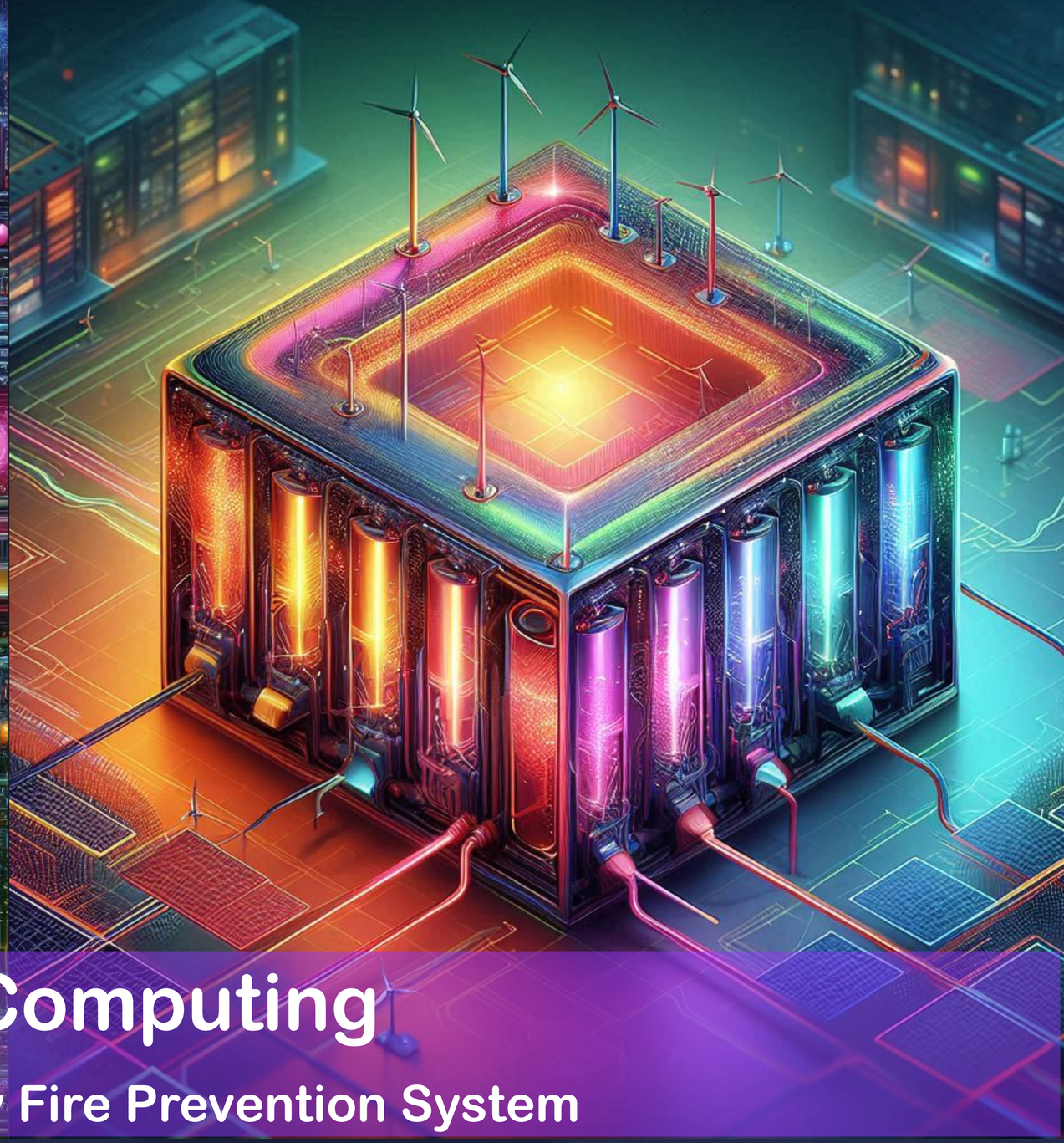

Quantum Computing

Q-AI Powered EV Battery Fire Prevention System

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

Quantum Computing

Q-AI - Powered EV Battery Fire Prevention System

Sudarshana Karkala

EV.Engineer, AI-Driven Battery Safety

Electric Vehicle Engineering & Development, CODE, IIT Madras

✆ +91 9845561518 | evdc1200125014 @ code.iitm.ac.in | car software systems @ gmail.com

What is Quantum Computing?

- Quantum Computing is a new paradigm of computing that leverages the principles of quantum mechanics to perform complex calculations at unprecedented speeds.

- Unlike classical computers that use bits (0 or 1),
  Quantum computers use **qubits**,
  which exist in superposition (both 0 and 1 simultaneously).

- Quantum properties like superposition, entanglement, and interference provide exponential speed-ups for solving specific problems.

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

Why Quantum Computing is Revolutionary?

