Secure Insect Monitoring System in Smart Connected Farms

Smart Connected Farms (SCF) has transformed agricultural practices and enabled monitoring insect populations in crops such as soybeans and corn for integrated pest management. In addition to conceptual knowledge, this project provides a hands-on experience by developing a low- and high-computational devices framework for efficient data collection and training insect detection models. Each low-computational device (having Raspberry Pi, camera, temperature, and humidity sensors) will gather data and then transmit it to a high-computational device (the Jetson Orin Nano) using the Long Range (LoRa) communication module. A significant vulnerability in this cyber-physical system (CPS) is data transmission security from Raspberry Pis to the edge server. The open LoRa network may suscept various cyber threats, including eavesdropping and man-in-the-middle attacks. We implement data encryption algorithms to protect against data leakage during transmission and transmission over the GSM cellular network to the cloud. This encryption strategy maintains the integrity and confidentiality of agricultural data, ensuring that pest management strategies are based on accurate and secure information.

Flow of the project

- ➢ **Sensor Configuration and Networking (Hands-on Experience)**
  - ▪ Equip the Raspberry Pis with sensors such as camera, temperature, humidity, and other weather data from meteorological APIs, and set up communication with the Jetson Orin Nano via the LoRa network.
- ➢ **End-to-End Encryption Development (Conceptual Knowledge)**
  - ▪ Design and implement an end-to-end encryption protocol to secure data transmitted from the Raspberry Pis to Jetson nano over LoRa.
  - ▪ Ensure lightweight encryption to be handled by Raspberry Pis but robust to prevent adversarial attacks such as eavesdropping and man-in-the-middle attacks.
- ➢ **Edge Processing and Decision Making (Implementation)**
  - ▪ Develop algorithms to store processed data locally or transmit it to the cloud server for storage and analysis to generate insights.
  - ▪ Implement secure data transmission protocols over the GSM network to protect data sent to the cloud against unauthorized access and tampering.
- ➢ **Security Testing**
  - ▪ Evaluate the system's performance in terms of data processing speed, accuracy of pest detection, and energy consumption of the devices.
- ➢ **Real-World Testing Experience**
  - ▪ We will test CPS in the university campus and Rolla County to validate its functionality and reliability, for sensor data collection.

What skills are needed?
- • Fundamental knowledge with machine learning frameworks and programming language Python/PyTorch.

- Hands-on expertise with the Raspberry Pi and sensor integration is advantageous but not mandatory.
- Familiarity with cloud platforms, particularly Azure, for data processing and storage is advantage.

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