Study of road transport system for Amravati city using Artificial Intelligence

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Abstract - *As the population grows and their mobility needs become more intricate, transportation systems must evolve to address advanced mobility issues. Furthermore, there are various instances in which traditional methods are useless, such as when processing large amounts of data provided by in-vehicle sensors and network devices. To solve these issues, several Artificial Intelligence-based solutions have been deployed to various areas of the transportation environment. In this study, the traffic system of Amravati city mainly in Rajkamal Square is studies as it is the most busy area in the city. The traffic density passing from the square in one hour by the conventional traffic signaling system is calculated. Then the probable outcomes from the proposed traffic signal controlling system created using artificial intelligence by scratch pygame python programming and algorithm was compared with the conventional one and results were drawn. It was seen than the proposed system is more effective and efficient than the current system since is can pass more vehicles in an hour than the current one reducing congestion occurs at traffic signal hence reducing fuel consumption and environmental pollution. The proposed traffic signaling system can be used all over the country for reducing problems like congestion and pollution occurs due to traffic jams at signal junction.*

1. INTRODUCTION

Technology has previously benefited organizations in resolving challenges; some of these solutions have revolutionized the way businesses run by lowering operating costs and increasing efficiency. The transportation industry is one of the next industries to successfully adopt new technology, as it faces hurdles such as traffic congestion, unexpected delays, and routing issues, all of which result in financial losses for the company. Traffic congestion, air and noise pollution, and traffic accidents are all serious concerns in metropolitan areas as the number of private automobiles on the road increases. Urban traffic congestion is becoming one of the most significant concerns. Smarter transportation networks, specifically intelligent/smart transportation, is one of the key smart city visions. Artificial intelligence (AI) has been instrumental in realizing the goal of a smart city. The former offers a scalable and dependable data collection and transmission infrastructure. Machines for intelligent transportation applications benefit from the latter's creative and unique qualities.

Artificial intelligence (AI) has emerged as a prominent area of research to address most of the present environmental sustainability difficulties as a result of global environmental challenges in the twenty-first century. A detailed grasp of the links between AI and data on the one hand, and transportation system characteristics and elements on the other, is required for successful AI implementation. It's also hoped that transportation officials will figure out how to employ these technology to improve traffic congestion and travel times.(Abduljabbar et al., 2019).

In this project, artificial intelligence is used to deploy a smart traffic light control system in Amravati to address issues such as traffic delays, environmental pollution, and carbon emissions caused by excessive fuel burning during traffic congestion, and large red time delays. Amravati was chosen for the proposed project since it is one of Maharashtra's fastest growing cities. By implementing a system that aims to reduce such problems by automatically computing the optimal green signal time based on the current traffic condition at the signal, we can ensure that the direction with more traffic is allotted a green signal for a longer period of time as compared to the direction with less traffic, jams at traffic signals and more fuel consumption.

2. LITERATURE REVIEW

Artificial intelligence (AI) is a vast field of computer science that aims to make machines behave like humans. AI is sometimes defined as a machine's ability to conduct human-like cognitive processes. Processing the data using powerful

algorithms has provided significant benefits to governments and corporations in recent years. In its current state, AI can handle challenges in real-time transportation, such as controlling the design, operation, timetable, and administration of logistical systems and freight transportation. The research focuses on specific areas of concern in the transportation industry, as well as difficulties that can be addressed with AI. Traffic Management, Public Transportation, Safety Management, Manufacturing, and Logistics are some of the sub-systems considered in Intelligent Transportation Systems where AI benefits are put to use (Iyer, 2021). Over the years, AI technologies have been deployed, and this paper explains how they might be useful to transportation applications. The most important AI application areas include system identification and function approximation, nonlinear prediction, design, planning, optimization, decision making, clustering, and pattern recognition (Kyamakya, 2006). Artificial intelligence technologies enable the creation of road and highway ecosystems via the Internet and digital platforms. These ecosystems enable the collecting and analysis of data on vehicles and road infrastructure to solve a wide range of problems related to transportation management. The use of "smart" control systems for federal roads and highways that are synced with the transportation control systems of significant cities and other territories allows for increased cargo turnover and passenger flow while maintaining traffic safety (Okrepilov et al., 2022).

