UNIVERSITY of RWANDA

ACEIoT

IoT-AI Based Smart Device for Radiation monitoring and prediction of Electrical power transmission lines

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Outline

1. BACKGROUND AND MOTIVATION
2. LITERATURE REVIEW
3. RESEARCH METHODOLOGY
4. IMPLEMENTATION
5. RESULTS AND DISCUSSION
6. CONCLUSION AND FUTURE DIRECTION

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- Introduction
- Problem Statement
- Research Aims and Objectives
- Hypothesis
- Introduction to RF electromagnetic field meter
- Raspberry Pi 4 computer Overview

Introduction

- Radiation is defined as the release or transfer of energy from any source
- Non-ionizing radiation and ionizing radiation are the two kinds of electromagnetic radiation.
- What type of Radiation emitted by electrical power transmission lines?

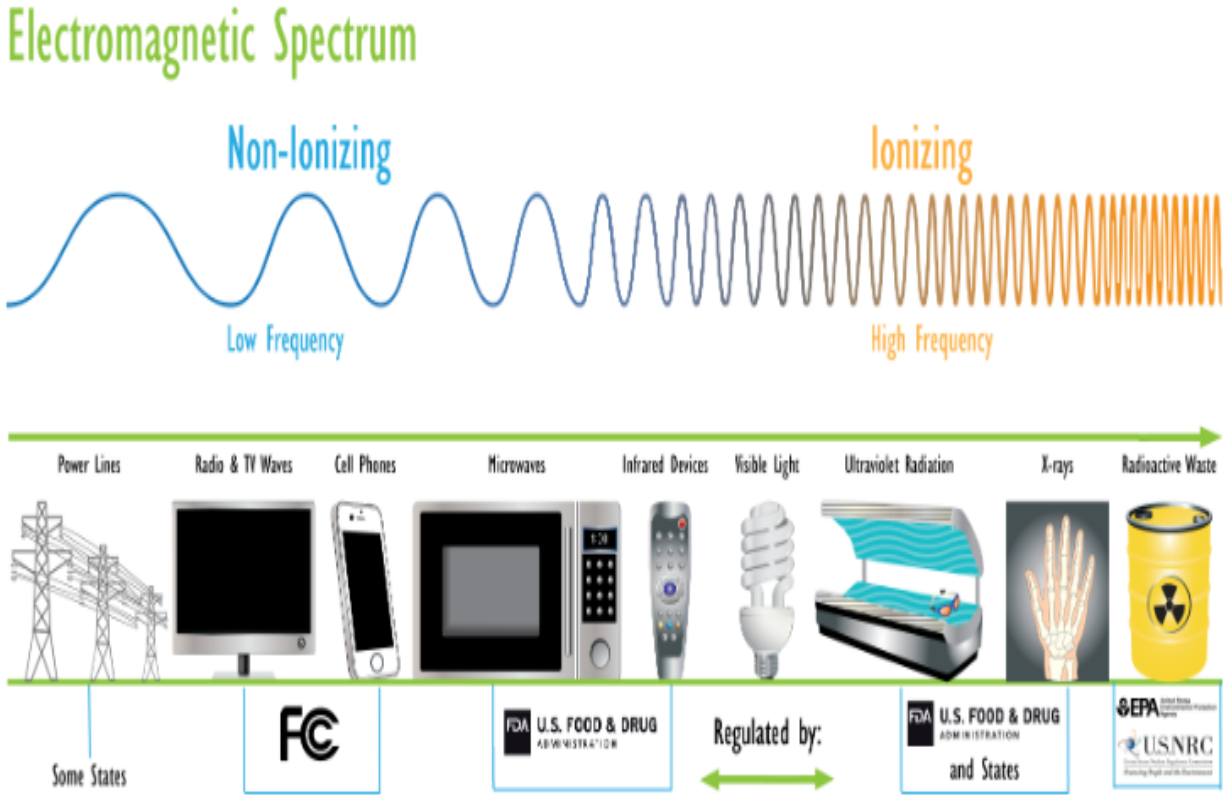

Fig1. electromagnetic spectrum

https://www.epa.gov/radiation/radiation-basics

Introduction

Effects of the electromagnetic radiation

- Ionizing radiation can harm tissue and genetic DNA because it can alter the atoms in living things. This presents a risk to one's health.

