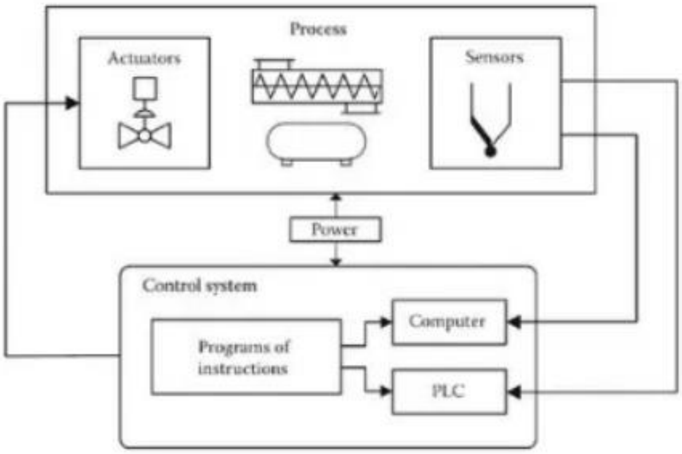
Unit-5
IoT case Studies

Industrial home automation

- Due to the rapid advances in technology, all industrial processing systems, factories, machinery, test facilities, etc. turned from mechanization to automation.
- A mechanization system needs human intervention to operate the manual operated machinery. As new and efficient control technologies evolved, computerized automation control is being driven by the need for high accuracy, quality, precision and performance of industrial processes.
- Automation is a step beyond the mechanization which makes use of high control capability devices for efficient manufacturing or production processes.

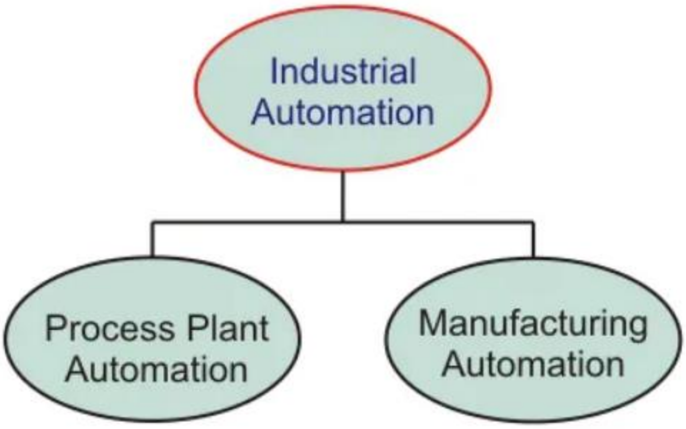


What is Industrial Automation

- **Industrial automation** is the use of control devices such as PC/PLCs/PACs etc. to control industrial processes and machinery by removing as much labour intervention as possible, and replacing dangerous assembly operations with automated ones.
- Industrial automation is closely linked to control engineering.Automation is a broad term applied to any mechanism that moves by itself or is self dictated.
- The word 'automation' is derived from ancient Greek words of Auto (means '*self*') Matos (means '*moving*').
- As compared with manual systems, automation systems provide superior performance in terms of precision, power, and speed of operation.
- In industrial automation control, a wide number of process variables such as temperature, flow, pressure, distance, and liquid levels can be sensed simultaneously.
- All these variables are acquired, processed and controlled by complex microprocessor systems or PC based data processing controllers.