Transportation is not overlooked by intelligent technologies that are infiltrating various aspects of human life. These technologies are designed to improve people or products mobility while also improving road safety and transportation comfort, reducing transportation collisions, and reducing environmental impacts. AI approaches enable apps to manage the complete transportation system - vehicles, drivers, infrastructure, and how these components dynamically supply transportation services (Šusteková D & Knutelská M, 2015). The use of artificial intelligence in transportation aims to address the difficulties of rising travel demand, CO2 emissions, safety concerns, and environmental degradation. When the system and users' behaviour are too difficult to model and predict, transportation difficulties become a hurdle. As a result, AI is seen as a good fit for transportation systems to address issues such as rising travel demand, CO2 emissions, safety problems, and environmental degradation (Abduljabbar et al., 2019). Artificial Intelligence (AI) has the potential to provide a vehicle for transformation in a time when the need to shift to a more sustainable techno-social paradigm is more pressing than ever before to avoid the negative consequences of a resource-intensive and unthinkingly opportunistic liveability philosophy that does not look far in the future. AI is described as a system's ability to accurately read external input, learn from it, and apply that learning to accomplish specific goals and activities through flexible adaptation. By eliminating the need for human labour and greatly enhancing our scientific and technical advancement, AI has the promise of making us healthier, wealthier, and happier (Nikitas et al., 2020). The evolution of transportation systems to tackle advanced mobility problems has become required as the population grows and their mobility needs become more sophisticated (Machin et al., 2018).

3. METHODOLOGY

The research was carried out in Amravati city. Population wise it is the 2nd highest populated city after Nagpur in the Maharashtra's Vidarbh region with population 7,78,087. Rajkamal Square is the most busy square and most populated area in Amravati so it is selected for the study. Rajkamal is moving from developing to developed area, resulting in urbanization and vehicular traffic as it a main and central area connecting Gandhi chowk, Jawahar gate, Jayastambh, Main market line, Rajapeth, Bus stand and Railway station.

The analysis was conducted using a simple framework for evaluating the existing traffic signal network present at Rajkamal Square. Readings of vehicular traffic for calculating the traffic density were taken for three times for the different timing of a day i.e. in morning, afternoon and at evening for 1 hour each and the result obtained from conventional traffic signal system were compared to proposed traffic signal system and conclusion was drawn. The data was collected by the videos taken at the traffic junction and field supervision by physical attendance.

In this study, Microsoft Excel was used for statistical analysis. Firstly the vehicular density of 1 hour is divided into 12 groups of 5 minutes for all the three timing in each four lane and the data was tabulated. Then total number of vehicles on four lane passed in 5 minutes was calculated and then all the vehicles passing through traffic junction in 1 hour from all the four lanes was calculated. Results obtained by calculating the traffic density passing in 1 hour both by conventional and proposed system were compared and further conclusion was drawn.

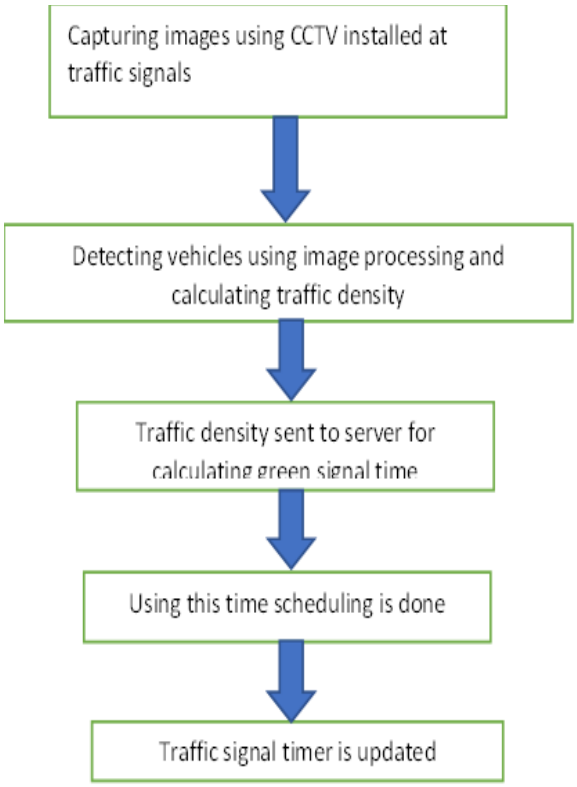

Fig. 1 Flowchart of the Stimulation

4 Proposed System

The traffic flow has no specific pattern that is followed, and the static signal timers pose a huge problem to the already critical problem of congestion. Therefore implementing a system which aims to reduce chances of such scenarios by automatically computing the optimal green signal time based on the current traffic condition at the signal will ensure that the direction with more traffic is allotted a green signal for a longer duration of time as compared to the direction of lessor traffic. This system can override the older system of hard coded lights which cause unwanted delays, reducing congestion and waiting time which will reduce the number of accidents and fuel consumption which in turn will help in controlling the air pollution.

