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Development of Automated System Data Collection of Traffic Control at Intersections and Violation Analysis Software Complex

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Abstract: Automation of traffic control at intersections to reduce traffic congestion and video images of traffic at the studied intersection were analyzed using a computer vision tool that extracts traffic flow data. However, most of these studies did not consider the systematic integration of traffic data collection methods in optimal signal timing control. This study developed a three-part system to create an optimized variable cctv time mode regulated by fixed-time road cctv cameras for a traffic congested intersection. The data underwent a further data collection process, resulting in an accuracy of more than 90%. The final dataset was then analyzed by a local transport expert.

Keywords: traffic congestion, smart transport, vehicle detection, urban transport, traffic monitoring, traffic light control.

Introduction

Urban population and the number of private vehicles, congestion and travel time delays are among the major challenges for the overall sustainability of urban transport systems worldwide. The consequences of traffic congestion (e.g., traffic safety issues, delays, and traffic-related air pollution) have been extensively studied in various urban contexts globally[1]. These issues are of great interest to transport planners and managers, who are tasked with solving the growing problems of urban transport. Traffic signal inefficiencies and resulting traffic management deficiencies have received considerable attention due to their impact on traffic congestion, vehicle speed, travel time, and vehicle emissions [2]. Recent studies have shown that optimized traffic signals are more effective and can help reduce congestion, improve vehicle speeds, and reduce overall air pollution . A growing number of motorists recognize the importance of real-time / near-real-time optimized traffic signal systems in helping to alleviate traffic congestion, improve road safety and reduce vehicle emissions. However, studies on the relevance of optimized traffic signal systems currently provide conflicting results regarding which type of optimization (e.g., real-time or real-time) is required under different traffic conditions in different cities and towns. . In addition, there is a lack of technical understanding of which type of modeling (e.g., microsimulation vs. macrosimulation) provides better results and how the integration between real-time traffic data and optimization processes can improve existing traffic control systems at signalized intersections to identify and regulate vehicle traffic. the next mechanism is to develop [8].

1-Image. (traffic light controller)

Real-time or real-time traffic light timing optimization requires continuous processing of large volumes of traffic, including traffic flow, speed, location, and different modes of transportation. To obtain this information, existing intelligent transportation systems (ITS) use a variety of technologies to collect data, including GPS tracking, video analytics, loop detectors, piezoelectric sensors, and more recently connected car technologies. The use of GPS tracking and CCTV video analysis has been steadily growing exponentially over the past two decades [1,2].

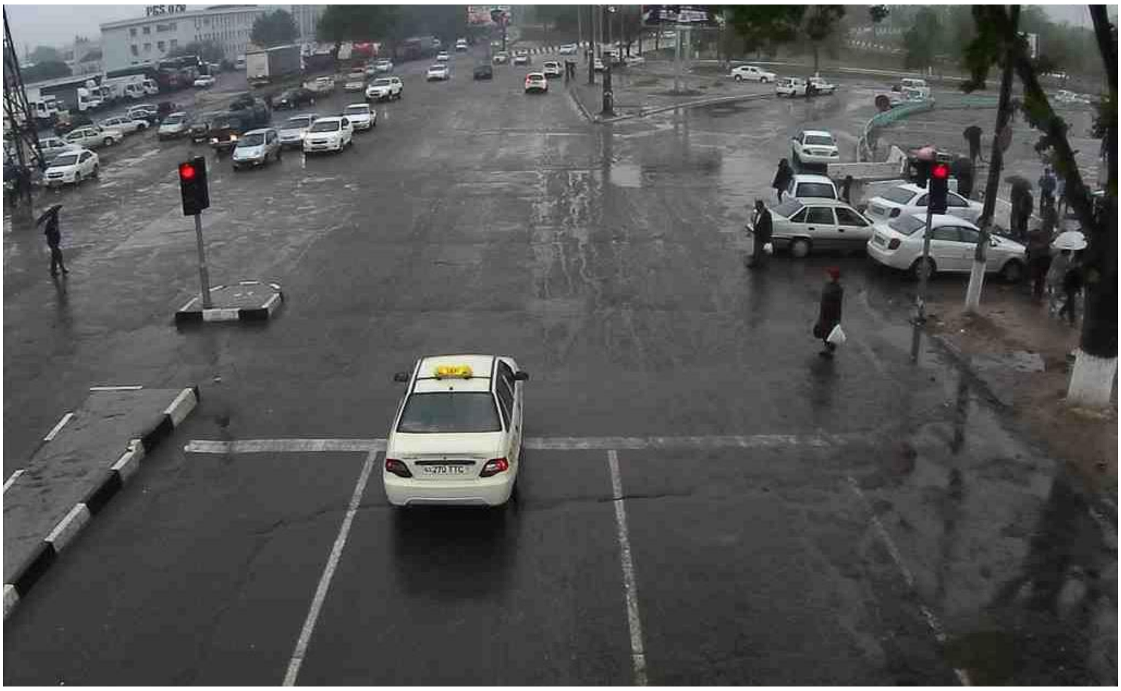
GPS and connected car technologies are reliable methods of data collection, but data collection supported by these technologies is often more expensive than alternative data collection methods. In contrast, CCTV-based video analyzes are increasingly cost-effective and easier to implement in the context of efficient data collection at segregated traffic intersections[1,2,8].

