



A SCIENTIFIC SEMINAR IN THE DEPARTMENT OF  
COMPUTER SCIENCE

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# **Optimizing Energy Consumption in IoT Networks Using Deep Learning Object Detection and Intelligent Data Transmission Scheduling**

تحسين استهلاك الطاقة في شبكات إنترنت الأشياء باستخدام تقنية التعلم العميق لاكتشاف الكائنات  
وجدولة نقل البيانات الذكية

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# INTRODUCTION



# INTRODUCTION



- **IoT is a combination of two words “Internet” and “Thing”. In simpler words, it can be defined as a thing that has some computational intelligence to act accordingly and connect with other things and people through the internet.**
- **The Internet of Things (IoT) refers to a network of physical objects devices, vehicles and other items that are embedded with sensors, software, and other technologies to connect and exchange data with other devices and systems over the internet**
- **IoT enables devices to perform actions automatically based on the data they collect without human intervention.**



# INTRODUCTION



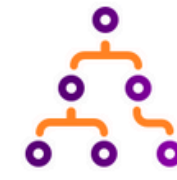
## Examples of IoT:



CLOUD



COMPUTER VISION



ANALYSIS



ROBOTICS



MACHINE LEARNING



CPU



AUTOMATION



DECISION MAKING



NATURAL LANGUAGE



CHAT BOT



CONNECTED CAR



API



FAST LEARNING



GATEWAY



BIG DATA



DATA ANALYSIS



MONITORING



SENSOR



AI



ALGORITHM



DEEP LEARNING



CONNECTED HOME



GPS



DATABASE

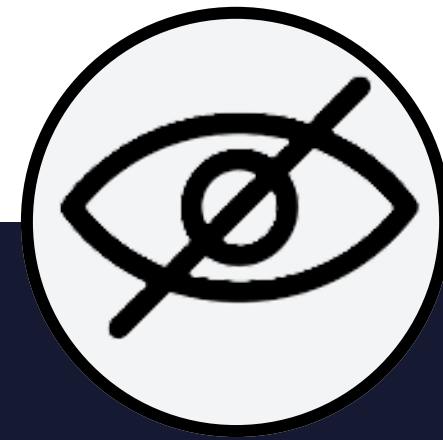


# Sustainability of IOT



Managing and reducing energy efficiency in IOT devices.

**ENERGY**



Managing the vast amount of personal data collected by IoT devices is a concern.

**PRIVACY**



Protecting data and devices from cyber threats is critical.

**SECURITY**



# PROBLEM STATEMENT



# PROBLEM STATEMENT



- **With the growth of the Internet of Things (IoT), billions of sensors will be created.**
- **According to cisco report, It is predicted that the devices of IoT will increase nearly threefold, rising from 9.7 billion in 2020 to over 29 billion in 2030**
- **The energy used by these devices is also a big worry. Although IOT devices are generally energy efficient, it will impact the energy consumption growth.**
- **With increase IOT devices, it consumes large amount of energy.**
- **We must understand the stages of IOT to improve energy efficiency in it.**

# STAGES OF IOT

**Sensing**  
(Sensors / Actuators)



**Stage 1**



**Networking**  
(Wi-Fi, Bluetooth, Zigbee)

**Stage 2**

**Analyzing and  
Pre-processing**  
(Edge IT)



**Stage 3**



**Storing and Analyzing**  
(Data center / Cloud)

**Stage 4**



# CASE STUDY



Our case study is based on a smart city application i.e. smart street lighting system that integrates deep learning-based object detection with an intelligent data transmission scheduling mechanism.

The study consists of the following components which help us to improve energy efficiency in stage 1 & stage 2:

1. Object Detection System.
2. Intelligent Data Transmission Scheduling.

**Sensing**  
(Sensors / Actuators)



**Stage 1**



**Networking**  
(Wi-Fi, Bluetooth, Zigbee)

**Stage 2**



# LITERATURE REVIEW



# LITERATURE REVIEW



In recent years researchers focused on solving the problem of energy consumption proposing many approaches and methods, causing great challenges regarding power consumption

Study	challenges	Area	Models	Results
Havard et al. (2019)	Air Conditioning	Smart budlings	ESP32 device and a BME680 sensor	save 30% in energy consumption.
Felipe et al. (2020)	Air Conditioning	Smart budlings	PIR sensor and camera	save 61.8% in energy consumption.
Luciano et al. (2019)	Streetlights	Smart cities	GPS	save 53% in energy consumption.
Utkarsha et al. (2020)	Streetlights	Smart cities	LDR sensor, schedule transmission	save 18.75% in energy consumption.
Aziera et al. (2020)	Streetlights	Smart cities	Infrared Sensor, LDR sensor	save 40% in energy consumption.
Roula et al. (2022)	Streetlights	Highways	object detection for cars	Accuracy with 89% and save 20% in energy consumption.