The main objective of this project is to design a traffic light controller based on Computer Vision that can adapt to the current traffic situation. The proposed system aims to use live video feed from the CCTV cameras at the traffic junctions for the real time traffic density calculation by detecting the vehicle at the signal and set the green signal time accordingly. The vehicles are classified as bike, car, bus/truck and rikshaw to obtain a more accurate estimate of green signal time.

Advantages of Proposed system

- Real time traffic light switching according to the current traffic density
- Virtually no new hardware to be installed
- Less expensive than sensors
- Autonomous: No need of manpower

Proposed System Model

- Proposed system will pass a snapshot from the CCTV cameras at traffic junctions for real time traffic density calculation using image processing and computer vision.
- This project used customized YOLO (you look only once) model for object detection in order to detect vehicles.

- The scheduling algorithm will use this traffic density and appropriately set the optimal green signal time for each signal, and update the red signal times of the other signals.
- Some of the factors considered in signal switching algorithm:

  - The processing time of the algorithm to calculate traffic density
  - The no. of lanes
  - Lag each vehicle suffers during start-up
  - The non-linear increase in lag suffered by the vehicles which are at the back
  - The maximum and minimum green signal time that can be set – This is done to prevent starvation of the lane with less traffic

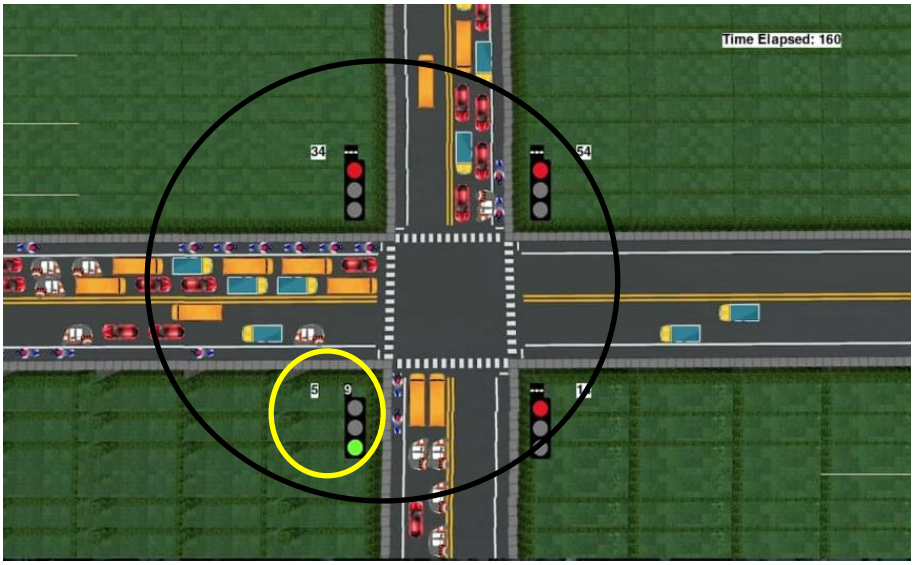

Fig. 2 Lower the green time as no. of vehicles are less

Fig.3 Greater green time sets as no. of vehicles are more

Fig.4 Due to inferior traffic signaling system, manpower is required to control the traffic

5 EXPERIMENTAL RESULTS

Compared the total number of vehicles that cross the intersection over a period of 5 minutes in the current system and the proposed adaptive system with the same distribution of traffic, over a total time of 1 hour with 12 simulations of 5 minutes each and different distributions of traffic.

The results obtained are tabulated in the form of number of vehicles lane-wise and the total number of vehicles passed.