2 -Figure (CCTV and surveillance)

3- Figure (ordering traffic at intersections)

4 – image. (CCTV camera monitoring program)

The purpose of this study was to develop an integrated automated traffic information technique based on video analysis of traffic at a signalized intersection. In addition, this data was used to model traffic in micro-simulations to determine optimized signal timing. This modeling, in turn, made it possible to create customized variable time profiles for a given isolated intersection. These variable timing modes allowed the signal timing to be adjusted according to different levels of day and night traffic volume based on the results of optimized traffic flow simulations. The main innovation of this study is the integration of various technological and technological solutions to develop a semi-automated system that effectively reduces traffic congestion. In addition, the system developed in this study can be implemented at a lower cost than highly complex and expensive systems such as customized or fully operational city-wide traffic control systems.



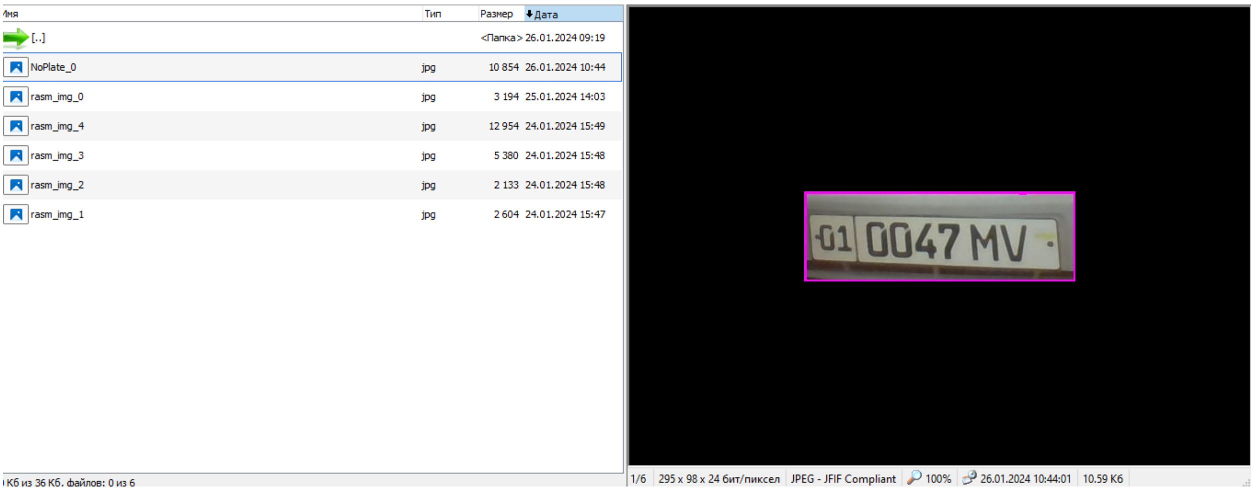
5-Image(car violations at intersections)

This study shows that a combination of low-cost hardware (e.g., CCTV), simulation software, and minimal expert data can be integrated and applied to implement optimized signal timing under realistic traffic conditions in a high-traffic urban environment.

