Final Year Project Showcase Batch 2019
Year 2023

Department: Telecommunications Engineering Programme: Telecommunications Engineering	
1	**Project Idea** Implementation Of Smart Farming Using Digital Twin Technology
2	**Process** The project is based on and implemented according to the below-mentioned methodology. Literature Review of IoT Edge AI and ML Algorithms. ● Hardware a) Fetch data into the microcontroller a) Implementation of Edge AI algorithm (Network) b) Sensor Configuration ● Software a) Data collection b) Data processing at the IoT hub c) Power Bi Processing ● Prototype installation ● Client installation ● Debugging
3	**Outcome** The project employs the Arduino Nano BLE Sense 3 with Edge AI capabilities, incorporating built-in sensors for humidity, temperature, and pressure, along with an external soil moisture sensor. Collected sensory data is structured in a datasheet, which is then stored in Azure block storage. Power BI is utilized for data visualization, presented through graphs and charts. The stored datasheet serves as the foundation for training a digital twin model using TensorFlow. The digital twin is programmed to receive sensory data from the soil moisture sensor via the Arduino IDE. Subsequently, the model processes this data to determine the activation of a water pump. The adoption of digital twin technology empowers farmers to remotely monitor environmental conditions in real-time, optimizing irrigation, temperature regulation, and more. It facilitates precise resource allocation, minimizing waste and enhancing yields. Predictive analysis becomes possible, allowing farmers to anticipate crop yields, disease outbreaks, and other agricultural factors. This insight empowers proactive decision-making, mitigating potential losses.
4	**Evidence (Theoretical Basis)** With the recent advancements in technology, certain ground-breaking inventions have made significant changes to the agriculture sector. One such pioneering invention is the digital twin technology. This report explores the primitive role of digital twin in smart farming and how it can optimize farming processes and enhance overall productivity. A digital twin is simply a virtual replica of a physical asset that provides real-time parameters of that particular asset to allow real-time simulation, monitoring, and analysis. In the context of Smart Farming, a virtual ecosystem is created where the digital twin technology replicates agricultural assets like livestock, crops, and machinery. The aim of this project is to create a digital replica of a farm to obtain insights into parameters such as soil moisture, humidity levels, temperature, and pressure. The digital model will monitor this real-time and make decisions according to the analysis. The project utilizes the Arduino Nano BLE sense 3 application with Edge AI feature and built-in sensors for humidity, temperature, and pressure, and an external sensor for soil moisture. All the sensory data acquired is organized in a datasheet. This data sheet is exported and stored in Azure block storage and Power BI is used to visualize this data in the form of graphs and charts. The stored datasheet is then used to train the digital twin model on TensorFlow. Using Arduino IDE, the Arduino is programmed to acquire sensory data from the soil moisture sensor. It inputs the data into the model that analyzes this data to decide if the water pump should turn on or off. Utilizing digital twin technology empowers farmers to monitor environmental parameters in real-time, streamlining remote monitoring to optimize

