average in the last ten years, and predicted that the speed might be dropped to 4kmph by 2035, which is slower than the walking speed. BRAC Institute of Government and Development indicated the effect of traffic congestion from two perspectives. Firstly, it consumes around 5 million working hours every day in Dhaka. Secondly, it costs $11.4 billion every year in the country. The Passengers' Welfare Association reported that traffic rules are violated by at least 87% of buses and mini busses. Each day 64 people are killed, and 150 people are getting injured across the country. [2] All the major cities throughout the globe experience traffic jams at certain hours of the day. It is not traffic jams in Dhaka, but it is inclusive traffic mismanagement and disorder. To solve those problems, the state government took larger projects, such as expanding footpaths, building flyovers, overpassing, and widening the roads, but no development had been seen yet. Dhaka is nearly 1% of the country's entire territory, but 36% and 44% of the total GDP and employment is contributed from here, respectively. The entire country is packed with disobedient drivers and foot-travelers who have no regard for traffic laws and rules. [2]

Bangladesh Road Transport Authority (BRTA) 3 reported that out of 3.1 million recorded vehicles in Bangladesh, Dhaka has nearly 1 million. Different researches point that the correct number of vehicles maybe around 5 million, including the registered 3.1 million. Out of this massive number of vehicles, 72% of them do not have fitness clearance. Revised Strategic Transport Plan (RSTP) analyzed that in 2016, around 30 million trips were made by the residents of Dhaka's every day, where 47%, 32%, and 9% involve buses, rickshaws and private cars respectively. It occupies 76% of the streets. Trucks load and unload commodity items, construction materials, and other goods in the middle of a road, causing massive traffic jams.[2] Some long-term projects were undertaken by the government in order to mitigate traffic jams, including two rapid bus routes, five metro rail lines, three-ring roads to deviate traffic from the city center, etc. But most importantly, Dhaka needs to be decentralized. Infrastructures failed to suit the scale of the population (18 million).

Manuscript received on January 11, 2021.
Revised Manuscript received on April 16, 2021.
Manuscript published on May 30, 2021.

* Correspondence Author
Tushar Deb Nath*, Department of Computer Science and Engineering, University of Asia Pacific, Dhaka, Bangladesh. Email: tushardebnath1992@gmail.com

Retrieval Number: 100.1/ijrte.E5232019521
DOI: 10.35940/ijrte.E5232.0510121

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication

Due to the pressure of this massive population, traffic condition is getting worse day by day.[2] Shepelev [3] discussed the use of multi-touch video cameras to collect the required information and to focus on the methods to improve them. Amount of pedestrians was also considered at the intersection. Data processing was done using statistical methods such as multidimensional scaling methods, cluster analysis, multiple regression analysis, and others. Basil and Sawant [4] pro- posed an IoT [5] based system that can make decisions for luminous [6] control depending on the intensity of light. Both of the `day' and `night' mode could be identified by setting up a fixed intensity value on the light-dependent resistor (LDR) [7] sensor. Lights of traffic lamp posts could be controlled by the infrared sensor (IR) sensor [8]. Solar cells [9] were used as a power source, and