Table 1. Vehicular count at morning as per current system

Current System					
Simulation No	Lane 1	Lane 2	Lane 3	Lane 4	Total
1	57	64	49	21	191
2	68	63	42	23	196
3	70	59	33	29	191
4	66	61	39	32	198
5	67	56	42	27	192
6	64	62	35	19	180
7	55	58	29	26	168
8	56	52	33	28	169
9	49	73	37	30	189
10	52	60	41	24	177
11	43	59	39	28	169
12	56	60	28	34	178
Total					2198

Table 2. Vehicular Count at Morning according to proposed system

Proposed Adaptive System					
Simulation No	Lane 1	Lane 2	Lane 3	Lane 4	Total
1	103	76	46	34	259
2	96	73	38	29	236
3	90	86	36	23	235
4	86	65	51	28	230
5	83	79	43	31	236
6	67	87	35	22	211
7	69	71	38	30	208
8	61	82	43	32	218
9	75	88	48	39	250
10	69	81	36	27	213

11	101	95	26	26	248
12	68	77	43	43	231
Total					2775

Table 3. Vehicular count at afternoon as per current system

Current System					
Simulation No	Lane 1	Lane 2	Lane 3	Lane 4	Total
1	49	54	47	36	186
2	51	43	39	34	167
3	47	49	36	41	173
4	41	51	41	39	172
5	56	46	32	34	168
6	46	52	47	28	173
7	33	48	51	36	168
8	47	52	44	33	176
9	52	63	39	29	183
10	55	59	46	29	189
11	39	49	28	44	160
12	44	51	41	41	177
Total					2092

Table 4. Vehicular count at afternoon according to proposed system

Proposed Adaptive System					
Simulation No	Lane 1	Lane 2	Lane 3	Lane 4	Total
1	55	59	64	37	215
2	60	51	43	49	203
3	61	47	49	46	203
4	47	59	55	44	205
5	68	56	46	42	212
6	59	66	59	37	221
7	47	53	48	51	199
8	66	57	56	49	228
9	69	72	52	41	234
10	59	55	59	46	219
11	51	59	49	48	207
12	54	64	48	49	215
Total					2561

Table 5. Vehicular count at evening as per current system

Current System					
Simulation No	Lane 1	Lane 2	Lane 3	Lane 4	Total
1	67	64	51	32	214
2	68	63	47	29	207
3	62	62	33	31	188
4	76	71	41	43	231

5	67	56	34	27	184
6	74	52	39	38	203
7	65	67	51	39	222
8	60	68	48	28	204
9	49	73	39	35	196
10	47	60	42	31	180
11	57	66	47	29	199
12	43	69	39	23	174
Total					2402

Table 6. Vehicular count at afternoon according to proposed system

Proposed Adaptive System					
Simulation No	Lane 1	Lane 2	Lane 3	Lane 4	Total
1	71	69	55	41	236
2	78	73	42	36	229
3	70	72	39	42	223
4	66	79	49	52	246
5	67	56	52	37	212
6	79	81	55	49	264
7	55	58	59	46	218
8	71	72	61	28	232
9	56	89	37	42	224
10	52	76	49	36	213
11	61	74	51	28	214
12	59	72	41	34	206
Total					2717

As we can see, with all conditions alike, the adaptive system was able to pass 2775 vehicles at morning, 2591 vehicles at afternoon and 2717 vehicle at evening at Rajkamal square while the current static system could pass only 2198 vehicles at morning, 2052 vehicles at afternoon and 2462 vehicle at evening respectively in one hour, which means 577, 481, 315 more vehicles passed through Rajkamal square at morning, afternoon and evening respectively.

$$\text{AVERAGE} = \frac{577+481+315}{3} = 457.66 \approx 458 \quad \text{.....(1)}$$

$$\frac{458}{12} = 38.61 \approx 39 \quad \text{.....(2)}$$

$$\frac{577+481+315}{2198+2052+2462} \times 100 = 20.45 \approx 21\% \quad \text{.....(3)}$$

Thus the proposed adaptive system can improves the performance by over 21% in an average.

The adaptive system on an average allows 458 more vehicles every hour and 39 more vehicles to pass every 5 mins as compared to the static system. This implies reduction in green signal time as well as waiting time of the vehicles.

6 CONCLUSION

Thus the proposed system sets the green signal time adaptively according to traffic density at the signal and ensures that the direction with more traffic is allotted a green signal for longer duration of time as compared to the direction with lesser traffic. This will lower the unwanted delays and reduce congestion and waiting time which will turn in reduce the fuel consumption and pollution.

According to the simulation results, the system shows about 21% improvement over the current system in terms of number of vehicles crossing the intersection which is a significant improvement. This system can be integrated with the CCTV cameras in major cities in order to facilitate better management of traffic.

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