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AI Based Traffic Light Control and Ambulance Detection

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ABSTRACT: In modern society, the efficient management of traffic flow and emergency response systems is paramount to ensuring public safety and minimizing congestion. Traditional traffic light control systems often operate on fixed schedules, leading to inefficiencies and delays, particularly during emergencies. In this context, the integration of artificial intelligence (AI) technologies offers promising solutions for dynamic traffic management and ambulance detection. This paper presents an innovative approach to traffic light control and ambulance detection using AI- based systems.

The proposed system leverages real-time data from various sources, including traffic cameras, sensors, and emergency service databases, to dynamically adjust traffic light timings based on current traffic conditions and the presence of emergency vehicles. Using machine learning algorithms, the system analyzes live traffic feeds to predict traffic patterns and optimize signal timings for improved traffic flow and reduced congestion .In the system incorporates computer vision techniques for ambulance detection, enabling rapid identification an trained on large datasets of emergency vehicle images, the system accurately recognizes ambulance sirens, flashing lights, and unique vehicle characteristics, facilitating prompt response and ensuring timely arrival at critical destinations. To demonstrate the effective prioritized passage of emergency vehicles through intersections. By employing deep learning models of the proposed approach, a real- time example scenario is presented, showcasing the dynamic adjustment of traffic light timings in response to changing traffic conditions and the seamless detection and prioritization of an approaching ambulance.

KEYWORDS: Deep learning, machine learning, Embedded system, Reinforcement learning.

I. INTRODUCTION

Traffic Congestion and traffic monitoring is one of the important problems all over the world. In this way, a traffic cycle will be established which will control the traffic. Traffic lights operate in a systematic way which causes a lot of delays for the drivers in some cases. Drivers can be unnecessary waiting for the time period. Our project to overcome the problem. An intelligent Hand Held Traffic light controller system using mobile application traffic police can be handled the traffic easy and Simple way.

II. REINFORCEMENT LEARNING

RL is based on Markov decision process (MDP) and learns to maximize long-term returns. In a fully observable environment, an agent observes a state st ∈ S at time t and performs an action at ∈ A according to a policy function π (a |s). Then the next state of the agent is st+1 according to a state transition probability function pt (st+1 |st, at), and the environment gives a reward rt = r (st, at,st+1). Suppose that an episode has P n steps, the agent obtains a return Ut = n τ=t γ τ−t rτ at time t, where γ ∈ [0, 1) is a discount factor. An action-value function, i.e., Q function Qπ (st, at), is the expectations of return Ut for future states and actions at the times.
In practice, the agent does not know Rt and St+1 and can only obtain the optimal Q function by estimation and Monte Carlo approximation. RL training is based on the experience et = (st, at, rt, st+1) in a data-driven way. The Q-learning algorithm is one of the most basic RL methods. Q function is fitted by the model Qθ with parameters, such as Q table,

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linear regression (LR) , and deep neural network (DNN). According to the behavior policy, the agent collects the training data and stores it in the experience replay buffer in the quadruple form of et= (st, at, rt, st+1). We use a common behavior policy named ϵ-greedy policy. It has the probability of ϵ for uniform sampling an action from A and probability of 1-ϵ for choosing an action with maximum Q value. at = (argmax a Qπ (st, a),with probability1 $-$ ϵ a random action, with probability ϵ . In the DQN algorithm, a target network is used to mitigate the bias caused by bootstrapping, and the temporal difference (TD) algorithm trains the agent, calculates the TD target yt = rt + γ max a Q st+1, a; θ − and TD error δt = Q (st, at; θ) − yt . The loss function is L (θ) = 1 2 |B| X et∈B (Qπ (st, at; θ) − yt) 2 (7) where each minibatch B = {(st, at, rt, st+1)} contains the empirical trajectory of the agent. The return is estimated by Rˆ t = PtB−1 τ=t γ τ−t rτ , where tB is the last step in mini batches. Other techniques can better estimate the Q function, such as double DQN, dueling DQN, and prioritized experience replay.

III. MULTI-AGENT Q-LEARNING

In this section, we first introduce the basic concepts and formulas of IQL. Then, the formulaic expression of MAQL is presented. Two control strategies are used to stabilize MAQL training. The first strategy uses the policy for stabilizing IQL in, i.e., to inform the local agent of the current policies of other agents. The second one considers the spatial distance of traffic lights and introduces a spatial discount factor to reduce the influence of remote traffic signals on local traffic lights so that local agent can concentrate more on improving local traffic conditions. Therefore, global TSC can converge more stably.

In a multi-agent network G = (V, E), agents i and j are neighbor if there is an edge connecting them. The set of all neighbors of agent is denoted by Ni, and a local region is denoted by VI = Ni∪i. The distance d between i and j is calculated by the sum of edges on the shortest path between i and j. As the neighborhood of agent i is Ni = {a, j, x} and the local region is Vi = {a, i, j, x}.

IV. RELATED WORKS

This section presents several techniques proposed in different papers in the same domain of the proposed system and discusses their features. Also, it summarizes the similarities and the differences
between these systems.

Intelligent ambulance system proposed in (G. Beri et al., 2016) combines two important systems that helps for saving lives, vital sign monitoring system and traffic control system using Advanced Virtual RISC (AVR) microcontroller. Vital sign monitoring is a system that records patient’s important vital signs and sends it at real time to the hospital server via personal computer (PC) using serial communications.

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ON There are many action settings, such as the duration of the current signal, the next phase of the traffic light, and holding or changing the current phase. We choose the second set and define each local action as a possible phase or a combination of the red and green phases at the intersection. This setting is more flexible and suitable for ATSC. According to the current intersection traffic, an agent performs the best phase from all possible phase set Ai. B. STATE The setting of a state is significant to describe the traffic condition at an intersection. We define the local state as follows: st, i = {waitt [li], wavet [li]}li∈Li where li is an incoming lane of intersection i and Li denotes all the incoming lanes of intersection i. wait describes the waiting time for the first vehicle in the lane, and wave represents the total number of vehicles in each incoming lane within 50m of the intersection. A lane Area Detector in SUMO is used to capture state information, which ensures the real-time ATSC. C. REWARD The definition of reward is vital in RL performance. The goal of an agent is to maximize long-term returns. Combined with the definition of reward in [3] and [4], a new reward function is defined as rt, i = −X li∈Li pressuret+1t [li] + a · waitt+1t [li] (19) where a [veh/s] is a trade-off coefficient, and pressure is the evaluation metric based on the vehicle queue length and can be simply measured. The reward is post-decision, and both pressure and wait are calculated at time t+1t. This kind of reward setting is closely related to state and action, which can directly reflect the degree of traffic congestion and vehicle delay time at the intersect

V. EXISTING SYSTEM

Optical systems are based on utilizing coded infrared (IR) transmission between the EV transmitter and the IR-receiver that can be validated against unauthorized use. In GPS-based systems, the EV location estimation can be improved in open areas without obstructions (e.g. high building) where the trilateration by the GPS satellites is possible and the multipath effect can be reduced. This requirement makes the use of GPS method is also restricted to some places.

VI. PROPOSED METHODS

We will create an android application for the ambulance. Through that application the ambulance driver can register the case of emergency. When the ambulance will be approaching the signal the image processing will then determine from where is the ambulance coming. It will stop performing the normal operation of the signals and will stops all the signals leaving the one through which the ambulance needs to pass. We will connect the traffic signals control system through your application so that the entries should be stored in the database. Also connect the image processing to the traffic signals. We need to also learn how to manipulate the traffic signals. We plan the development this project in below mentioned modules. Module 1: Admin Module 2: Driver/Ambulance Module 3: Controlling Signals 3.1 Module 1: Admin Module This module is fully responsible for providing the route to the drivers of the ambulance. Also it will monitor and track the ambulance from where it is arriving and where it is going. 3.2 Module 2: Driver/Ambulance This module is responsible for sending the request to the admin to get permission to reach to the location. As soon as the driver sends request he will have to wait for the route. After the route is decided, the driver will then send request to the cloud database to create green corridor.

3.3 Module 3: This module is a module dedicated to the manipulation of the signals. As soon as the cloud gets the request, the cameras will be activated for image processing. Once the ambulance is spotted then it will verify and provide a green corridor. The above figure depicts the flow of the project. The admin that is the official person from the hospital, who wants to send an organ for transplant will send the notification to the driver. The driver will receive the notification and will select path of the source and the destination. The admin will send a message to the traffic control department that will provide green corridor to the ambulance after receiving its location. The driver will be able to track the ambulance as to get assurance that the ambulance will reach its proper location.

VII. ABOUT THE ALGORITHM

Algorithm 1 Multi-Agent Q-Learning for ATSC Input: α, γ, T, |B|, ηθ. Output: {θi}i∈V.

initialize s0, π0, t ← 0, k ← 0, B = ∅;
while stop condition is not reached do
for i ∈ V do
perform at,i from πt,i ;
receive r˜t,i and st,i ;
end for
B ← B ∪ st,i, at,i,r˜t,i,s˜t+1,i , πt,i i∈V ;
t ← t + 1, k ← k + 1;
if t = T then
initialize s0, π0, t ← 0;

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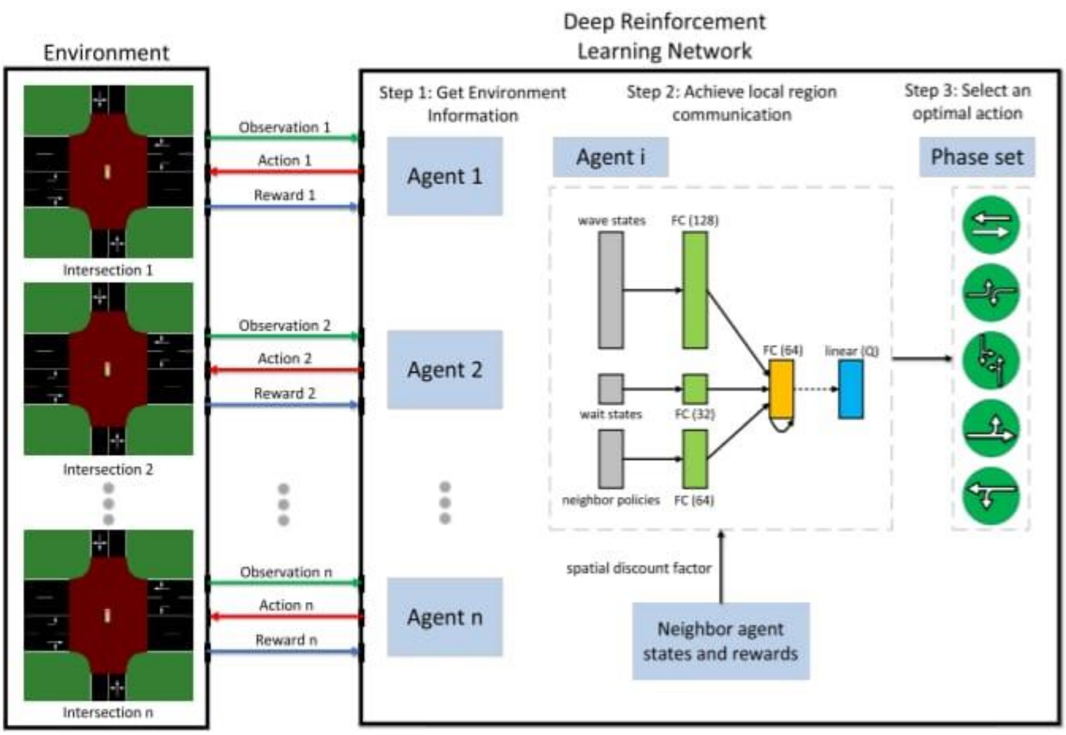
```
end if
if k = |B| then
for i∈ V do
estimate R^ τ, i, ∀τ ∈ B;
estimate R˜ τ, i, ∀τ ∈ B;
calculate y˜t, i and L˜ (θi);
update θi with ηθ · ∇L˜ (θi);
end for
B ← ∅, k ← 0;
end if
end while
```

VIII. INPUT DATASET

It is the source of real time traffic data which is representing the current traffic situation in the area. There are many sources and methods suggested by researchers from where we can obtain this data like placing sensors and cameras at the junctions to capture the traffic flow and applying algorithm to obtain the intensity of the traffic but all these approaches are so much cost effective and complex to implement (Castillo et al. 2015). Also the accuracy of this data is the most important ingredient of our proposed solution. Google Maps APIs is the easy and reliable source from where we can drive the traffic intensity for our optimal distribution (Fairfield and Rumson 2011).Travel time in current and future traffic is now available through the Distance Matrix and Directions APIs of Google Maps which is requested by server after every threshold time. This threshold time is configurable as it is inversely proportional to network communication cost.

IX. ARCHITECTURE DIAGRAM



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X. RESULT

Traffic Light	Red	Yellow	Green
1	0	1	0
2	1	0	0
3	1	0	0
4	1	0	0

Initially, all signals at a particular junction will turn yellow and as the traffic increases the signal will start turning green in sequence. The normal flow of traffic shows that signal 1 will turn green first, and then signal 2 followed by signal 3 and at last signal 4. The order of the traffic lights began as a green light that lights up at traffic signal 1, and the red light of other traffic lights. Each vehicle has been given 2 seconds time to pass through the particular signal. The duration of this groups utilizing 3DCGSA, then corresponding data is learned through interfrequency planning. Utilizing EEG SIGNAL DATASET, tests, the proposed strategy beat customary methodologies in its capacity to recognize pressure states. Nevertheless, our procedure has some cutoff

XI. CONCLUSION AND FUTURE WORK

The envisioned AI-Based Traffic Light Control and Ambulance Detection system, incorporating CNN algorithms, stand as a groundbreaking approach to enhancing traffic management and emergency response in urban environments. The project's underlying premise is to leverage the power of artificial intelligence for more responsive and intelligent traffic control, particularly in scenarios involving emergency vehicles like ambulances.

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