Internet of Things

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Industrial Revolution

18th century

Industry 1.0
Mechanisation

Steam powered engine, handmade to machine-based processes

19th century

Industry 2.0
Electrification

Electrification, Oil, Mass Production

20th century

Industry 3.0
Automation

Automation through use of electronics and information technology

today

Industry 4.0
Networking

Invention of the computerized network, IoT, AI, Big data

https://ie.rs-online.com/web/generalDisplay.html?id=did-you-know/industry-4.0
Technologies involved in Industry 4.0

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What is Internet of Things?
The idea of the Internet of Things is that instead of having a small number of powerful computing devices in your life, you have a large number of low energy, ubiquitous computing devices.
Many different industries are unlocking the power of the IoT fueling innovation to optimize processes and increase efficiency.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Example</th>
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</thead>
<tbody>
<tr>
<td>ENERGY GRIDS</td>
<td>Environmental data logging, substation monitoring, grid efficiencies</td>
</tr>
<tr>
<td>SMART BUILDING</td>
<td>Energy use monitoring; sensors in heaters and chillers to find inefficiencies</td>
</tr>
<tr>
<td>INDUSTRIAL &amp; MANUFACTURING</td>
<td>Assembly-line equipment reporting, inventory management; automation</td>
</tr>
<tr>
<td>RETAIL</td>
<td>Point of sale, vending machines, supply chain</td>
</tr>
<tr>
<td>TRANSPORTATION</td>
<td>Fleet management, freight tracking, urban congestion management</td>
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IoT Overview

83B devices will be connected to the Internet by 2024

Connecting, managing, and securing things leads to new insights that can improve the way we live.

Latest Trends in IoT Applications

- Smart and Safe Retail
- Smart buildings – “Internet of Behavior”¹
- Smart clothing
- Telemedicine – continuous monitoring and recording the health data
- Smart home offices
- Solar and hybrid luminaires for street lights²

Latest Trends in IoT Systems

- Camera as an IoT sensor
- AI/ML/DL techniques for data analysis
- Digital Twins
- Forensics Enabled IoT systems
- Blockchain technology
- 5G connectivity
IoT Requirements/Challenges

- Scalability
- Interoperability
- Manageability
- Analytics
- Security
- Sustainability
- Trustworthy working (safety)
IoT Architecture – 5 Layered Approach

- Business Layer
- Application Layer
- Processing Layer
- Network or Connectivity or Communication Layer
- Perception or Physical Layer
Perception or Physical Layer

• Contains sensors, actuators and edge devices
  • Sensors – temperature, humidity, camera, light, hall effect, piezoelectric, sound, touch, soil moisture sensor, EEG sensor, ECG sensor, pulse oximeter
    • Transforms analog signal into digital signal using sensors
  • Actuators – stepper motor, electric motor, infusion pump, temperature valves
    • Transforms digital signals into analog forms using actuators
  • Edge devices – Arduino, Raspberry-pi, Edison
    • Connect to sensors/actuators

• Interacts with the environment to sense the surrounding, collect data and send it to the gateway
Network/Connectivity Layer

- Transmits the data collected by the perception layer to servers, gateways or cloud and vice versa
- Communication protocols
  - Wifi, ethernet, Bluetooth, Zigbee, LoRA, MQTT, Cellular networks,
Application Layer

• Provides API to monitor, analyze, visualize and control IoT systems (edge devices/gateways)

• Revolutionizes various vertical markets to address their business needs by supporting mobile applications, different use cases etc
Processing Layer

- A software that provides APIs to devices/sensors to connect to gateways
- Analyzes data collected from the perception layer to provide meaningful insights before it gets send to the cloud i.e. computation at the edge
Business Layer

• Uses data from previous layers to take business decisions such as increase in productivity or efficiency or profit

• Makes decisions by analyzing large data from various IoT systems or instances of IoT systems using machine learning techniques
IoT architecture – healthcare use case

• Care any place and any time

Physical Layer → Communication Layer → Processing Layer → Application Layer → Business Layer

Ubiquitous Monitoring → Vital Signs → Progress → Feedback

Diagnosis, data analysis, and storage lab → Remote doctor → Hospital datacenter

Middleware Layer
IoT communication Protocols
Machine Learning for IoT Applications
Elderly Care Monitoring
Object Tracking and Detection in Multiple Cameras

- Deepsort – for object tracking
- Yolov5 – for object detection
Gait Detection for Parkinson’s Patients

- Parkinson’s disease (PD) patients commonly go through gait impairments.
- Change in the person’s gait while walking is one of the important indicators of the disease progression.
- Accurate gait change estimation requires long term monitoring.
- Current methods are required to be performed in the clinic under the observation of the trained healthcare professionals.

Use of ML algorithms:
- Use smartphone sensors – Gyroscope and Accelerometer data to predict gait impairment using ML models.
- Use Camera – Analyze patient walking videos to predict gait impairment using deep learning models.
ML for IoT
Security
Digital Forensics for Medical IoT Devices
Intrusion Detection System on MQTT Protocol

- MQTT networks are susceptible to various cyber-attacks.
- The broker can be prone to several security attacks:
  - DOS attack
  - Brute-Force
  - Malformed Packet
  - Invalid Subscribe/Publish request
  - TCP SYN flood attack
  - Port Scanning
  - Will Payload attack
Intrusion Detection using ML Algorithm

- **Data Collection**
  - Capture the network packets and generate the flows-based features.
- **Analysis and Attack Detection:**
  - Data Pre-processing and Machine Learning algorithms
- **Preservation and Presentation:**
  - Creating System Alerts
  - Storing the malicious packets in database
Physiological Signal Modeling

1. Call '108'
2. Nearest Ambulance
3. Nearest specialty hospital based on the patient needs

ML Model
- Re-generate ECG Signal
- Predict the next possible ECG peak

E.g. Tele-ambulance System
Summary

• Industrial IoT
• IoT Overview
• Architecture
• Communication Protocols
• Machine Learning for IoT