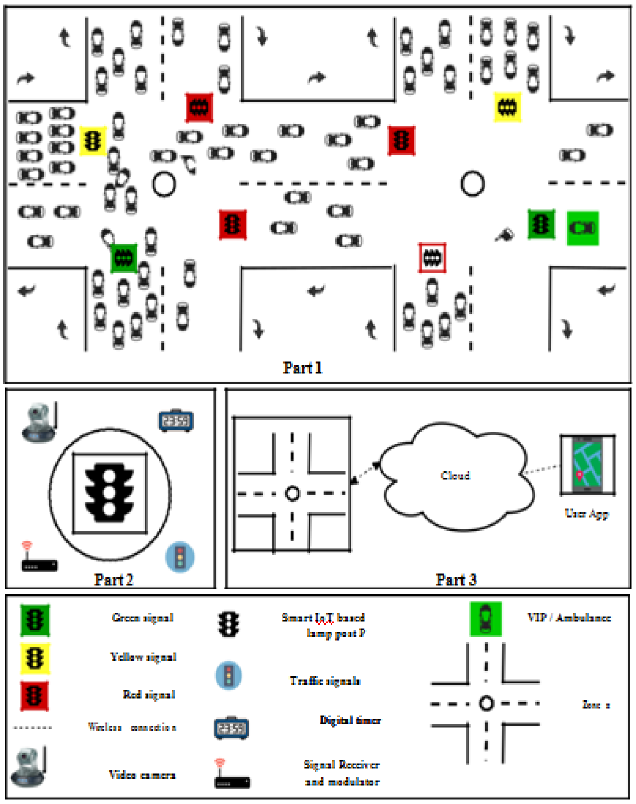

Fig. 2 Proposed automated traffic manipulation system

There was a backup DC supply for the emergency. The total system could work without traffic police, and traffic signals could be controlled automatically and monitored the entire system through the internet by installing Closed Circuity (CC) cameras based on a fixed time with equal priority to all the lanes. Saifuzzaman [10] had discussed that current tra c control systems are dependent on fixed signal timing. Autonomous traffic compactness in which signal timings were updated depending on the number of vehicles in each lens. Wi-Fi transceiver shield [11] [12] was used to transmit the amount of traffic of the current system to the next traffic signals. Signals were updated based on the traffic density of the past messages. Also, they introduced an image processing technique for counting the number of vehicles. Some other research [13,14,15] are also focused on IoT based traffic manipulation system. The above-discussed systems mainly focused on the timing, the number of vehicles on the roads, and pedestrian at the intersection. Still, a more generalized solution is required. All emergencies like ambulance, firefighters or VIP Passing, etc. need to be considered. An app[16] [17] is required so that foot-travelers are aware of the traffic congestion and lane changing. Thus, by finding the flaws of existing methods, this study proposes a united IoT based traffic manipulations system. The proposed IoT based method is fully auto-mated and capable of handling all kinds of emergencies. The proposed app is connected with the cloud workstation, and users are informed about the traffic conditions. It was developed by considering the number of traffic and fixed signal timing in a particular lane. This system can also handle emergencies of VIPs and ambulances. The system is automated and developed based on IoT. Here all lamp posts in any intersection zone are embedded [18] and connected with the cloud workstation [19] through the internet [20]. The lamp post is identifying the traffic congestion of its respective lane and also monitoring the time of yellow and red light signals with a digital timer. In the general case, each lane will be in the green light state for three minutes, but when the pres-sure of traffic in a particular lane is immense, then the time for the green light signal of the lamp post on that particular lane will be increased. In the worse scenario, a lamp post of a particular lane will not be in the red or yellow signal state for more than 15 minutes. VIP emergencies can be handled with an emergency signal, but the signals must send from the official traffic authority. For ambulance emergencies, the same process can be applied, and the surveillance cameras can automatically identify the ambulance and act accordingly. Fig. 2, Part 1 shows a summary of the proposed automated traffic control system, where all the cars of the lanes are controlled in an ideal manner.

Overall, the public transport system of Dhaka is not adequate and properly routed. The introduction of a dependable public transport system is needed so that the pressure of vehicles reduce on the road. The rest of the paper is articulated as follows. Section 2 hold Methods. The result analysis is discussed in Section 3. The paper is concluded in section 4.

II. METHODOLOGY

In the proposed method, each lamp posts are integrated with a surveillance video camera [21], a digital timer, a signal modulator, and a signal receiver. Fig. 2, Part 2 shows the internal structure of the smart lamp post. A lamp post consists of a video camera, digital timer, signal receiver and modulator, and display. Fig. 3 clear illustrates an overview of the working process of the smart lamp post, where the signal receiver maintains the connection between the lamp post and the AI traffic signal controller. The video camera counts the number of cars, and the digital timer keeps track of each lane’s activation and waiting time. Emergency signal checking will be done at first. If the signal flag