# PROPOSED MODEL



# PROPOSED MODEL



**The model integrates Deep learning-based object detection with an intelligent data transmission scheduling mechanism.**

## **1. Object Detection System:**

**Utilizes deep learning models to detect pedestrians, cars, buses, trucks, bicycles in real-time. Cameras installed on streetlights capture video feeds, which are processed locally or on edge devices to minimize latency.**

# DATASET

**We selected a Traffic Detection dataset that includes images of various street objects such as cars, buses, trucks, people, bicycles, and other items relevant to street lighting. The dataset, used to train the model, was collected from the internet.**

**Over 15,000 images were gathered to cover a wide range of object states, viewing angles, appearance frequencies. This ensures that the proposed model will be prepared for various angles and conditions.**



# PROPOSED MODEL



NO DETECTION  
Default (20%)

PEDESTRIAN  
30%

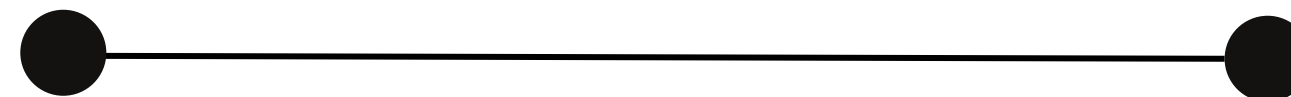
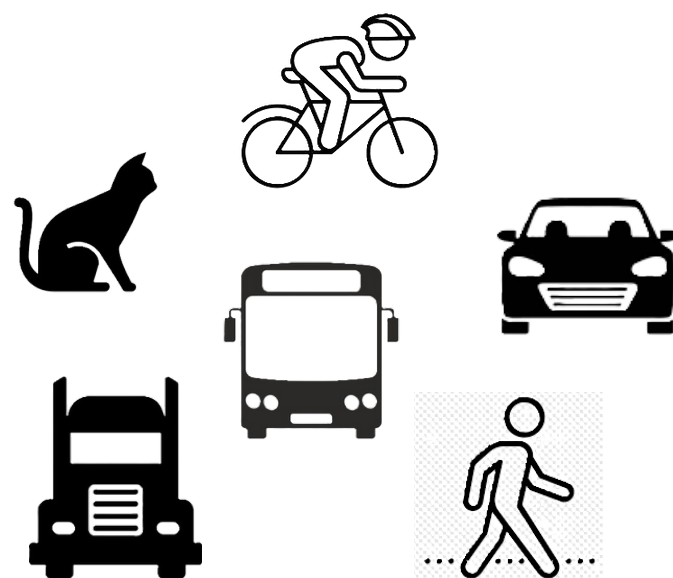
CAR  
50%

CAR  
70%

BUS  
90%

TRUCK  
90%

ANIMALS  
Default (20%)