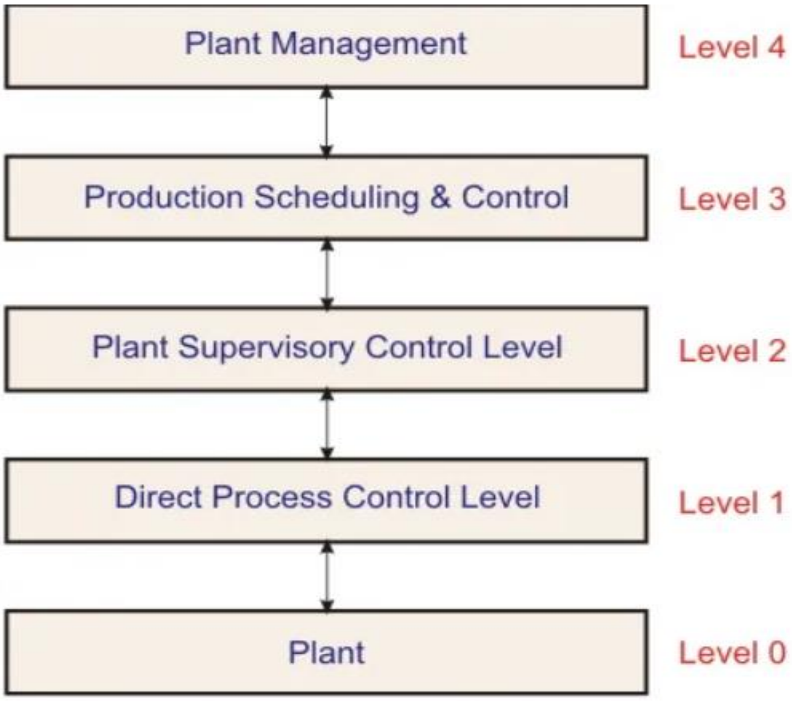
Types of Industrial Automation

- Industrial automation is the use of computer and machinery aided systems to operate the various industrial operations in a well-controlled manner.
- Depends on the operations involved, the industrial automation systems are majorly classified into two types, namely process plant automation and manufacturing automation.



Process Plant Automation

- In process industries, the product results from many chemical processes based on some raw materials. Some of the industries are pharmaceuticals, petrochemical, cement industry, paper industry, etc. Thus the overall process plant is automated to produce the high quality, more productive, high reliable control of the physical process variables.



Process Plant Automation System Hierarchy

- Level 0 or Plant: This level consists of machines which are closest to processes. In this, sensors and actuators are used to translate the signals from the machines and physical variables for the purpose of analysis and to produce the control signals.
- Direct Process Control: In this level, automatic controllers and monitoring systems acquire the process information from sensors and correspondingly drives the actuator systems. Some of the tasks of this level are-
  - Data acquisition
  - Plant monitoring
  - Dara checking
  - Open and closed loop control
  - Reporting

Plant Supervisory Control: This level commands the automatic controllers by setting the targets or set points. It looks after the control equipment for optimal process control. Some of the tasks of this level are:

- Plant monitoring performance
- Optimal process control
- Plant coordination
- Failure detection, etc.

Production Scheduling and Control: This level solves the decision-making problems like resource allocation, production target, maintenance management, and so on. Tasks of this level include:

- Production dispatch
- Inventory control
- Production supervision, production reporting, etc.

Plant Management: This is the higher level of the process plant automation. It deals more with commercial activities than technical activities. Tasks of this level include-

- Market and Customer analysis
- Orders and sale statistics
- Production planning
- Capacity and order balance, etc.

Manufacturing Automation System

- ➢ The manufacturing industries make the product out of materials using machines/robotics. Some of these manufacturing industries include textile and clothing, glass and ceramic, food and beverages, paper making, etc.
- ➢ New trends in manufacturing systems have been using automation systems at every stage such as material handling, machining, assembling, inspection, and packaging. With the computer-aided control and industrial robotic systems, manufacturing automation becomes very flexible and efficient. The figure below shows the manufacturing automation system hierarchy in which all functional levels are automated by using different automation tools.

Challenges faced by industry related IoT application

- ➢ High investment cost
- ➢ Secure data storage and management
- ➢ Connectivity outages
- ➢ Blending Legacy and IIoT infrastructure

Home automation

9.2 Home Automation

9.2.1 Smart Lighting

A design of a smart home automation system was described in Chapter-5 using the IoT design methodology. A concrete implementation of the system based on Django framework is described in this section. The purpose of the home automation system is to control the lights in a typical home remotely using a web application.

