# Energy Efficient Street Lighting System Using ML

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*Abstract :* It has become extremely necessary to reduce the consumption of electricity due to the increasing needs and limited resources for its generation. Streetlights place a heavy demand on electricity usage. Conventionally, the streetlights remain lit during their operational hours even when they are not required or when full brightness is not necessary; for example, during periods of low traffic volume or even during summer season. Thus, the focus of this system is to control the intensity and pattern of street lights. This controlling will be done with the help of ML algorithms used for recognizing the need of electricity for a particular area depending on given input parameters like traffic volume of that area, climate in the area, time and day of the week. Use of this system will not just save electricity but ensure the presence of required light intensity for safety purposes. There is a need to just connect the existing streetlights with the proposed system thus, reducing the cost of investment like building all together new street lights or even installation of sensors. The system will operate on its own without the need of human intervention, though a special access is granted to the administrator.

***Index Terms* - Machine Learning, Energy Conservation, Adaptive lighting.**

## I. Introduction

Electricity consumption has increased especially in cities due to rapid urbanization and increase in population. The world's population is projected to increase by 72% by 2050 and hence there might be an increase in demand for electricity [1]. Streetlights are an important part of a city's infrastructure and provide much needed illumination during night time for crime prevention and traffic accident avoidance [2]. Although streetlights are crucial for personal safety and road safety, they are also the biggest consumers of a city's total electricity budget and contribute to 40% of a city's energy budget [3]. Furthermore streetlight consume 2.3% of global electricity [4] and hence saving energy by smartly modifying the use of streetlights is required. LEDs can greatly aid in saving electricity consumption. LEDs reduce carbon dioxide emission, have a longer lifetime and consume less electricity. Around the world, there are 300 million streetlights, out of which only 10% work on LEDs [5]. Using LEDs instead of street lamps can reduce and cut energy cost by 50% [6].

The approach that we will be using to optimize the use of street lights is presented in this section. The dataset will include different parameters like traffic density, time, day of the week, season, etc. We will be using multiple supervised machine learning algorithms. From those, the one which gives more efficiency will be finalized. Considering all the data provided, algorithm will find out the intensity requirement and for that requirement it will generate a switching pattern to control the street lights based on pattern as well as intensity.

As the supervised learning like SVM (Support Vector Machine), Naïve Bayes, Random forest will be used. The algorithm will first train the system for different situations. For example, during periods of low traffic volume, the requirement of light on the streets will be relatively low. So, in this case, the system will suggest different switching patterns (like zig-zag or alternate) that will provide enough light on the streets. Later on, the efficiencies of all the algorithms will be analyzed based on the actual requirement to select the best performing algorithm and this algorithm will be implemented on the actual system. In the below figures, green colour represents lights ON with full intensity, red colour represents OFF, yellow represents lights ON with low intensity.