MORE THAN ONE  
DETECTION  
100%

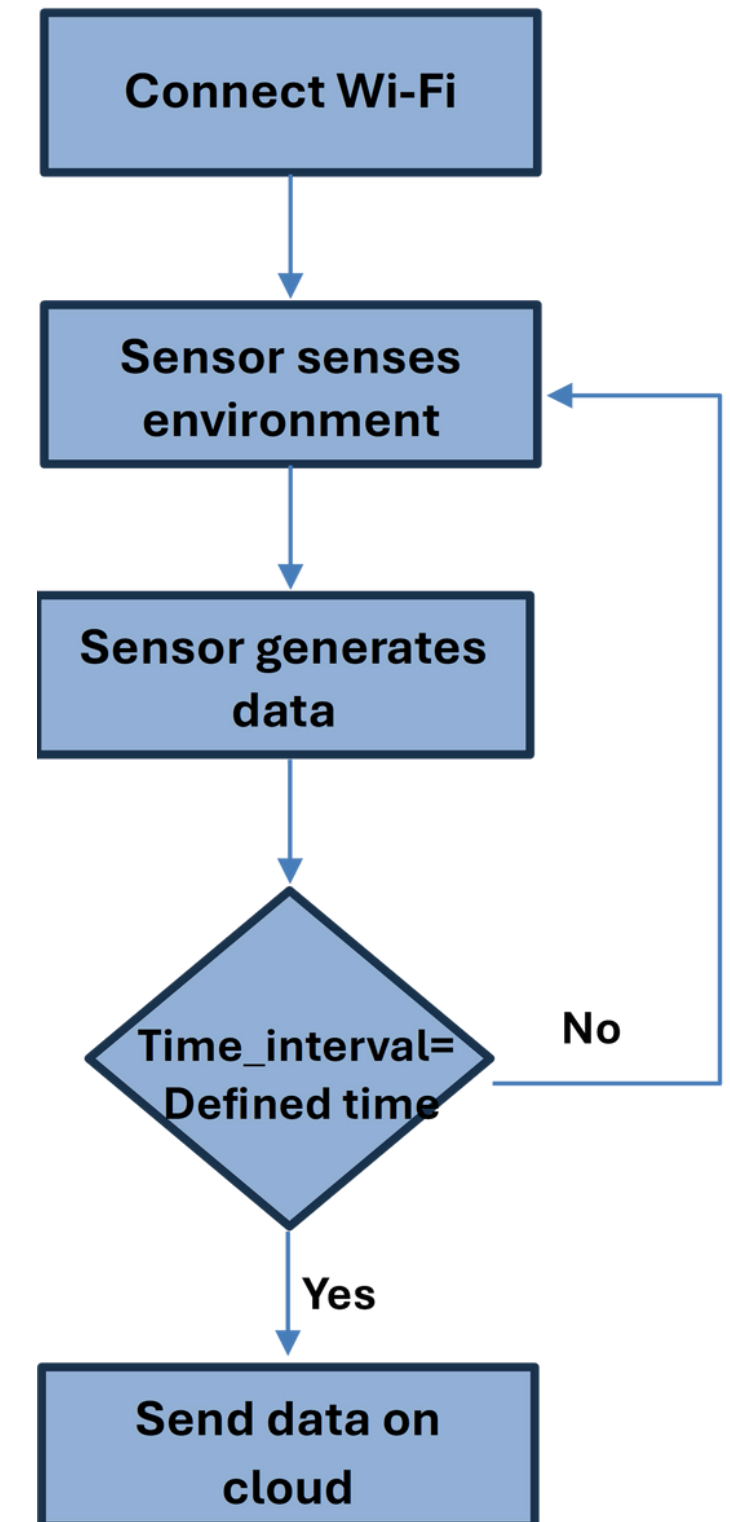


# PROPOSED MODEL

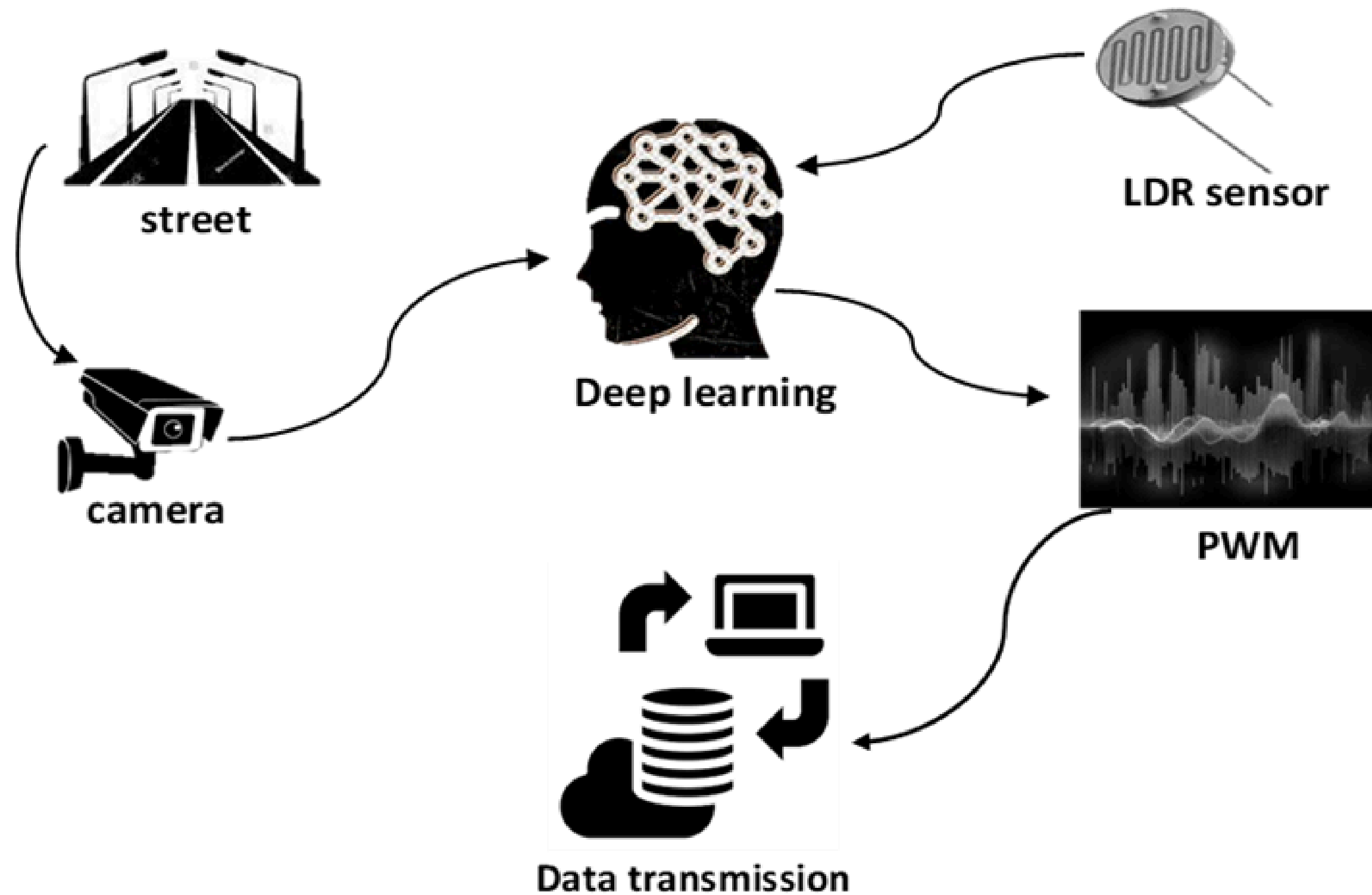


## 2. Intelligent Data Transmission Scheduling:

It reduces energy consumption and bandwidth usage, data transmission is scheduled intelligently. The system transmits data only in time interval. During periods of inactivity, the system reduces the transmission frequency or enters a low-power state



# PROPOSED MODEL





# OBJECTIVES



# OBJECTIVES



## 1) Energy Efficiency:

**Save the sustainability of energy and minimize Energy Consumption: Reduce the overall energy usage of IoT devices, particularly those that are battery-operated, to extend their operational life.**

## 2) Accurate Object Detection:

- High Detection Accuracy: Implement deep learning models to accurately detect objects within the IoT network, ensuring reliable data collection and processing.**
- Low Latency Detection: Ensure that object detection processes are fast and efficient, minimizing delays and enhancing real-time decision-making.**

## 3) Intelligent Data Transmission:

**Develop intelligent scheduling algorithms that determine the optimal times and frequencies for data transmission, reducing unnecessary energy consumption.**



# OBJECTIVES



**There is no specific information about energy consumption in the New Administrative Capital, but we can estimate the energy consumption in the streets with a simple calculation.**

Number of street lights ( $N$ ) = 10,000 lights.

Average power rating of each light ( $P$ ) = 150 watts.

Average operational hours per day ( $H$ ) = 12 hours.

Monthly Consumption =  $N \times P \times H \times 30$