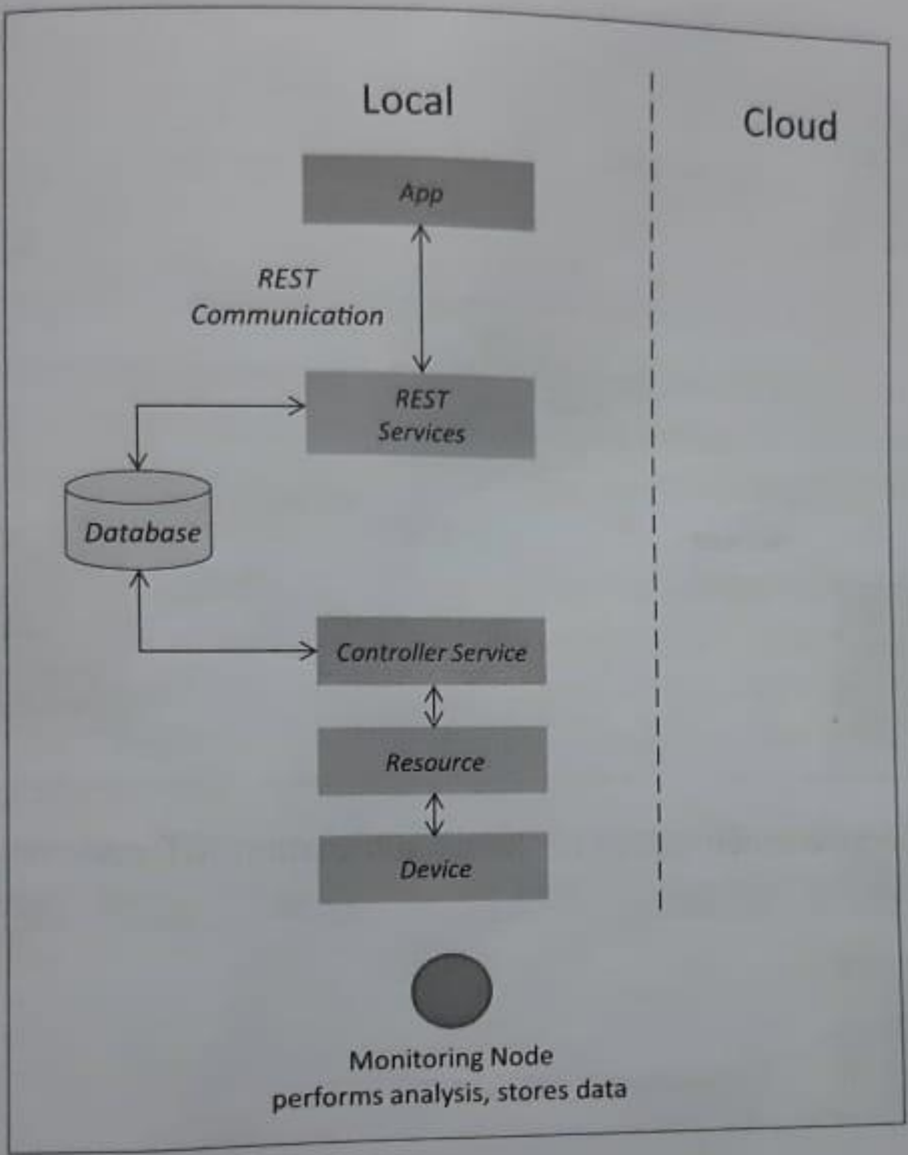
The system includes auto and manual modes. In auto mode, the system measures the light in a room and switches on the light when it gets dark. In manual mode, the system provides the option of manually and remotely switching on/off the light.

Figure 9.1 shows the deployment design of the home automation system. As explained in Chapter-5, the system has two REST services (mode and state) and a controller native service. Figures 9.2 and 9.3 show specifications of the mode and state REST services of the home automation system. The Mode service is a RESTful web service that sets mode to auto or manual (PUT request), or retrieves the current mode (GET request) . The mode is updated to/retrieved from the database. The State service is a RESTful web service that sets the light appliance state to on/off (PUT request), or retrieves the current light state (GET request). The state is updated to/retrieved from the status database.