	irrigation, maintain temperature etc. It also facilitates precise and targeted resource allocation, reducing waste and optimizing yields. Moreover, it allows predictive analysis where farmers can analyze the obtained data to predict crop yields, pest and disease outbreaks, and other factors affecting agriculture. This helps farmers take proactive measures and make better-informed decisions to minimize potential losses.
5	**Impact on Sustainability of Urban Regions or SDG-11 "Sustainable Cities and Communities"** Implementing smart farming with digital twin technology contributes to sustainable urban development by reducing the environmental impact of food production. It allows cities to access locally produced, efficiently grown crops, reducing the need for long-distance transportation and promoting community-based agriculture.
6	**Competitive Advantage or Unique Selling Proposition** In our smart farming digital twin, neural networks play a pivotal role in shaping system design. Their primary function revolves around establishing a robust decision-making model that replicates the cognitive processes of the human brain. By leveraging neural networks, our digital twin gains the ability to analyze intricate agricultural data, such as soil moisture conditions. This empowers the system to make informed decisions autonomously, optimizing crucial factors like water flow, irrigation, fertilization, and pest control. Additionally, neural networks contribute significantly to elevating system efficiency. Through continuous learning and adaptation, these networks refine their predictive capabilities, ensuring that the digital twin evolves into a proficient decision-making tool. Ultimately, the integration of neural networks fortifies the intelligence of our smart farming digital twin and drives substantial enhancements in operational efficiency, enabling sustainable and high-yield agricultural practices. Hence, neural networks help to implicate Edge AI algorithms, allowing us data monitoring and decision-making without any internet connection, which an ordinary agriculture system requires in order to process. Moreover, a neural network-based system also ensures efficient and faster processing compared to a traditional Python-based system.
a	**Attainment of any SDG** **SDG#11: Sustainable Cities and Communities:** Implementing smart farming with digital twin technology contributes to sustainable urban development by reducing the environmental impact of food production. It allows cities to access locally produced, efficiently grown crops, reducing the need for long-distance transportation and promoting community-based agriculture. **SDG#12: Responsible Consumption and Production:** Digital twin technology in smart farming enhances production efficiency, optimizing resource use, reducing waste, and promoting responsible consumption. Precision farming techniques enabled by digital twins minimize the overuse of water, pesticides, and fertilizers, aligning with sustainable production practices and ensuring efficient resource allocation.
b	**Environmental Aspect** Implementing smart farming with digital twin technology reduces resource wastage, minimizes chemical use, and lowers greenhouse gas emissions, promoting environmentally sustainable agriculture and responsible production.
c	**Cost Reduction of Existing Product** The cost reduction of the existing product is 20,000 rupees and, the breakdown is as follows: 1. Arduino Nano Sense BLE: 16,000 rupees 2. IoT sensors: 2,000 rupees 3. Miscellaneous expenses: 2,000 rupees

d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process** (e.g., What is the issue is current process and what improvement you suggests) **Deeper Neural Networks:** Incorporate deeper neural network architectures for precise monitoring of intricate greenhouse environments. **Feature Engineering:** Integrate additional parameters like wind speed, sunlight duration, and soil pH to enhance the neural network's understanding of irrigation requirements. **Larger Datasets:** Scale up the dataset to encompass diverse climatic conditions and soil types, improving the model's generalization. **Hyperparameter Tuning:** Fine-tune learning rates for better adaptation to gradual growth changes in crops. **Regularization Techniques:** Implement regularization mechanisms, especially for hydroponic farms, to prevent overfitting. **Ensemble Learning:** Aggregate predictions from multiple neural networks to navigate sudden weather changes in expansive outdoor fields. **Advanced Architectures (CNNs):** Consider convolutional neural networks (CNNs) for monitoring animal grazing patterns using satellite imagery. **Data Preprocessing:** Meticulously clean and normalize data from diverse sensors for unbiased predictions, especially in mixed crop scenarios. **Transfer Learning:** Utilize pre-trained models on analogous data for faster adaptation to specific use cases. **Real-time Adaptation:** Implement real-time parameter adaptation for rapidly maturing crops like lettuce to provide relevant irrigation recommendations throughout their growth stages. **Explainable AI:** Incorporate explainable AI techniques to enhance transparency and trust in the system's recommendations. **Edge Computing:** Deploy segments of the neural network on edge devices to ensure timely irrigation decisions in areas with limited internet connectivity.	
7	**Target Market :** The target market for implementing smart farming with digital twin technology includes farmers, agricultural businesses, home agricultural setups, and ag-tech companies seeking data-driven insights for improved agricultural processes and sustainability. Additionally, educational institutions, advisors, and government organizations play essential roles in its adoption and promotion.	
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11	**Video (If any)**	https://drive.google.com/drive/folders/1-qNOIbXZ-VTqYUVnaaombzB1BurWWahD