Retrieval Number: 100.1/ijrte.E5232019521
DOI: 10.35940/ijrte.E5232.0510121

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication

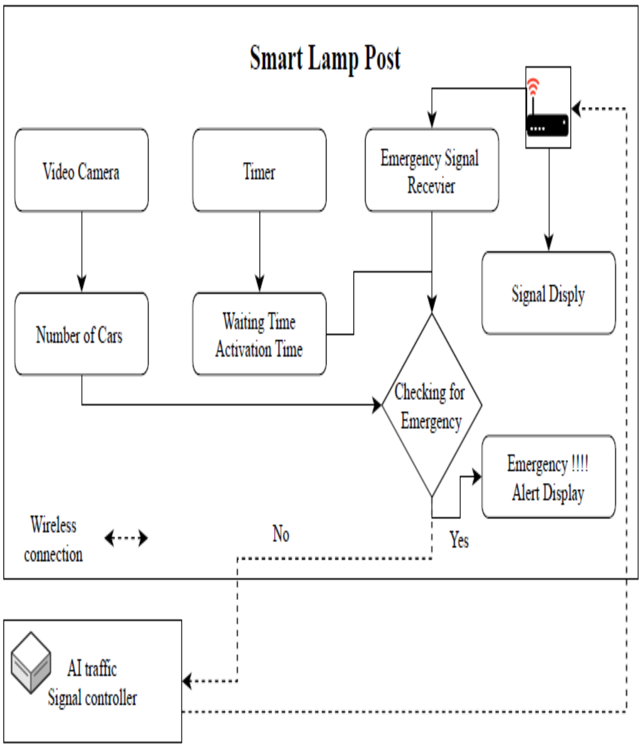

Fig. 3 Structure of the proposed Smart lamp post

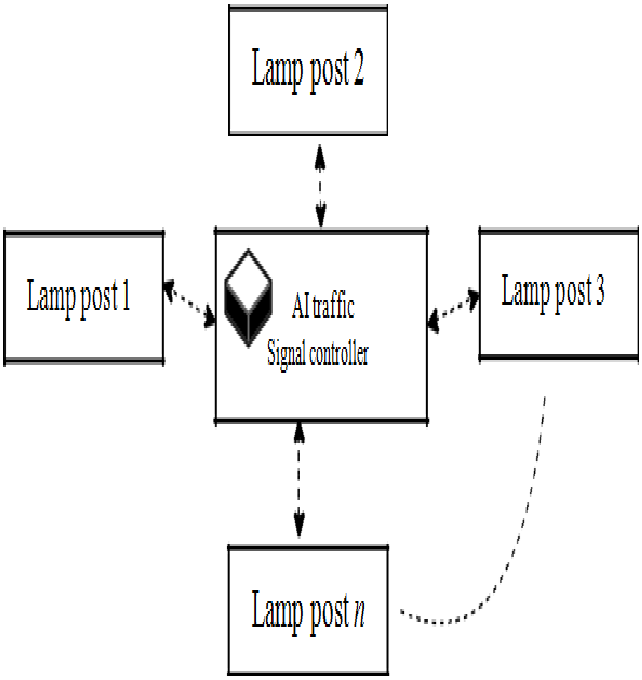

Fig. 4 Connection of lamp posts in an intersection with AI traffic control center

Is one, the emergency lane will be activated. If there is no emergency signal, then the data from the video camera and timer will be sent to the AI traffic signal controller. Fig. 4 shows that each intersection has an AI traffic signal controller for all the lamp posts in that intersection. The AI traffic signal controller will decide the traffic passage based on the data received from the smart lamp post and the proposed algorithm.

The camera of a particular lamp post is used to identify the congestion of traffics on that lane. The study of Shepelev [3] was used for video processing. Methods were proposed in order to collect data from the camera with video analysis in a traffic congestion situation. Different statistical methods

Table- I: Table of considered variables

Variable	Unit
Number of vehicles driven in the 1st window	one unit
Number of vehicles driven in the 2nd window	one unit
Number of vehicles driving in the 3rd window	one unit
Number of vehicles in the queue	one unit
t1 { time of movement of the 1st vehicle from the stop line to the beginning of rounding	second
t2 { time of movement of the 1st vehicle in an arc (until the exit from the turn)	second
Number of vehicles completing the passage to the red signal of the traffic light	one unit
Sampling for the maximum possible number of vehicles driving	one unit
L1 { the distance from the stop line to the border of the intersection with the conflicting direction	meter
L2 { the curvature of the carriageway when turning right	meter
The actual number of passing cars	one unit

Were used for data processing, i.e., multidimensional scaling methods, cluster analysis, and multiple regression analysis. Tasks were divided into two parts. Firstly, identification of the factors influencing the congestion at the intersection. Secondly, congestions were divided into clusters based on their characteristics. The entire process of identifying the number of cars are divided into three parts, and its listed below:

- Variable Selection
- Data Collection
- Detection Methods

The data were collected for various intersections. At each intersection, lanes were selected that meet the following requirements: turn right, turn left, and way towards the junction. Twenty- five, such bands, were selected. The data was collected over a certain period of time from "date" to "date". The set of features from the video stream used in the study is presented in Table 1. An intersection is the area of junction, the fork of roads at the same level, cross-roads. The throughput is determined mostly by the structure of the cloverleaf. Notably, based on the arc, when turning right and the position of printing (stop lines, crosswalks). This investigation was put forward to secure the location of the marking, the influence of the magnitude of the arc. L1: represents the distance from the stop line with the conflicting direction, m to the border of the intersection. L2: represents the curvature when turning right, m of the carriageway. Data L1, L2 are static characteristics of the intersection. Data acquisition system has many features; one of them is that its design is particularly dedicated for outdoor cameras, which are stationary and consists of multi-sensor. The system works with Intersvyaz company's outdoor cam-eras[4]. Neural networks were used in this system. The system uses the Mask R-CNN or variation Faster R-CNN in order to recognize the road transport.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication

Table-II: Decision table of lamp posts in 4-way lane intersection

Sr. of lamp posts	No. of car	Waiting time (minute)	Activation time (minute)	Emergency signals	Past status	Current status
1	10	5	0	0	Red	Red
2	20	2	0	0	Green	Red
3	8	10	0	0	Yellow	Yellow
4	6	0	1	1	Red	Green

The R-CNN mask is a combination of the faster R-CNN that performs object detection (class + bounding box) and FCN (Fully Convolutional Network), which creates a pixel border. The R-CNN mask is conceptually simple: the faster R-CNN has two exits for each candidate object, a class label, and an o set bounding box. To this is added a third branch, which displays the object mask - this is a binary mask that indicates the pixels in which the object is in the bounding box. But the additional mask output differs from the output of the class and block, which requires the extraction of a much more accurate spatial location of the object. For this, the R-CNN mask uses the fully collapsed k (FCN) network. The FCN is a popular algorithm for semantic segmentation. This model uses various convolution blocks and maximum pool layers to reduce the image to 1/32 to its original size. Then this algorithm makes a class prediction at this level of detail.

Finally, the algorithm uses the sample and deconvolution layers to resize the image to its original size. The mask R-CNN unites two networks, namely: the faster R-CNN and the FCN into one significant architecture. The loss function for the model is the total loss when performing classification, creating the bounding box, and creating the mask. For the training of the system, a dataset was assembled, in which about one thousand marked images were collected for one intersection. The images were taken at different times of the day, under different weather conditions. This allows us to receive data under any conditions without loss of quality. Into Faster R-CNN, the image is provided as an input to a convolutional network which provides a convolutional feature map. Instead of using selective search algorithm on the feature map to identify the region proposals, a separate network is used to predict the region proposals. The predicted region proposals are then reshaped using a RoI pooling layer which is then used to classify the image within the proposed region and predict the o set values for the bounding boxes [22]. Another feature of the system can be considered that it works with poor quality cameras.

Statistical approaches were extensively used for processing and investigating information received at junctions from street sensory monitoring cameras for road conditions. The quantitative rules of transport flow in close association are distinguished by these techniques with their qualitative content. The problems of statistics in this investigation are most closely related to real life. They are correlated with the detection of trend features of road traffic at junctions under traffic jam conditions. Multiple regression analysis, cluster analysis, factor analysis techniques were used in this research. It is essential not only to collect real-time [23] data from video cameras quickly and accurately but also to be able to process the collected information using appropriate statistical methods. Nowadays, under conditions of the wide distribution of high-performance sensor [24] systems, the collection of data does not present significant difficulties. The prominence is the intelligence to obtained and process data accurately. We process information using the SPSS computer program. The use of statistical data offers to the familiarization of experts in conveyor logistics with the state on the streets, contributes adjustment to varying states and securing the best supervision judgments.

The output from the digital timer, No of cars, and the output from the digital signal receiver was considered by the lamp post and sent to the cloud workstation of that zone in order to show a traffic signal. From the workstation, the data are transferred to the public app, and the process is showed in Fig. 2, Part 3. The cloud work station maintains a table. For each intersection zone, all decisions of individual traffic lamp posts are represented in that table. Table 2 represents a demo version of each lamp posts in 4 lane intersection zone. In Table 2, the 3rd lamp post is supposed to be in the green state as it has the yellow status previously, but the 4th lamp post had an emergency signal, which causes the 3rd lamp post to be in the yellow state. Algorithm 1 and Algorithm 2 describe the decision making process of the proposed system.