■ Box 9.1: Django model for mode and state REST services - models.py

```
from django.db import models

class Mode(models.Model):
    name = models.CharField(max_length=50)
```



ıure 9.1: Deployment design of the home automation IoT system

```
e(models.Model):
iodels.CharField(max_length=50)
```

th the implementation of the system, we first map services to Django models
the model fields for the REST services (state - on/off and mode - auto/manual)

Serializers for mode and state REST services - serializers.py

```
.models import Mode, State
framework import serializers

Serializer(serializers.HyperlinkedModelSerializer):
```

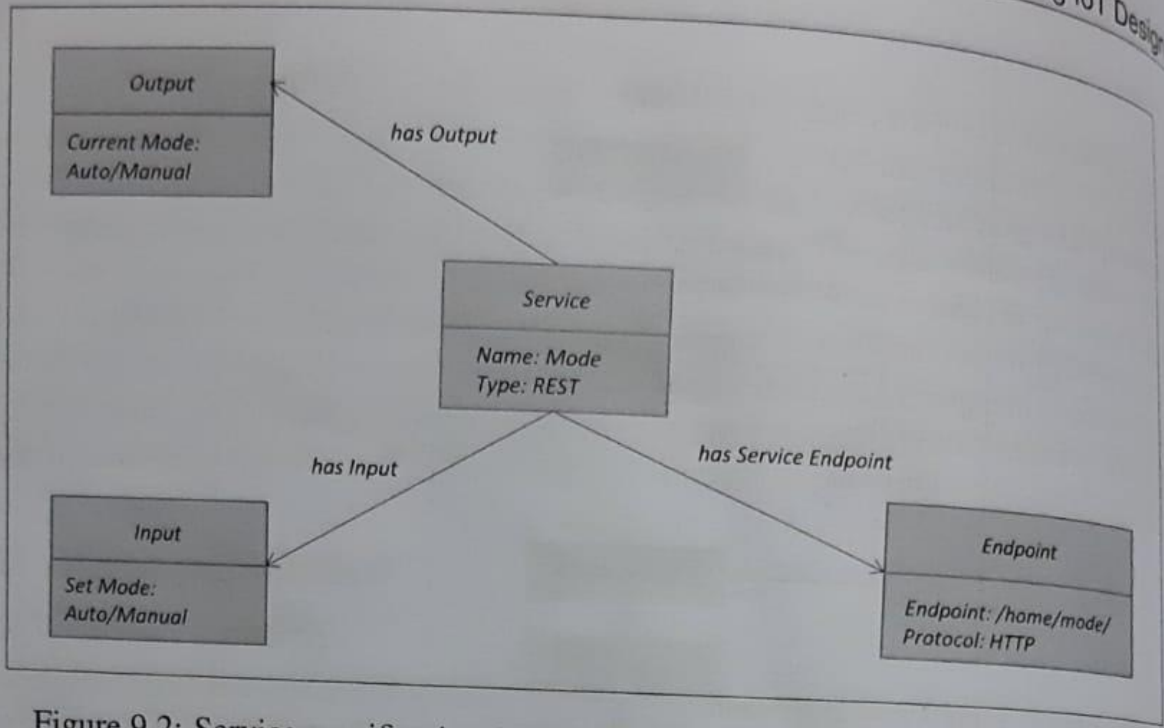


Figure 9.2: Service specification for home automation IoT system - mode service

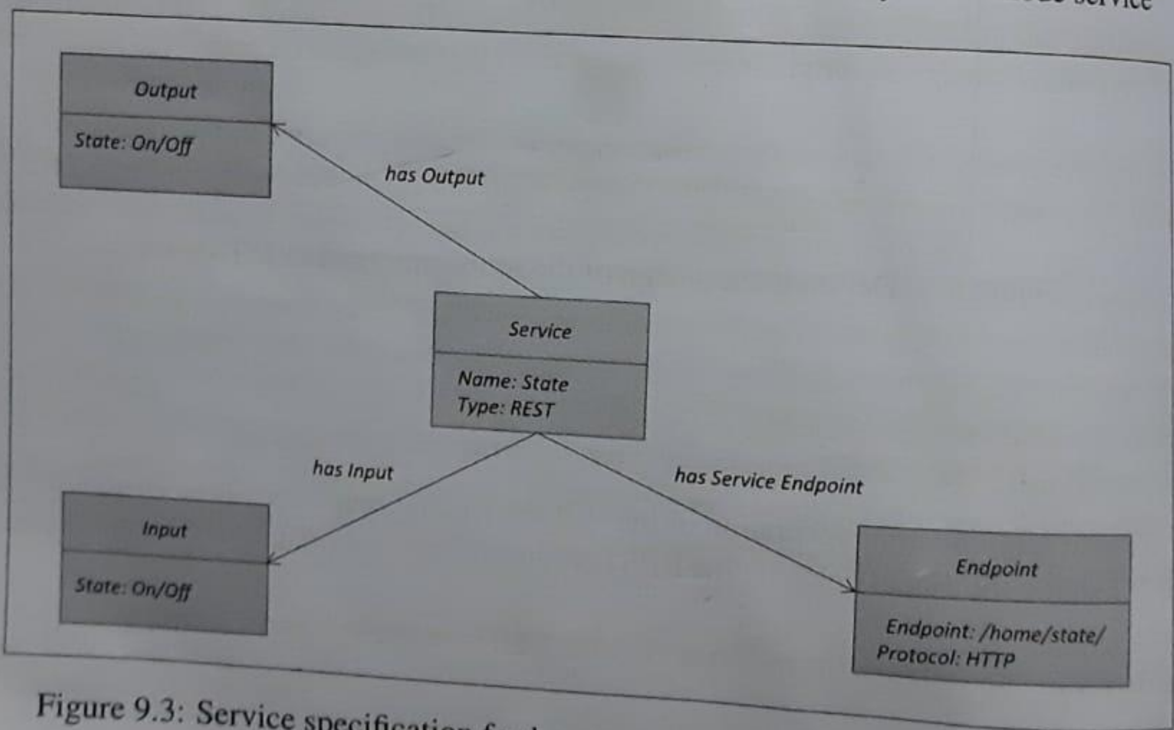


Figure 9.3: Service specification for home automation IoT system - state service

```
class Meta:
```

```
model = State
fields = ('url', 'name')
```

