**ENVIRONMENTAL MONITORING**

**IOT to Enable Smart Environmental Monitoring**

From [animal conservation](https://www.iotforall.com/iot-environment-conservation-poaching) to flood detection, IOT helps protect people from environmental dangers. Here are just a few examples of how organizations can implement smart environmental monitoring.

1. **Water Conservation**: According to the United States Environmental Protection Agency, household leaks waste approximately nearly [900 billion gallons of water](https://www.epa.gov/watersense/statistics-and-facts#:~:text=Water%20Stats,gallons%20of%20water%20annually%20nationwide.) annually nationwide. By integrating sensors into water management systems, smart homes and buildings can efficiently monitor their water usage, detect leaks, and decrease water wastage.
2. **Animal Conservation:**Most national parks protecting endangered species lack connectivity. Without a way to intelligently track the animals and their movements, it is difficult for rangers to monitor national parks. IOT solutions with a reliable network help create a sustainable and safe way to track animals simply and efficiently. These networks serve to collect data from sensors distributed throughout expansive areas.
3. **Sustainable Farming:**IOT technology is bringing the physical world of farming into the future. Whether that means using sensors to track soil conditions, water levels, or the quality of their crops, [farmers are greatly benefiting from connectivity](https://www.iotforall.com/smart-farming-technology-and-benefits). Long-range, low-power sensors can measure environmental conditions that influence crop production, track the health of livestock, and enable efficiencies that can reduce environmental impact while maximizing yield and minimizing expenses.
4. **Flood Monitoring:**To respond faster to floods and prepare for future ones, governments need to monitor waterways in real-time, predict the risk of flooding, and alert emergency personnel and citizens in advance of a flooding event. Sensors integrated with long-range, low power technology autonomously monitor rising sea levels as a result of climate change. The use of these sensors has been valuable in coastal regions with a high risk of flooding.

# IOT in Smart Cities: A Survey of Technologies, Practices and Challenges

## **Abstract**

Internet of Things is a system that integrates different devices and technologies, removing the necessity of human intervention. This enables the capacity of having smart (or smarter) cities around the world. By hosting different technologies and allowing interactions between them, the internet of things has spearheaded the development of smart city systems for sustainable living, increased comfort and productivity for citizens. The IOT for Smart Cities has many different domains and draws upon various underlying systems for its operation

## **Introduction**

With a bulging world population and increasing urbanization which is set to grow by more than 10% in the next 30 years [[**1**](https://www.mdpi.com/2624-6511/4/2/24#B1-smartcities-04-00024)] resulting in a total of 70% living in cities by 2050, countries around the world are looking at equipping their cities to deal with the influx of people and the stress it will bring to current city systems [[**2**](https://www.mdpi.com/2624-6511/4/2/24#B2-smartcities-04-00024)]. This is to be carried out keeping in view the UN Sustainable Development Goals 2030 [[**3**](https://www.mdpi.com/2624-6511/4/2/24#B3-smartcities-04-00024)]. In this regard, Smart Cities have come out as a major initiative by various governments in making cities more navigable and welcoming to the expected population increase and providing city dwellers a better living experience, as is evidenced by the multiple projects ongoing on both the public and private level [[**4**](https://www.mdpi.com/2624-6511/4/2/24#B4-smartcities-04-00024),[**5**](https://www.mdpi.com/2624-6511/4/2/24#B5-smartcities-04-00024),[**6**](https://www.mdpi.com/2624-6511/4/2/24#B6-smartcities-04-00024),[**7**](https://www.mdpi.com/2624-6511/4/2/24#B7-smartcities-04-00024)]

## **Smart City Components**

A smart city is made up of several components which are illustrated Smart city applications typically have four aspects associated with them, the first is the collection of data, the next is its transmission/reception, third is the storage and fourth is analysis. The collection of data is application dependent and has been a real driver for sensor development in the various domains. The second part is the exchange of data, this involves data transmission from the data collection units towards the cloud for storage and analysis. This task has been achieved in several manners, many smart city ventures have city-wide Wi-Fi networks, 4G and 5G technologies are being used, as well as various types of local networks which can convey data either on a local level or a global level.