For simplicity, we are considering the Algorithm 1 and Algorithm 2 for a four-lane intersection. The input of the proposed algorithm is the number of cars in each lane c[ ], the waiting time of each lane t_w[ ], the activation time of each lane t_a[ ], emergency signal array e[ ], emergency flag e-flag[ ] and lane ranking l[ ]. Firstly, the proposed algorithm checks for emergency signals using the emergency ag. If there is no request for emergency signals, then the algorithm will go for scheduling tasks and go for Algorithm 2 from the line number 16 of Algorithm 1, where inputs are the number of cars in each lane c[ ], the waiting time of each lane t_w[ ], the activation time of each lane t_a[ ], and lane ranking l[ ]. At first, the waiting time of each lane will be checked, and if the waiting time of any lane is more than 15 minutes, then that lane will be activated. If any lane has the highest number of cars and the waiting time of that lane is 2nd from the top, then that lane will be activated. Except for these special cases, all the lanes will be activated for 3 minutes, respectively, one after another.

We developed a novel method in order to check the emergency signal of a lamp post. To develop the proposed emergency checking method, let's consider the number of the car, time, and emergency signal as c, t, and e, respectively. Total number of cars in a lane l, T_c^l

$$T_c^l = \sum_{i=0}^{n} c_i \quad (1)$$

Here i is a counter and rises up to n. Again, the Total amount of waiting time in a lane, $T_{t_w}^l$ before turning into the green signal from red or yellow

Algorithm 1 Traffic flow control

Retrieval Number: 100.1/ijrte.E5232019521
DOI: 10.35940/ijrte.E5232.0510121

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication

```
input:
    c[ ]: number of cars in each lane
    t_w[ ]: waiting time of each lane
    t_a[ ]: activation time of each lane
    e[ ]: emergency signal array
    e_flag[ ]: emergency flag
    l[ ]: lane ranking
output:
    lane id's with green and yellow signals g_lane, y_lane respectively.
procedure CONTROL(c,t_w,t_a,e,l)
  if e_flag==1 then
     e=priority_checking(e)
     g_lane = e[ 0 ]
     y_lane = e[ 1 ]
  else
     l= SCHEDULER(c,t_w,t_a, l)
     g_lane = l[ 0 ]
     y_lane = l[ 1 ]
  return g_lane,y_lane
```

Algorithm 2 Traffic scheduling

```
procedure SCHEDULER(c,t_w,t_a,l)
  identify the index of the top two t_w & c of the lanes as h_w[ ] & h_c[ ] respectively
  if h_w[ 0 ] is_greater_than 15 then
     active h_w[ 0 ] as l[ 0 ]
     active h_w[ 1 ] as l[ 1 ]
  else if h_c[ 0 ] is_equal_to h_w[ 1 ] then
     active h_w[ 1 ] as l[ 0 ]
     active h_w[ 0 ] as l[ 1 ]
  else if current lane t_a[ i ] is_greater_than 3 then
     active t_a[ i+1 ] as l[ 0 ]
     active t_a[ i+2 ] as l[ 1 ]
  return g_lane,y_lane
```

signal. The total amount of activation time in a lane, $T_{t_l}^{l}$ before turning into yellow or red signal from green signal. So, Emergency signal checking, E,

$$E= [f(x)] \tag{2}$$

Where, f(x) is the RT activation function and x is variable.

$$x= [T_c^l + T_{t_w}^{l} + T_{t_l}^{l}].e \tag{3}$$

The proposed RT activation function in order to check the emergency signal is as follows. Fig. 5 shows the graph of the activation function.

$$f(x) = \begin{cases} \frac{1}{1+e^{x}}, & \text{if } x>0 \\ 1, & \text{if } x<=0 \end{cases} \tag{4}$$

Whenever more than one emergency signal were coming to the traffic control center at a time for a cross-section, then the priority checking of the