Data Collection in Traffic Management: Video Analysis

In recent years, closed-circuit television (CCTV) has gained more attention among the various sources of real-time traffic data traffic video due to its advantages associated with fast response times, and this system can be monitored or recorded later. is a closed-circuit video system that uses video cameras to transmit images. A variety of data over large regions can be collected by CCTV, increasing the scope of automatic analysis of urban traffic activity. Using CCTV and other traffic videos (such as simulated videos), the processed data from the visual image includes traffic parameters, including speed, traffic composition, vehicle patterns, vehicle types, vehicle identification numbers, can provide valuable information regarding traffic regulations or traffic accidents and turning movements. important for joint design. This information helps with traffic management and provides advantages over other data collection methods. In addition, video image processing facilitates the process of traffic data mining by identifying traffic patterns or rules.

6-Image. (Sending the vehicle number to the base when violations occur)



7-Image. (Retention of the vehicle number in the database in case of violations)

Vehicle detection using video analysis can be done using several methods (e.g., frame difference, optical flow, and background subtraction). In the case of optical flow, vehicles are detected using pixel-level intensities, and this method is more functional when the video capture device is moving. The method is not very efficient in real-time conditions due to the large computational requirements. The frame differentiation method uses the intensity of pixel changes to detect moving objects in the video and consider the dynamic environmental conditions within the videos they analyze. If the background image and car color are similar, frame difference is vulnerable to car misclassification. Frame difference also cannot detect static objects within video frames. Unlike vehicle detection and frame difference, BS is a more robust method considering its ability to detect static and moving objects and the fact that BS is not affected by the color of vehicles. Given the robustness of BS algorithms, many recent studies and video analysis vehicle detection applications have used this method and obtained accuracies of about 95% in simple traffic scenarios and more than 70% in complex scenarios. The BS approach includes several parametric (e.g., single Gaussian or median filter), non-parametric (e.g., kernel density estimation), predictive (e.g., Kalman filter) methods used to identify different classes of vehicles in a region of interest (ROI). These regions of interest can be defined from a predefined virtual street (e.g., a rectangular box within a video frame) or using blob tracking, where the algorithm also detects the vehicle trajectory within the ROI . The use of a method such as BS with optical flow or virtual ring or blob tracking generally depends on the system design and the system context in which they are used. The existing literature shows that, along with parametric methods using a virtual street, the BS method is more widely accepted due to its robustness and ease of use.

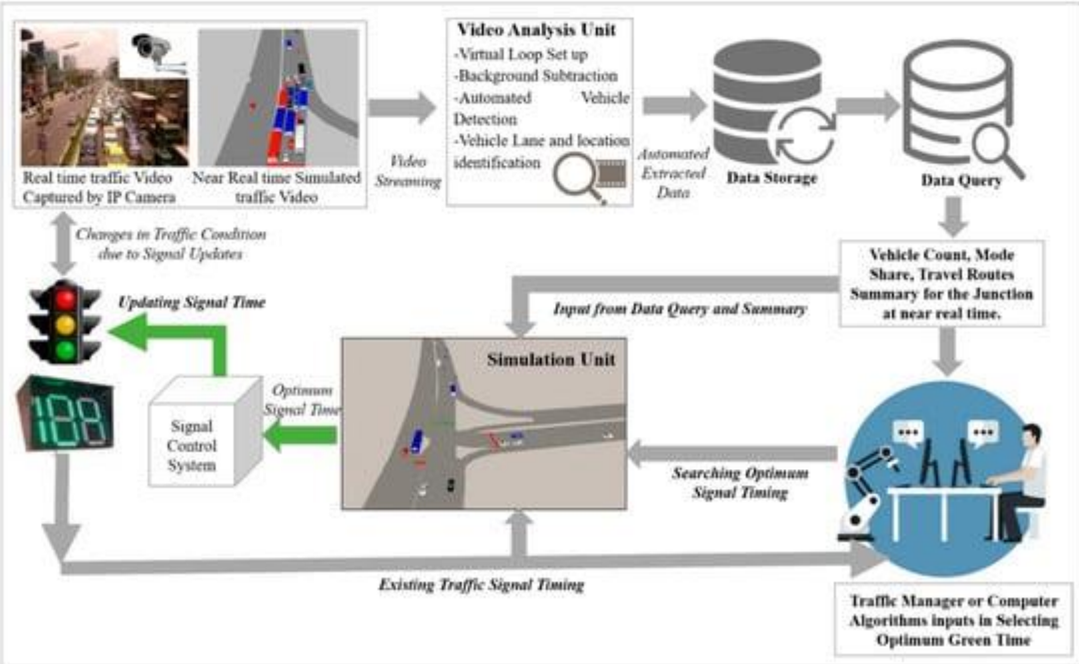
Signal timing optimization using simulation models

Optimizing signal timing to reduce traffic congestion was first proposed in the 1950s. Due to the emergence of modern technologies, the availability of real-time data, data mining tools, and the wider use of micro- and macro-simulation models, traffic signal timing management has become more effective. Optimization of traffic signal systems is generally achieved by using two different types of signal optimization systems, split cycle and offset optimization techniques (SCOOT) and microprocessor optimized vehicle motion (MOVA).

SCOOT systems optimize multiple connected signalized traffic intersections on a city scale or in specific city zones. In contrast, MOVA is used to optimize single-signal traffic junctions at the micro-scale. SCOOT systems minimize overall congestion, vehicle stop-starts, and travel times by synchronizing green-red signal timings based on traffic flow approaching an intersection and traffic flow between successive junctions . These systems efficiently handle macro-scale traffic; however, SCOOT requires significant investment and management. Simulation programs such as TRANSYT and LinSig are popular software environments for SCOOT optimization processes.

Overview of the proposed system

proposed an integrated system that combines data acquisition and simulation processes to update traffic signal timing . In the proposed system, video analysis was used to obtain information about the types and number of vehicles traveling on different links of the studied link. This data was then used to run simulation models to determine the optimal signal timing that could reduce congestion levels. Figure 7 shows the overall design of the proposed system. The process starts with streaming videos from live or simulated sources. Streaming videos act as a source of vehicle-specific information needed for further processing. The videos are fed into the "Video Analysis Unit" (Subsystem 1), where virtual loop detectors use an algorithm (discussed in the next section) to detect and classify different vehicles and related information such as lane, link connectivity, and track location. used to identify data. road connections. This data is then stored in a data storage system (ie, a server). In the next stage of the system (subsystem 2), a process of automatic requests from the server produces a summary of the data every 15 minutes. This data includes the number and types of vehicles detected at different links of the connection , and how many vehicles change from one link to another and vice versa. All these data are necessary to prepare the simulation model as necessary data for the third subsystem of the proposed system.



8-image. (the process of working the algorithm of the program)

Conceptual design of the proposed system showing the integration of the three subsystems. Subsystem 1: Video Analysis, Subsystem 2: Automated Survey, Subsystem 3: Simulation.

In Figure 7-8 as shown, video analysis and query results produce the basic data needed for the "Simulation Unit" (Subsystem 3). The simulation unit allowed experimenting with different signal timing scenarios that varied the vehicle flow and signal timing change rate. These scenarios were then compared with the results of the available signal time. To reduce congestion by achieving optimal signal timing, this proposed system can take two approaches, i.e. using computer algorithms to obtain optimal signal timing or expert knowledge of local traffic conditions (e.g. peak/off-peak). usage flow, driver behavior and vehicle mix). With these approaches, different combinations of signal times can be studied in simulation and the best results can be applied to reduce congestion. After the simulation unit produces the optimal signal timing that reduces congestion and increases vehicle speed at the junction, the signal timing parameters can be sent to the traffic light control system. Then the actual changes in traffic and speed at the intersection can be observed.

Simulation units developed in this proposed system have already been applied in other studies focused on traffic management. However, the system proposed in this study integrated these three subsystems and partially automated the integration process. Previous studies have used one of these subsystems or taken a more manual approach to control solutions (eg, independent use of vehicle tracking, 13). This study not only integrated subsystems (eg, performing an automatic query to generate general information), but also introduced the option of integrating the knowledge of local experts. These steps are taken to ensure greater efficiency and effectiveness in traffic light timing.

Conclusions

Improving transportation conditions in rapidly growing cities in developing regions is a constant concern of city planners, traffic managers, and environmentalists to improve travel efficiency and the quality of the natural world. Eliminating nearly obsolete fixed-time signals at busy intersections in favor of variable-time signal systems adapted to existing traffic conditions could make a significant difference to traffic congestion, safety, and air pollution. This study demonstrated the integration of various available and relatively inexpensive technologies to create a more efficient traffic signal control system. The proposed system integrated video data analysis, data collection, and expert judgment to optimize variable signal timing and reduce congestion at a signalized intersection based on microsimulations.

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