## **Conclusions**

This paper presents a broad coverage of the Internet of Things in Smart Cities. Providing a detailed discussion of Smart Cities and its different domains, we present IOT as a vital enabler of smart city services and discuss the various smart city architectures and the challenges that are faced in the deployment of smart city applications. We follow this up with a review of the sensing and networking technologies used for such applications and discuss the usage of AI in smart cities. For each of the applications discussed for the various components, we have deliberated upon the type of deployment based on the technologies and architectures discussed to present an overview of the current research scenario in IOT based Smart Cities.

## **Author Contributions**

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Develop a Python script on the IOT devices to send real-time environmental data to the monitoring platform.

#### SOCKETS AND MYSQLDB

Sockets that facilitate networking in IOT devices include TCP/IP and UDP, which are compatible to work with Python packages. TCP/IP and UDP act as transport layer protocols for communication..

#### MATPLOTLIB

To get data insights visualizes the most paramount operations by giving a variety of graphs to represent the data.

#### REQUESTS, TKINTER AND TENSORFLOW

To make HTTP calls and parse responses in Python, the **request package** acts as a major protocol for data exchanges.  **GUI** puts the aspects of Python script in a controlled distribution, which enables functional testing and repeated executions in IOT Python devices. Therefore, the numerical computations of machine learning initiated into the IOT systems utilize the representation in data flow graphs dealing with huge non-linear datasets and deep learning aspects.

### **IOT DEVICES USED TO DEVELOP APPLICATIONS IN IOT**

* Raspberry Pi Model 3
* Intel Edison

### **IOT SENSORS SIMULATORS USED IN PYTHON PROGRAMMING INCLUDE:**

MQTT protocol for the IOT in Python enables high-speed data exchange with low payload communication between the devices. User-friendly requests of MQTT are made directly in Python. Data is collected in real-time and easily analyzed in mathematical computation libraries.

#### AZURE IOT SDK IN PYTHON

Azure IOT hub offers a variety of features for IOT SDK usage which provides the ability to connect devices and services. The IOT SDK is supported by the MQTT protocol which facilitates the data exchange processes.

The device requirements to be used along with Python include:

* Python version 3.7+: helps in both asynchronous and synchronous API
* Azure-IOT-device library

The IOT hub SDK helps with the following aspects: access, processing, and analysis of data for machine learning applications.  
The Azure IOT hub helps collect messages and feedback data collected by IoT devices and is displayed in the code below:

**1. Plan Your Project:**

- Define the scope and objectives of your project.

- Determine the number and types of sensors you'll need.

- Select the locations within the parks where you want to deploy the sensors.

**2. Choose IOT Hardware:**

- Select appropriate IOT hardware for your sensors. Popular options include Raspberry Pi, specialized IOT development boards.

- Choose suitable sensors for measuring temperature and humidity.

**3. Set Up Hardware:**

- Connect sensors to your chosen IOT devices.

- Ensure that your IOT devices have Wi-Fi or cellular connectivity options.

**4. Develop Python Script:**

- Write Python scripts to interface with the sensors and collect data.

- You'll need to use libraries or SDKs provided by the sensor manufacturers to read sensor data.

- Write code to send this data to a central monitoring platform.

**5. Choose a Monitoring Platform:**

- Select a platform or server where you'll receive and store the data from your IoT devices. This could be a cloud-based solution or a local server.

**Import Required Libraries**:

import time

import Adafruit\_DHT

import requests

**Set Up Sensor and API Endpoint**:

sensor = Adafruit\_DHT.DHT22

pin = 4 # You may need to adjust this based on your wiring

api\_url = 'https://yo*u*r-monitoring-platform.com/data-endpoint'