Graph of RT activation function

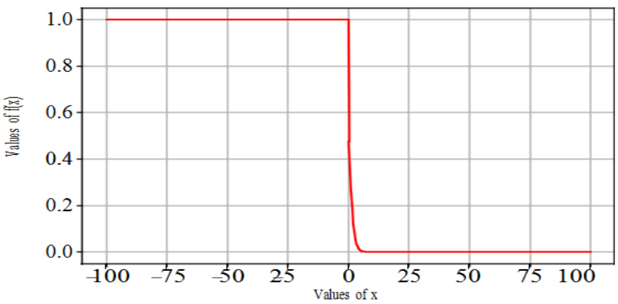

Fig. 5 Graph of proposed RT activation function: Equation no. 4

emergency signal is done. The priority of the emergency signals was shown in Table 3. Government officials include president, prime minister, etc. They have the first priority. Law enforcement agencies include State Police and Highway Patrols, County Police and County Sheri s, Township and Municipal Police, and other agencies that have officers sworn to enforce laws. Fire and rescue services are provided by the county and municipal re departments, and by surrounding re departments through mutual aid agreements. In most large urban areas, full-time professional personnel staff fire and rescue departments. In many suburban and in most rural areas, volunteers primarily provide re and rescue services. The primary responsibilities of EMS are the triage, treatment, and transport of crash victims. In many areas, re and rescue companies provide emergency medical services. Emergency medical services have evolved as primary caregivers to individuals needing medical care in emergencies. As with police, emergency medical personnel have a defined set of priorities. They focus on providing patient care, crash victim rescue, and ensuring the safety of their personnel. Public safety communications services are emergency call takers and dispatchers. In larger urban areas, call taking and dispatching du-ties may be separated. Call takers route emergency calls to appropriate dispatch. Most larger urban areas have emergency capabilities so that call takers can obtain the location of landline emergency calls. Many rural areas do not yet have an emergency. Most calls on highway emergencies come from cellular telephones that are currently not able to provide location information for emergency calls.

Table-III: Priority of the emergency signals

Priority	Emergency cases
1	Government officials
2	Law Enforcement
3	Fire and Rescue
4	Emergency Medical Services
5	Public Safety Communications

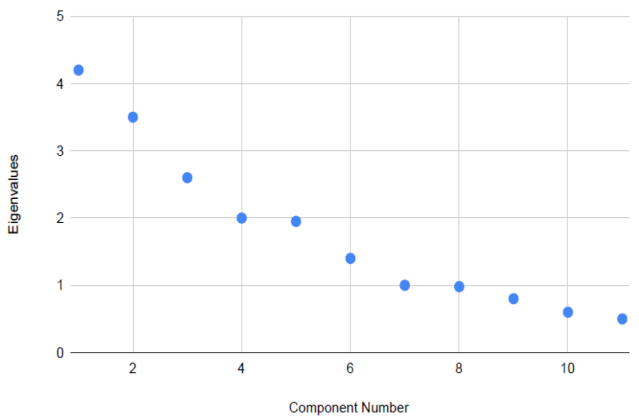

Fig. 6 Graph of eigenvalue

III. RESULT ANALYSIS

In order to perform factor analysis, eleven source variables were established. Factor analysis can be conducted in various methods. For this experiment, principal component analysis has been used.

Retrieval Number: 100.1/ijrte.E5232019521
DOI: 10.35940/ijrte.E5232.0510121

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication

In order to obtain a simpler structure for the interpretation of the selected factors, the rotating factors procedure was carried out, which corresponds to a large value of a load of each variable only for one factor and a small one for all other factors. The most popular rotation option is the Varimax orthogonal method [25] was used in this study. The scatter plot Fig. 6 shows the eigenvalues on the y-axis and the number of factors on the x-axis, which indicates a downward curve. The "leveling o " point of the slope in the curve indicates the number of factors that should be generated by the analysis. Based on the scatter plot, five factors can be taken. The eigenvalues for them are more significant than 1.5. There-fore, the graph of eigenvalues (scatter plot), shown in Fig. 6 allows concluding that ve factors can be distinguished. The performed factor analysis helps to switch to latent variables while reducing the number of variables from twenty

