Internet of Things (IoT)

UNIT – 4: IoT Application Development

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Introduction

IoT Application Development is the process of designing, building, and deploying Internet of Things (IoT) solutions that connect physical devices to the internet and enable them to collect, process, and share data. In today's world, IoT applications are transforming industries like healthcare, agriculture, home automation, transportation, and smart cities.

For example — smart home systems like **Google Nest** and **Amazon Alexa** use sensors and devices connected through the cloud to monitor and control lights, temperature, and security.

IoT application development combines **hardware (like Raspberry Pi, Arduino)**, **software (Python, Linux)**, and **cloud platforms (AWS, Azure, Google Cloud)** to create intelligent, connected systems.

👉 In short (Hinglish): IoT application development ka matlab hota hai "ek complete system banana jisme devices internet ke through communicate karte hain aur data exchange karke smart decision lete hain."

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1. IoT Design Methodology

Definition

IoT Design Methodology refers to a structured step-by-step approach to design IoT-based systems efficiently. It helps developers to move from an idea to a working product logically and reduces development errors.

Explanation

The design methodology includes all stages like problem identification, device selection, communication planning, data storage, and analysis. It ensures the IoT system is **scalable, secure, and reliable**.

Steps in IoT Design Methodology

Step	Description	Real-Life Example

1. Requirement Identification	Define the problem and goal.	Smart irrigation system for farmers.
2. Device Selection	Choose hardware like sensors and controllers.	Soil moisture sensor, Raspberry Pi.
3. Data Communication Design	Plan how data will travel (Wi-Fi, Bluetooth, etc.)	Using MQTT or HTTP protocols.
4. Cloud or Local Storage Setup	Decide where data will be stored and processed.	AWS IoT Core cloud platform.
5. Application Development	Build an interface (dashboard or mobile app).	App showing soil moisture levels.
6. Testing and Deployment	Check system performance and deploy.	Testing sensors in real farm conditions.

Working Process (Flow Chart)

Problem Identification → Device Selection → Communication Setup → Cloud Storage →

Application Interface → Testing → Deployment

👉 *Hinglish Explanation:*
IoT design karte time sabse pehle problem ko samjha jata hai, phir device choose kiya jata hai, data transfer ka medium select kiya jata hai aur phir final app ya dashboard banaya jata hai jo user ko output show karta hai.

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2. Linux on Raspberry Pi

Definition

Linux is an open-source operating system that powers Raspberry Pi boards and allows users to run commands, manage files, and control IoT devices easily.

Explanation

The Raspberry Pi generally uses **Raspberry Pi OS (formerly Raspbian)**, which is a Debian-based Linux system. It provides flexibility to install Python, connect sensors, and run IoT applications smoothly.

Key Features of Linux on Raspberry Pi

- Open-source and free to use.
- Lightweight and optimized for IoT.

- Supports Python, Node.js, and other programming tools.
- Provides full control over GPIO (General Purpose Input/Output) pins.

Real-World Example

In a **smart security system**, Raspberry Pi runs Linux to control a camera, detect motion, and send alerts to a mobile device.

👉 *Hinglish Explanation:*
Linux ek aisa operating system hai jo Raspberry Pi ko “brain” jaisa power deta hai. Iske through hum sensors aur devices ko command de sakte hain aur IoT ka pura control kar sakte hain.

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3. Raspberry Pi Interfaces

Definition

Interfaces on Raspberry Pi are the physical and logical connections that allow it to interact with sensors, devices, and external systems.

Types of Interfaces

Interface	Full Form	Use	Example
GPIO	General Purpose Input/Output	Connects sensors and LEDs	Temperature sensor input
I2C	Inter-Integrated Circuit	For low-speed communication	Connecting accelerometer
SPI	Serial Peripheral Interface	High-speed data transfer	Display modules
UART	Universal Asynchronous Receiver Transmitter	Serial communication	GPS module connection
USB / HDMI / Ethernet	Universal ports	Display and internet access	HDMI monitor or LAN cable

Working Example

In a **home automation project**, Raspberry Pi uses GPIO pins to turn ON/OFF lights, I2C for sensors, and Wi-Fi for cloud communication.

👉 *Hinglish Explanation:*
Raspberry Pi ke ye ports uske “hands” aur “ears” jaise hote hain – ye devices se baat karte hain aur unka data process karte hain.

4. Programming Raspberry Pi with Python

Definition

Python is the most widely used programming language for IoT because it is simple, powerful, and has many libraries for sensor communication and cloud integration.

Explanation

Python on Raspberry Pi allows direct access to GPIO pins to control hardware devices like LEDs, motors, and sensors. Libraries like gpiozero, RPi.GPIO, and paho-mqtt make IoT programming easier.

Example Code

```
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BOARD)
GPIO.setup(11, GPIO.OUT)
while True:
   GPIO.output(11, True)
   time.sleep(1)
   GPIO.output(11, False)
   time.sleep(1)
```

Working Example

This code blinks an LED connected to Raspberry Pi every second — commonly used as a “Hello World” of IoT.

Real-Life Application

Used in **Smart Traffic Light Systems** or **Automatic Door Control** where Raspberry Pi and Python control timing and sensors.

👉 *Hinglish Explanation:*
Python simple aur beginner-friendly language hai jisse hum Raspberry Pi ke pins se direct control kar sakte hain — jaise ek remote device ke liye brain code likhna.

5. Data Storage on Cloud / Local Server

Definition

Data storage in IoT refers to saving collected data from sensors or devices either on a **cloud platform (remote)** or a **local server (on-site)** for future processing and visualization.

Explanation

IoT devices generate large volumes of data continuously. Storing this data helps in analytics, visualization, and machine learning integration.

Types of Storage

Type	Description	Example
Cloud Storage	Stores data on the internet; accessible anywhere.	AWS IoT, Google Cloud, Azure IoT Hub.
Local Storage	Stores data on the device or local network.	SQLite, Raspberry Pi local server.

Real-Life Example

- Smart city projects store traffic and pollution data on cloud servers for analysis.
- Local weather stations use Raspberry Pi for offline data storage.

Working Process (Flow)

1. Sensor collects data (e.g., temperature).
2. Raspberry Pi processes it.
3. Data sent to cloud via Wi-Fi.
4. Cloud stores and displays it on dashboard.

👉 *Hinglish Explanation:*
IoT data ka main kaam hota hai “store karna aur analyze karna.” Cloud par store karne se data har jagah access hota hai jabki local server par fast aur secure rehta hai.

Conclusion

IoT Application Development is a multidisciplinary process that integrates **hardware, software, and cloud technologies**. Using Raspberry Pi, Linux, and Python, students can design working IoT systems like smart homes, health monitors, and environment trackers. The data can be stored and analyzed locally or on the cloud to provide real-time decisions.

👉 *Hinglish Summary:*
Is unit se humne seekha ki IoT system kaise design hota hai, Raspberry Pi kaise

program hota hai aur data ko cloud/local server par kaise store kiya jata hai. Ye process har smart system ka base hai — chahe wo smart city ho ya smart watch.

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