Monthly Consumption =  $10000 \times 150 \times 12 \times 30$

Monthly Consumption = 540,000 kWh

**For instance, in the New Administrative Capital, street lighting consumes approximately 540,000 kWh of electricity monthly. Our study aims to reduce the energy consumption of street lights.**



# METHODOLOGY

# METHODOLOGY

Collect a diverse dataset of street scenes under various conditions (day, night, weather variations)

Integrate the object detection system with the streetlight control mechanism.

The system will be able to detect any movement, and the smart controller based on trained artificial network will send signals to the illumination controller to raise and reduce the intensity of the street lighting accordingly and scheduling data transmission

**Data Collection**

**Model Training**

**Adaptive Lightning Control**

**Data Transmission Scheduling**

**Integrates All steps of Methodology**

Train a deep learning model on data collection

Implement local processing to minimize latency and reduce the need for continuous data transmission to central servers.



# EXPECTED OUTCOMES



- **Implement deep learning models to accurately detect objects such as vehicles, pedestrians, and cyclists, ensuring the lights are on when needed.**
- **Reduce the energy consumption of street lights by ensuring they are only on when necessary.**
- **Develop efficient data transmission schedules to reduce energy consumption in the communication process.**
- **Strong and accurate Deep learning-based system for Object Detection.**



# Thanks and Acknowledgement



# Thank you

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