Table-IV: Variable description

R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin Watson
0.950	0.902	0.409	1.881	1.533

one only to five. The sharp decrease in the number of variables will make it possible in the future to greatly facilitate the study of the behavior of traffic rows under traffic congestion. In order to select the entirety of the primary impactful variables, multiple regression analysis was used. The impact was considered to be on the through-put of the crossings under the traffic jam situation. This analysis helps to rank the chosen variables. The ranking is done according to the strength of their authority on the throughput of crossings. It also helps qualify the strength of the influence. The multiple regression method was developed in order to predict the throughput of the crossings. The prediction is made in terms of specific values of its fundamental characteristics. The entire process is indicating a result of the analysis. The actual number of passing cars is considered to be the dependent variable since this variable is the criterion of the intersection capacity. Independent ones are the remaining variables from Table 1. The package of statistical computer programs SPSS was used for the analysis using the option "Multiple linear regression analysis". Table 4 shows the overall t statistics and a summary of the multiple linear regression model. The coefficient of many correlations R has indicated the relationship with a set of the independent variables equal to .958 of the dependent variable "The original number of transpiring cars". The adjusted R^2 of the proposed model is .409, with the coefficient of many determination $R^2 = .902$. This means that in the data, the linear regression has 90.2% of the variance. The Durbin-Watson d = 1:533 and is in between the two critical values of $1:5 < d < 2:5$. So, there is no first-order linear auto-correlation in multiple linear regression data.

Characterizations by a set of features, the division of the intersections can be achieved with the cluster analysis. Classification of the crossings and identification of the corresponding structure is done. This model focused on the compact removed groups of intersections, which are separated from each other. In other words, a \natural" partitioning of the aggregate of these intersections into areas of the gathering is found. The Squared Euclidean distance was taken as a measure of proximity. The Ward's approach was chosen as the clustering method and it allows forming clusters with minimal dispersion.

IV. CONCLUSION

This study focused on the traffic conditions of Bangladesh and proposed an IoT based advance traffic control system. This system can automatically manipulate the traffic system and handle emergency traffic situations. All the lamp posts of each crossroads are connected with the internet and focus on the number of cars, activation time, waiting time, and emergency signals in each lane. For detecting vehicles, a data collection system is used. The system works with outdoor cameras of "Intersvyaz" company, and it is a software that works on the basis of neural networks. For recognition of road transport in the system, Mask R-CNN is used. The R-CNN Mask is a combination of the faster R-CNN that performs object detection (class + bounding box) and FCN (Fully Convolutional Network), creating a pixel border. A large number of experiments with data sets show that the proposed method is superior to some existing algorithms in accuracy and provides real-time detection. Again, to handle the emergency signals, a complete new activation function was developed. Time complexity of the proposed system is also favorable. Overall, the proposed system solves all the problems mentioned above. Although the proposed system covers all the basic problems but there many scopes, where this study can be improved. Though scopes can be denoted as the limitations. A better video processing can be proposed for faster real time car detection and count. This study consider 4 factors in order to handle the traffic signals, which can be modified. Emergency activation function can be represented in a less expensive way. This study only focus on the compact removed groups of intersections, which are separated from each other.

CONFLICT OF INTEREST

On behalf of all authors, the corresponding author states that there is no conflict of interest.

REFERENCES

1. DAILYSTAR (2020) ttps://www.thedailystar.net/country/bangladesh-road-accidents-in-2019-saw-signi cant-rise-1849381. (access-date: 18-04-2020)
2. DAILYSTAR (2020) https://www.thedailystar.net/opinion/society/tra c-jam-the-ugly-side-dhakas-development-1575355. (access-date: 19-04-2020)
3. Vladimir Shepelev, Sergei Aliukov, Kseniya Nikolskaya, Arkaprava Das, Ivan Slobodin (2020) The use of multi-sensor video surveillance system to assess the capacity of the road network. Transport and Telecommunication, volume 21, no. 1, 15{31
4. Elizabeth Basil and Prof. S. D. Sawant (2017) IoT based Tra c Light Control System using Raspberry Pi. International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS-2017)
5. I-Vongsingthong, S. Smanchat, S. (2014) Internet of Things: A review of applications & technologies (PDF). Suranaree Journal of Science and Technology