After implementing the Django model, we implement the model serializers. Serializers allow complex data (such as model instances) to be converted to native Python datatypes that can then be easily rendered into JSON, XML or other content types. Box 9.2 shows the serializers for mode and state REST services.

Figure 9.4 shows a screenshot of the home automation web application.

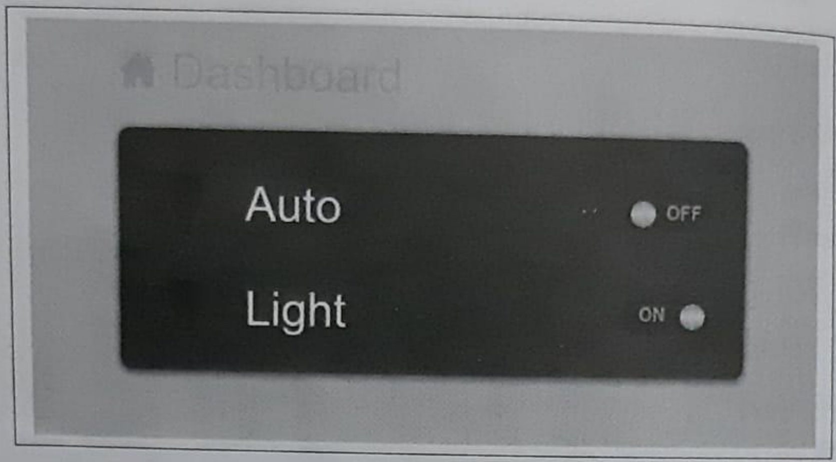


Figure 9.4: Home automation web application screenshot

Figure 9.5 shows a schematic diagram of the home automation IoT system. The devices and components used in this example are Raspberry Pi mini computer, LDR sensor and relay switch actuator.

Figure 9.6 shows the specification of the controller native service that runs on Raspberry Pi. When in auto mode, the controller service monitors the light level and switches the light on/off and updates the status in the status database. When in manual mode, the controller service, retrieves the current state from the database and switches the light on/off. A Python implementation of the controller service is shown in Box 9.6.

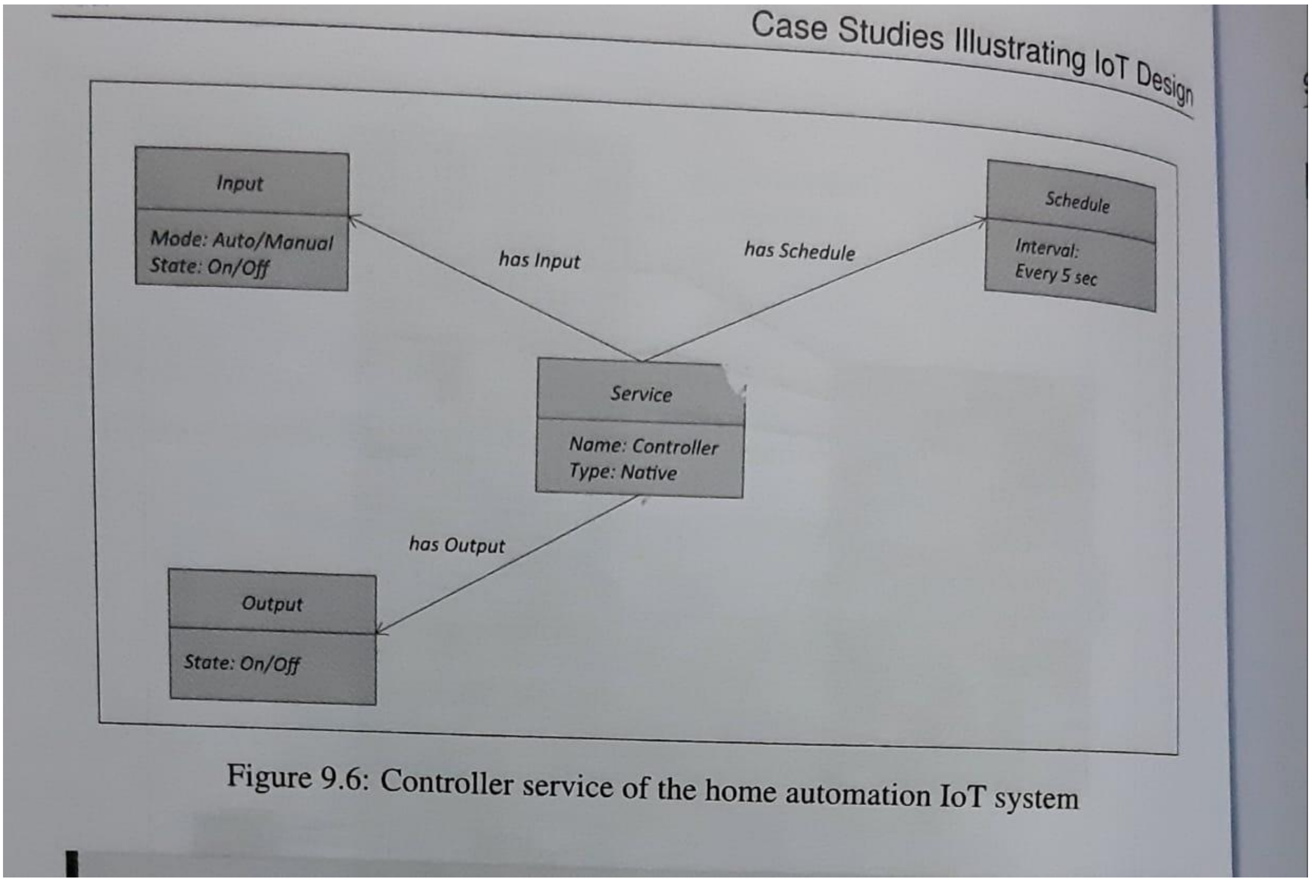


Figure 9.6: Controller service of the home automation IoT system

Advantages

- Managing all of your home devices from one place.
- Flexibility for new devices and appliances.
- Maximizing home security.
- Remote control of home functions
- Increased energy efficiency.
- Improved appliance functionality
- Home management insights.

Health and fitness monitoring

Wearable internet of things devices that allow for non-invasive and continuous monitoring of physiological parameters can aid in ongoing health and fitness monitoring. These wearable gadgets come in a variety of shapes and sizes, including belts and wristbands. The wearable devices are part of a body area network, which is a sort of wireless sensor network in which data from a number of wearable devices is continuously delivered to a master note (such as a smartphone), which subsequently sends the data to a server or a cloud-based back-end for analysis and achievement. Health-care providers can look over the obtained data to see if there are any health issues or irregularities.

Body temperature, heart rate, pulse oximeter oxygen saturation (SPo2), blood pressure, electrocardiogram (ECG), movement (with accelerometers), and electroencephalogram are examples of common body sensors (EEG). In healthcare, a ubiquitous mobility method for the body sensor network is presented. An integrated electrocardiogram (ECG), accelerometer, and oxygen saturation (SPo2) sensor is used in a wearable ubiquitous healthcare monitoring system. The Fitbit wristband is a wearable gadget that tracks steps, distance, and calories burned during the day, as well as sleep quality.

Wearable electronics

Wearable electronics, such as smart watches, smart glasses, wristbands, and fashion electronics (with electronics integrated into clothing and accessories (example: Google Glass or Moto 360 Smart watch), provide a variety of functions and features to assist us in our daily activities while also encouraging us to live a healthy lifestyle. Smart watches that run a mobile operating system (such as Android) have more features than just keeping time. Users can use smartwatches to search the internet, listen to and watch audio/video files, make calls (with or without an associated mobile phone), play games, and use a variety of mobile applications.

Smart glasses allow users to utilize voice commands to capture images and record videos, receive map directions, check flight status, and search the internet. Smart shoes use inbuilt sensors to track walking or running speed and leap, and they may be coupled with smartphones to visualize the data. The daily exercise and calories burned can be tracked using a smart wristband.

2.4.2 Air Pollution Monitoring

IoT based air pollution monitoring systems can monitor emission of harmful gases (CO_2, CO, NO, NO_2, etc.) by factories and automobiles using gaseous and meteorological sensors. The collected data can be analyzed to make informed decisions on pollutions control approaches. In [41], a real-time air quality monitoring system is presented that comprises of several distributed monitoring stations that communicate via wireless with a back-end server using machine-to-machine communication. In [42], an air pollution system is described that integrates a single-chip microcontroller, several air pollution sensors, GPRS-Modem, and a GPS module. In chapter-9 we provide a case study on an air pollution monitoring system.

Figure 2.3: Applications of IoT for environment

2.4.3 Noise Pollution Monitoring

Due to growing urban development, noise levels in cities have increased and even become alarmingly high in some cities. Noise pollution can cause health hazards for humans due to sleep disruption and stress. Noise pollution monitoring can help in generating noise maps for cities. Urban noise maps can help the policy makers in urban planning and making policies to control noise levels near residential areas, schools and parks. IoT based noise pollution monitoring systems use a number of noise monitoring stations that are deployed at different places in a city. The data on noise levels from the stations is collected on servers or in the cloud. The collected data is then aggregated to generate noise maps. In [43], a noise mapping study for a city is presented which revealed that the city suffered from serious noise pollution. In [44], the design of smart phone application is described that allows the users to continuously measure noise levels and send to a central server where all generated

information is aggregated and mapped to a meaningful noise visualization map.

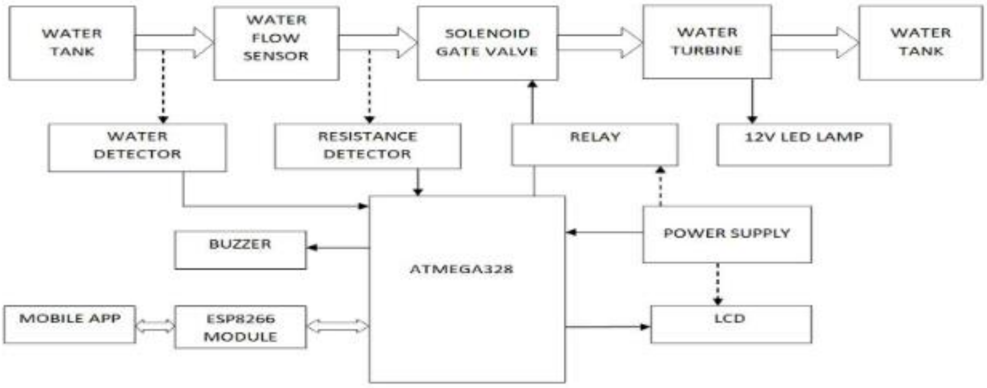
Humidity detection:

