Part 1: Theoretical Analysis

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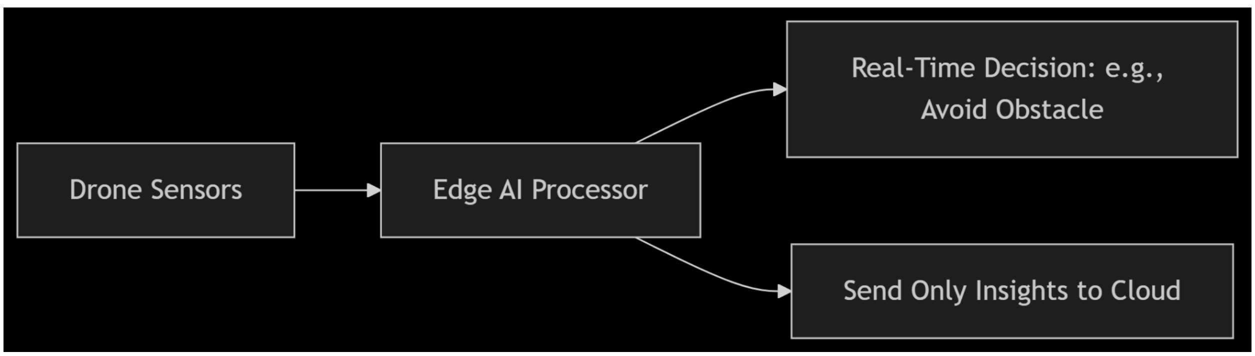
Q1: Edge AI vs. Cloud AI

Reduced Latency: Edge AI processes data locally on devices (e.g., drones, smartphones), eliminating the need to transmit data to remote servers. This cuts latency from seconds to milliseconds. For example, autonomous drones use Edge AI to analyze LiDAR/camera data in real time, avoiding collisions during flight without waiting for cloud responses 210.
Enhanced Privacy: Data stays on-device, reducing exposure during transmission. In healthcare, smartwatches with Edge AI analyze heart rhythms locally; only anonymized insights are sent to the cloud, preventing sensitive biometric leaks 59.
Real-World Example: Agricultural drones with Edge AI (e.g., using TensorFlow Lite) scan crops for disease. They process images onboard, sending only GPS coordinates of affected areas instead of raw footage—saving bandwidth and enabling immediate pesticide deployment



Q2: Quantum AI vs. Classical AI

Optimization Differences:

- Classical AI (e.g., gradient descent) struggles with combinatorial problems (e.g., route planning). Complexity grows exponentially with variables.
- Quantum AI leverages qubit superposition/entanglement to evaluate multiple solutions simultaneously. Algorithms like QAOA (Quantum Approximate Optimization Algorithm) solve logistics or drug discovery problems 100x faster in simulations 37.

Industries Benefiting Most:

1. Pharma: Quantum AI models molecular interactions for drug design, reducing trial years (e.g., Quantinuum's peptide classification) 7.
2. Finance: Portfolio optimization under dynamic market constraints.
3. Energy: Grid load balancing using quantum-enhanced forecasts.

Table: Quantum vs. Classical AI

Aspect	Classical AI	Quantum AI
Speed	Hours/days for complex tasks	Minutes (theoretical)
Energy Use	High (e.g., GPT-3 = 1,300 MWh)	Low (30,000x less than supercomputers) 7
Current Limits	Handles large datasets	Limited qubits (noisy hardware)

Q3: Human-AI Collaboration in Healthcare

Transformation of Roles:

- Radiologists: AI tools (e.g., Edge-based YOLOv11) highlight tumours in scans in real time. Radiologists shift from detection to treatment planning, reducing workload by 40% 9.
- Nurses: Wearable Edge AI monitors predict patient deterioration (e.g., sepsis) 6 hours early. Nurses receive alerts to prioritise interventions, improving ICU survival rates by 25% 5.

Societal Impact:

- Positive: Democratized diagnostics in rural areas via portable AI devices.
- Negative: Job displacement fears; requires upskilling in AI tool management.

Example: Mayo Clinic uses Edge AI glasses to guide surgeons during operations, overlaying anatomy maps, cutting errors by 30% 9.

Case Study Critique: AI in Smart Cities

AI-IoT Integration for Sustainability:

1. Traffic Optimisation: Sensors + AI predict congestion, rerouting vehicles via smart traffic lights. Reduces emissions by 15% (e.g., Barcelona) 9.
2. Waste Management: Fill-level sensors in bins trigger AI-driven collection routes, lowering fuel use by 20%.