Classical vs Quantum Comparison

- Classical AI : Sequential processing, limited by binary logic.
- Quantum AI : Parallel processing using qubits, enabling faster problem-solving.

Exponential Speedup

- Quantum computers can solve problems that would take classical computers millions of years in just minutes.

Key Applications

- Cryptography
- AI & Machine Learning
- Material Science
- EV Battery Optimisation

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

Key Quantum Concepts

- **Qubits :**

  The fundamental unit of quantum computation, capable of existing in multiple states at once.

- **Superposition :**

  A qubit can be both 0 and 1 at the same time, enabling parallel computation.

- **Entanglement :**

  A unique quantum phenomenon where qubits are interconnected, allowing instantaneous information transfer.

- **Quantum Interference :**

  The ability to manipulate qubit probability distributions to achieve optimal outcomes.

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

Real-World Quantum Applications in Energy & EVs

Battery Chemistry Optimisation:

- Quantum computing accelerates the discovery of new battery materials with higher energy density and faster charging.

Predictive Battery Health Management:

- Quantum AI models improve battery lifespan predictions and prevent thermal runaway.

Quantum-Powered Energy Optimisation:

- Quantum Approximate Optimisation Algorithms (QAOA) enable more efficient charging, discharging, and energy distribution in EVs.

Quantum Cryptography for EV Security:

- Quantum Key Distribution (QKD) ensures unbreakable encryption for EV communication networks.

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

Quantum Computing vs Classical Computing in EV Batteries

Classical EV Battery Simulations:

- Uses numerical methods for battery chemistry and performance modelling.
- Limited by processing power and complexity of equations.
- Example: Traditional simulations struggle to predict degradation patterns in high-capacity solid-state batteries.

Quantum-Powered EV Battery Simulations:

- Uses Quantum Chemistry Algorithms for molecular-level material discovery.
- Optimises electrochemical reactions for next-gen battery efficiency.
- Example: IBM and Daimler successfully used quantum simulations to study lithium-sulfur battery mate
  improving efficiency and reducing computational time significantly.

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

Quantum Machine Learning (QML) for EV Batteries

Why QML?

- Enhances pattern recognition in battery failure detection.
- Can model high-dimensional battery degradation faster than classical AI.
- Integrates with existing Battery Management Systems (BMS) to provide real-time insights and predictive maintenance alerts.
- Works alongside classical AI models to optimise battery performance while reducing computational overhead.

QML Use Cases in EV Batteries:

- Battery Health Prediction using Variational Quantum Circuits (VQC).
- Thermal Runaway Risk Analysis using Quantum Neural Networks (QNNs).
- Quantum-enhanced BMS Decision-Making: Helps optimise battery usage based on real-time conditions.

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

Quantum Optimisation for Battery Charging & Discharging

Challenges in Battery Optimisation:

- Classical algorithms struggle with multi-variable optimisation in real-time energy management.
- Limited efficiency in predicting battery degradation and optimal charge cycles.

Quantum Approximate Optimisation Algorithm (QAOA):

- Optimises charging cycles to extend battery lifespan.
- Reduces charging time while preventing overcharging risks.
- Real-World Study: Researchers at Volkswagen and D-Wave Systems have explored QAOA for optimising battery performance and EV fleet energy management, showing significant improvements in energy distribution and longevity.

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

Quantum Cryptography for EV Battery Cybersecurity

Why Cybersecurity Matters?

- EV batteries are connected devices, vulnerable to hacking and data breaches.

Quantum Cryptography Solutions:

- Quantum Key Distribution (QKD): Ensures secure communication in EV networks.
- Post-Quantum Cryptography (PQC): Protects battery data storage and firmware updates.

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

The Future of Quantum Computing in EV Batteries

Next-Generation Battery Materials:

- Quantum simulations will discover new high-density, fast-charging materials.

AI-Quantum Hybrid Models:

- Future EVs will combine AI & Quantum AI for maximum efficiency.

Scalable Quantum Computing for Commercial EV Use:

- Quantum computers will become cost-effective and mainstream in battery R&D.

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

The Future of Quantum Computing in EV Batteries

Challenges & Limitations :

- **Hardware Scalability :** Current quantum processors have limited qubit stability and error rates.
- **Cost & Infrastructure :** Quantum computing requires specialised cryogenic environments, making widespread deployment costly.
- **Integration with Classical Systems :** Quantum computing needs to work alongside classical AI & existing BMS for practical adoption.
- **Standardisation & Regulation :** EV industry standards for quantum-driven optimisations and security protocols are still evolving.

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

TO BE DONE

Sudarshana Karkala | ✆ +91 9845561518 | ✉ carsoftwaresystems @ gmail.com | carsoftwaresystems.com

Join Us in Creating a Fire-Free EV Future!

Looking for Strategic Partners, Pilot Customers & Investors.

Thank you

Sudarshana Karkala

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