- Practically, every part of exercise contains controlled schedules of temperature as well as humidity. However, the exact value of temperature with its significant feature in any field is essential in monitoring .
- Constant perception in temperature is utilized in various industries like the pharmaceutical industry as the driving force behind these monitoring systems, computerized and straightforward temperature sensors can use.
- Resistors, semiconductors, thermistors estimate temperatures values. These components are present inside the sensor to retrieve the temperature in consonance with the circumstances.
- The primary goal of our system is to supervise the live temperature and humidity within a low cost . Raspberry Pi is the observational system or controller which is used for the cloud saving. Python is the programming language which is utilized in Raspberry Pi.
- HTU 211D sensors is a temperature sensor which is used here for the sensing purpose . This comprises of temperature ascertaining capacity and favorable fundamental position of utilizing HTU 211D sensors, which boasts of less weight and ease of use.
- The sensor is associated with Raspberry Pi utilizing connecting wires. Temperature sensor HTU 211D sensors is utilizing is perused put away, and shown in the Raspberry Pi unit . IoT based devices in homes and industries are used for controlling all the electrical or electronic devices which are present.
- Additionally, the saved information of the IoT devices can be controlled from anywhere .
- The sensor analyzes the graphical representation of the observed data in every user defined format wherever in the world. In this work, IoT based Arduino with Raspberry Pi microcontroller is used.

- Humidity and temperature monitoring using Arduino is an exciting and secure process. Furthermore, this flexible system obtains more values in calculating the actuator from the data saved on the internet.
- For connecting the Arduino board with Raspberry Pi, USB line serial interface is essential to connect with any application.

Water flow detection:

- system consists of water flow detector that is employed to take a note of what quantity of water has been transferred from one place to the other.
- If there's leak in pipeline the water detector senses the water flow and sends signal to the controller. The controller sends the signal to the relay then the solenoid valve activates mechanically.
- Quantity of water flow and resistance value is monitored. Resistance value has been set different for different locations.
- The location can be known using the resistance value viewed within the mobile app. The water turbine rotates once there's water flow and power is generated.
- A. Water Flow Sensor
- The rate of flow of water or the amount of water being provided is measured using the water flow detector.
- Rate of flow of water is measured in litres per hour. If there's leak within the pipeline, it's detected by the water detector and the detector sends signal to the microcontroller.
- Once the leak is detected the solenoid valve turns OFF.



- Resistance Detector Resistance detector measures the resistance of the copper wire connected to the pipe. Once water leaks tangency hap- pens.
- Tangency is often determined by measuring resistance between two cables at one end. The value of resistance tells us the precise location of the tangency.
- Each location contains a bound resistance value using which we can easily locate the area of leak
- C. Function of Microcontroller
- The leak in pipeline is detected by the water detector that successively sends the signal to the controller. The controller sends the signal to the relay that turns off the solenoid's valve.
- Once the solenoid valve is off there is no water flow within the pipeline. Once there is water flow within the pipeline the water rotary engine rotates and power is generated.
- An alphanumeric display is connected to the controller that displays the quantity of water flow within the pipe and also the resistance value.
- The controller is connected to the ESP module that transfers the information to the mobile application where we are able to view the location of water leak within the pipeline. Fig. 2 depicts the internal wiring connections involved in connecting the controller with water detector, water flow sensor, solenoid valve and IoT module.

- D. ESP8266 Module ESP8266 module is a standalone low cost wireless transceiver used to communicate with the WiFi module.