Retrieval Number: 100.1/ijrte.E5232019521
DOI: 10.35940/ijrte.E5232.0510121

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication

6. Karmen Franinovic and Luke Franzke (2015) Luminous Matter Electroluminescent Paper as an Active Material. 9th International Conference on Design and Semantics of Form and MovementAt: Milano
7. Anis Yuniati and Rochan Rifai (2019) Study of simple spectrophotometer design using LDR sensors based on arduino uno microcontroller. Journal of Physics Conference Series 1153:012099, Ferbruary 2019
8. Gines Benet Gilabert, Francisco Blanes, Francisco Blanes, Jose Enrique Simo and Pepita Perez (2002) Using Infrared sensors for distance measurement in mobile robots. Robotics and Autonomous Systems 40(4):255-266, september 2002
9. Shruti Sharma, Kamlesh Kumar Jain, Ashutosh Sharma (2015) Solar Cells: In Research and Applications|A Review. Materials Sciences and Applications 06(12):1145-1155. Jan-uary 2015
10. Mohd. Saifuzzaman, Nazmun Nessa Moon and Fernaz Narin Nur (2017) IoT Based Street Lighting and Traffic Management System. 2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC)
11. Tariq AL-KadiZiyad, AL-Tuwaijri and Abdullah AL-Omran (2013) Arduino Wi-Fi Net-work Analyzer. Procedia Computer Science 21:522-529, December 2013
12. Gyu-Sik Kim (2017) ESP8266 Wi-Fi Module For Monitoring System Application. Global Journal of Engineering Science and Researches, January 2017
13. Mahbub, M. (2020) NB-IoT: applications and future prospects in perspective of Bangladesh. Int. j. inf. tecnol. https://doi.org/10.1007/s41870-020-00469-x
14. Kumar, S., Raza, Z. (2017) Using clustering approaches for response time aware job scheduling model for internet of things (IoT). Int. j. inf. tecnol. 9, 177{195, https://doi.org/10.1007/s41870-017-0020-0
15. Kumar, S., Baliyan, A., Tiwari, A. et al (2019) Intelligent tra c controller. Int. j. inf. tecnol. https://doi.org/10.1007/s41870-019-00405-8
16. Muhammad Haris, Basit Jadoon and Farhan Hassan (2017) Evolution of Android Oper-ating System: A Review. Conference: International Conference on Advanced ResearchAt: Melbourne, AustraliaVolume: 2nd. November
17. Carlos Balsalobre-Fernandeza, Mark Glaisterb, Richard Anthony Lockey (2015) The validity and reliability of an iPhone app formeasuring vertical jump performance. Journal of Sports Sciences
18. Xin Wang, Zhong Wang, Wei Huang and Shao Lei Zhang (2017) Summary of Embedded Systems Development, 5th International Conference on Frontiers of Manufacturing Science and Measuring Technology (FMSMT 2017)
19. S. M. Raj Kumar, C. Naveen Kumar (2017) Design of Workstations for Computer Users: A Review. IRE Journals | Volume 1 Issue 4 | ISSN: 2456-8880. October 2017
20. Ioannis P. Chochliouros, Anastasia S. Spiliopoulou, Evangelos Sfakianakis (2013) Living Labs in Smart Cities as Critical Enablers for Making Real the Modern Future Internet. Communications in Computer and Information Science 384:312-321, September 2013
21. G. van Voorthuijsen, H. van Hoof, M. Klima and Petr Pata (2005) CCTV e ective-ness study. Security Technology. 39th Annual 2005 International Carnahan Conference on Technology
22. Gandhi, R. (2018) R-CNN, Fast R-CNN, Faster R-CNN, YOLO.Object Detection Algorithms July 9, 2019. https://towardsdatascience.com/r-cnn-fast-r-cnn-faster-r-cnn-yolo-object-detection-algorithms36d53571365e
23. Kamaran Faraj, Ali FarajAli Faraj, Tara Nawzad and Pshko Rasul Mohammed Amin (2015) Response Time analysis for Apache Web server versions based on 32 or 64 bit Architecture. INTERNATIONAL JOURNAL OF COMPUTER SCIENCES AND ENGI-NEERING 3(10):38-42
24. Shadman Fahim Ahmad, Abrar Hasin Kamal and Iftekharul Mobin (2016) Ultrasonic Sensor Based 3D Mapping & Localization. International Journal on Computer Science and Engineering (IJCSE)
25. Basto, M, Pereira (2012) J. An SPSS R-Menu for Ordinal Factor Analysis. Journal of Statistical Software, 46(4), pp. 1{29

AUTHOR PROFILE

Tushar Deb Nath., Recently I have completed my graduation from University of Asia pacific in Computer Science and Engineering. In the meantime, I worked on many research papers but among these research paper my best work is on IOT (G-TBSA: A Generalized Lightweight Security Algorithm for IoT), besides I worked on web development. If I am talk about my strength. I would like to say, I am so industrious and focused on my goal. Last but not the least I have some interest zone for instance Data Science, IOT, Artificial intelligence, Machine learning, Deep learning, Natural language processing, Computer vision etc.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication