Optimizing Urban Traffic Flow Using Reinforcement Learning: A Real-World Simulation at Hitech City Junction

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Urban traffic congestion at busy intersections severely degrades transportation efficiency. This study presents a reinforcement learning (RL) framework for optimizing traffic signal timing at Hitech City Junction, a complex urban intersection in Hyderabad. The RL agent is trained in a realistic traffic simulation environment (using SUMO) with state features including lane-specific vehicle counts and waiting times, and actions corresponding to switching to another signal phase or extending the current green phase. Traffic flow profiles are calibrated to reflect the junction's real demand patterns. A Q-learning–based algorithm is employed to learn a control policy that minimizes cumulative vehicle delay. The RL-based controller is evaluated against a conventional fixed-time signal plan across varying traffic demand scenarios. Simulation results demonstrate that the RL agent achieves significantly lower average waiting times and reduced queue lengths compared to the baseline. Under peak conditions, the proposed approach yields up to a 25% reduction in average delay, substantially improving traffic throughput. These findings validate the feasibility of applying RL to real-world traffic control and underscore its potential to enhance urban mobility through more adaptive and efficient signal management. The framework thus offers a promising direction for future deployment of intelligent traffic control systems in metropolitan settings.

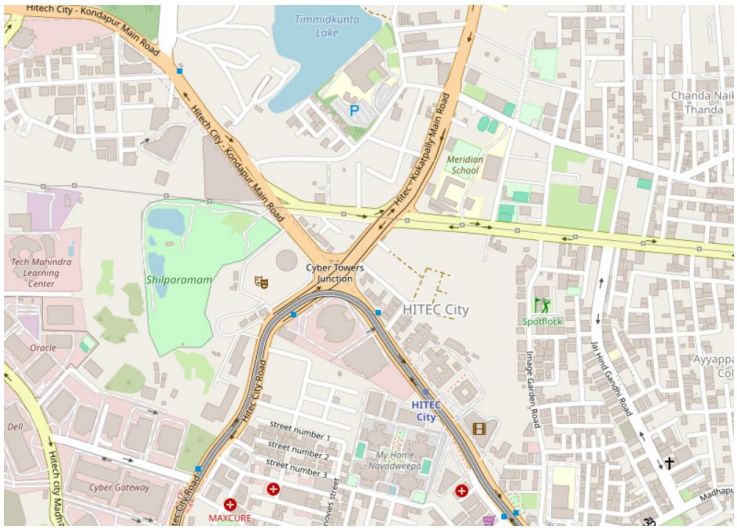

Fig.1 – 1nm x 1nm area simulated with three-fold symmetry and triangular pattern of atomic lattice as observed by STM

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