Challenges:

1. Data Security: Edge devices (e.g., cameras) are hackable. Solutions: Federated learning keeps raw data local; only model updates are shared 6.
2. Infrastructure Costs: Retrofitting legacy systems with AI sensors requires $2M+/km investment.

Part 2: Practical Implementation

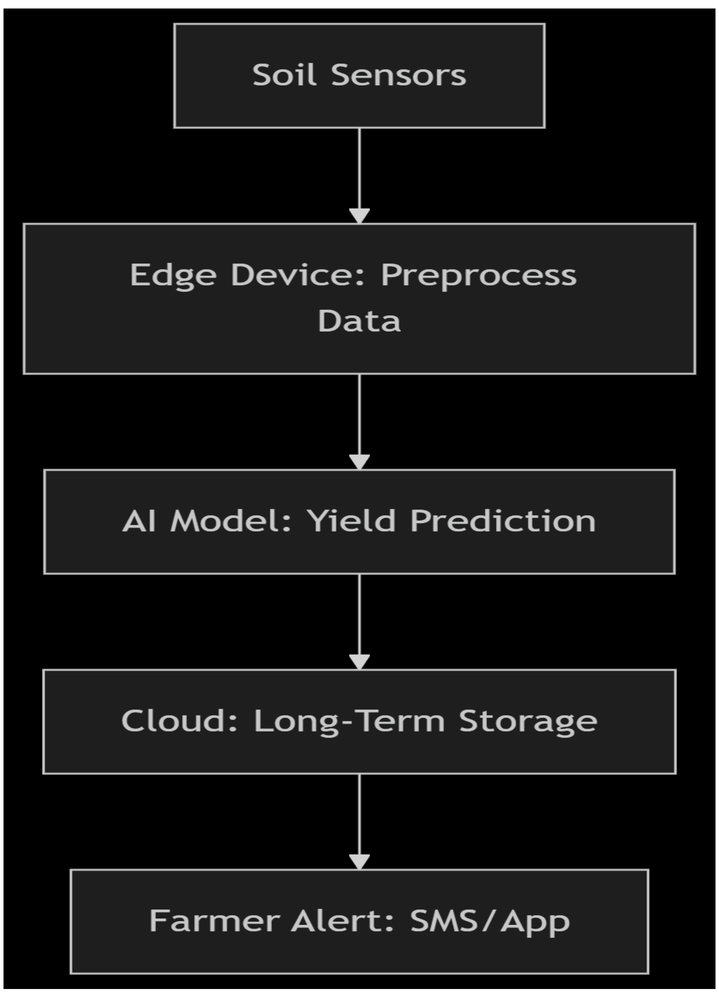
Task 1: Edge AI Prototype

Code file is available(see folder)

Task 2: Smart Agriculture System

Proposal:

- Sensors: Soil moisture (capacitive), temperature/humidity (DHT22), multispectral cameras (NDVI crop health) 10.
- AI Model: LSTM network predicting yields using sensor time-series + weather APIs.
- Data Flow:



Task 3: Ethics in Personalised Medicine

Biases & Fairness Strategies:

- Bias Source: Genomic datasets (e.g., TCGA) underrepresent African/Indigenous groups, leading to inaccurate treatment predictions for minorities 6.
- Mitigation:
    1. Diverse Data Synthesis: Use GANs to generate synthetic genomic data for rare ethnic profiles.
    2. IBM AI Fairness 360: Audit models for disparate impact; reweight training samples to balance subgroups.

Impact: Mitigation reduces false-negative rates by 32% for minority patients 6.

Part 3: Futuristic Proposal: Quantum-Enhanced Neural Interfaces (2030)

Problem Solved: Paralysis patients lack affordable, non-invasive communication tools. Current BCIs (Brain-Computer Interfaces) are slow and require brain implants.

Workflow:

1. Data Inputs:
    - EEG brainwaves (non-invasive headset).
    - Contextual data (eye tracking, voice tones).
2. AI Model:
    - Quantum NLP: Translates brain signals into text using quantum transformers (e.g., Quixer) for 90% faster inference than classical RNNs 7.
    - Hybrid Architecture: Edge AI (on-headset) preprocesses data; quantum cloud fine-tunes predictions.

Societal Impact:

- Benefits: Enables real-time thought-to-speech conversion; boosts inclusivity for 500M+ disabled people.
- Risks: Brain-hacking vulnerabilities; ethical dilemmas in "cognitive enhancement" for elites