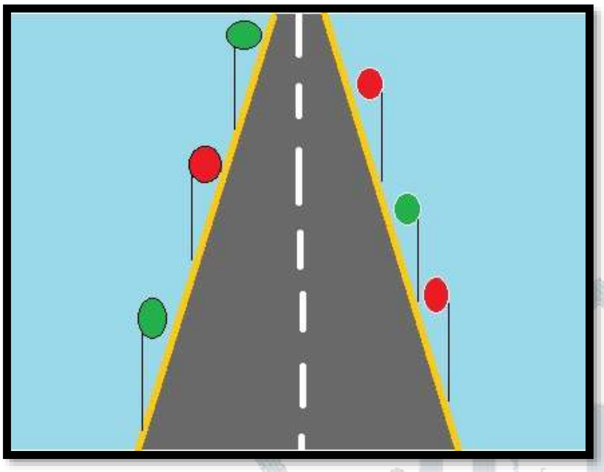


*Figure 1. Alternate switching pattern*

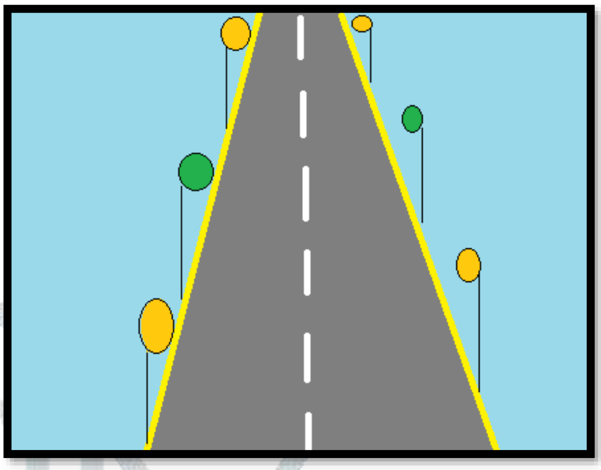
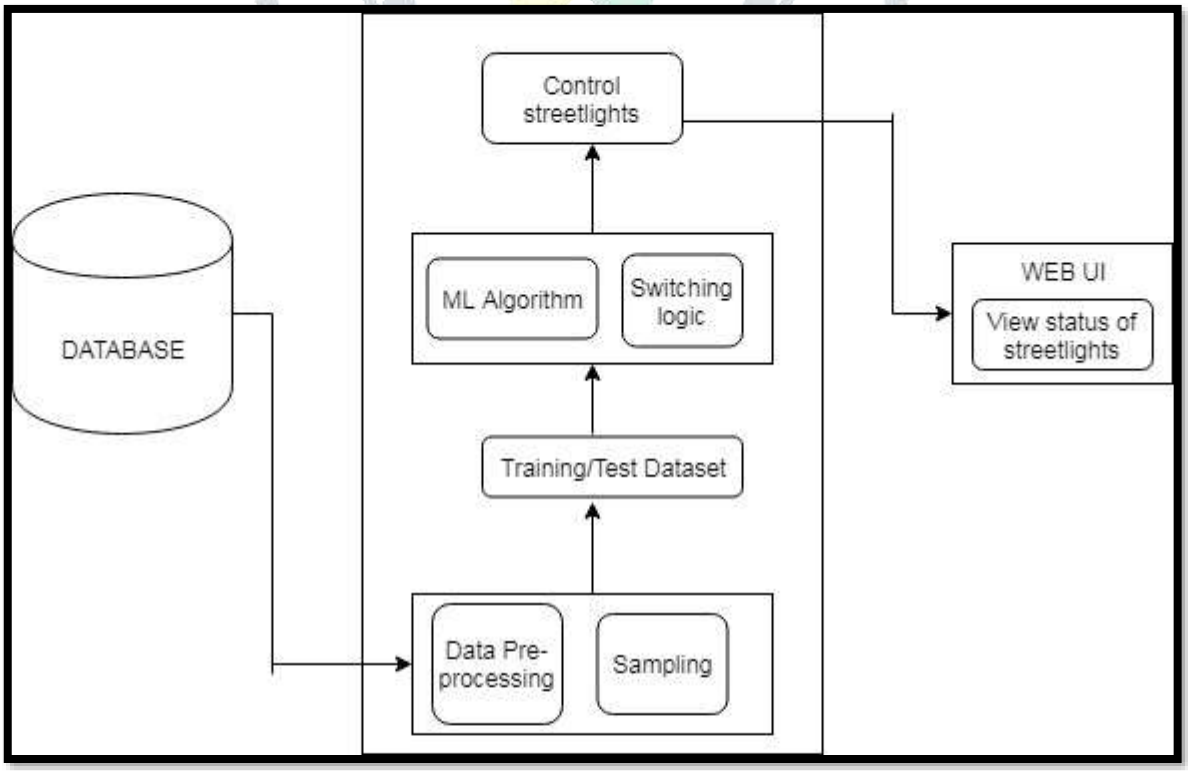


*Figure 2. Dimming pattern*

There will be an interface provided for the system manager to view the current status of the area he is responsible for, give access to override the system controlling i.e. for exceptions and emergencies. The manager can securely login based on his area and password. The output and representation of this system will be simulated on a model built using Arduino board ESP 8266 and LEDs representing the streetlights.

## II. SYSTEM ARCHITECTURE



## III. LITERATURE REVIEW

Owing to the significant energy requirements of street lighting and its financial and environmental impact, several systems have been proposed to reduce their energy consumption. Predictive monitoring and adaptive control systems have used smart cameras to acquire traffic data and predict dimming models for optimal energy consumption. Such systems have been successful in achieving energy savings upto 30% [5]. Adaptive lighting systems based on traffic sensing adaptively adjusts streetlight brightness based on the current traffic conditions. The simulation results presented indicate that the proposed lighting scheme can consume up to 30% less energy [7]. TALiSMaN real-time adaptive lighting scheme, detects the presence of vehicles and pedestrians and dynamically adjusts their brightness to the optimal level. Based on the simulation results, TALiSMaN provided an energy saving of 45–98% compared to the state-of-the-art schemes evaluated [8]. The Virtual metering in the IEC 61499 application is used to quantify energy savings in simulation scenarios with different traffic volumes. Across a range of traffic volumes representative of rural roads, the simulations indicate that smart dimming can deliver energy savings of 14% to 70%, with savings increasing as traffic density decreases [9].

Along with the advantages of all the systems described above, there are some limitations also. The Adaptive lighting systems based on traffic sensing shows low performance when dealing with high traffic and low vehicular speed. The system consumes 40% more energy in small areas as compared to larger areas due to high traffic congestion [7]. Also, TALiSMaN does not consider off-grid streetlights which are popular in areas where access to mains power line is restricted [8].

## IV. SUITABLE ALGORITHMS

Machine learning algorithms like SVM (Support Vector Machine), Naïve Bayes, Random Forest, Decision Tree, KNN can be used. Out of these, we have planned to implement SVM, Naïve Bayes and Random Forest.

## V. EXPECTED RESULTS

1. Comparison of the outputs of three algorithms.
2. Consuming less energy compared to the existing street light system.
3. Recommendation of the streetlighting pattern.
4. Controlling lights according to situational requirements. For example, in heavy traffic, maximum streetlights should be switched on whereas, during times when the streets are not used much, the number of lights that are switched on should be reduced.

## V. FUTURE WORK

In future, better algorithms can be used for improving efficiency of the system. Datasets can be improved to get legitimate and precise information. More focus can be on applying the pattern for switching on actual street lights.

## VI. DISCUSSION

After execution, the three different results from different algorithms will be analyzed and a better performing algorithm will be chosen for the system.

## VII. ACKNOWLEDGEMENT

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