- According to certain research, Non Ionizing radiation may impact how information from genes is used for cellular activities at certain degrees of exposureand may increase the risk of childhood leukemia and cancer.

Problem Statement

- Claims by some scientists that long-term exposure to electromagnetic fields may be the cause of childhood leukemia & other forms of cancer
- the power transmission industry is struggling to efficiently monitor radiation levels and foresee potential risks
- The complete answers to any of these and related questions are not currently available however at the present time, the most common practice is to avoid excess exposure over a long period of time and depend on manual inspections
- As a result, an IoT-AI Based Smart Device for Radiation monitoring and prediction of electrical power transmission lines must be developed to address these concerns.

Research Aims and Objectives

General Objective: is to develop an IoT-AI Based Smart Device for Radiation monitoring and prediction of electrical power transmission lines.

Specific Objectives:

- Reviewing the existing works on electrical power transmission radiation monitoring and prediction in order to identify and address their weaknesses and limitations
- Determining the requirements of implementing new solution (IoT-AI based, ML, functionalities)
- Design an IoT and AI based prototype to be used for electrical power transmission radiation monitoring and prediction
- Evaluating the developed solution on electrical power transmission radiation monitoring and prediction.

Hypothesis

- It is hypothesized that the FPGA-based SoC design will have a significantly lower power consumption during the inference phase in comparison to when the deep neural network is being run on a regular computer.

- The necessity of this system is at high level since the operators can proactively identify and mitigate radiation-related risks, thereby improving overall system safety and efficiency.

RF electromagnetic field meter Overview

- specially developed for measuring or monitoring electromagnetic field

for example: cell-phone station, hospital equipment, radar, micro-wave oven, radiation work, TV antenna, Radio station, welding equipment, baking- equipment, television, computer, factory, laboratory, and another environment.

- For precision measurement consideration, the meter is included two probes: EP-04L (Low frequency Probe, 100 KHz to 100 MHz) EP-03H (High frequency Probe, 100 MHz to 3 GHz)
- Unit: V/m, W/m^2, mW/cm^2

Fig2. RF electromagnetic field meter

Raspberry Pi 4 Overview

- The Raspberry Pi 4 remains a versatile and affordable platform that can be used for a variety of educational, hobbyist, and practical applications
- Its improved hardware specifications enable it to handle a wider range of computing tasks and projects

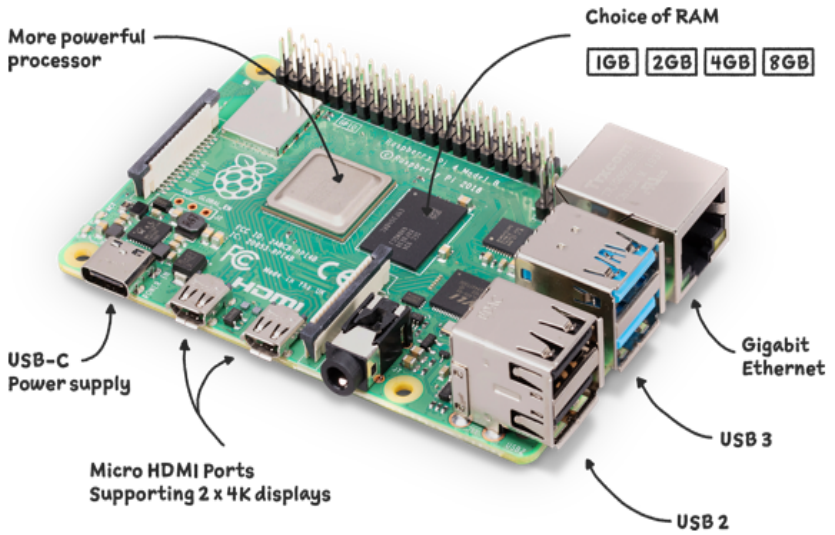

Fig3. Raspberry Pi 4

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Literature Review

Table 1. State of the art

Authors	Research topic	Methodology	Results
Sa Li et al.	Assessment of supervision monitoring for radiation environment around the typical research reactors in China	conducted an investigation of the radiation environment monitoring mode,	Tips on topics related to improving the monitoring of the radiation environment around research reactors have been provided.
Tambasaf idy et al	IoT-based Environmental and Ionizing Radiation Monitoring System	designed an IoT-based system which is composed of a set of interconnected equipment which is able to monitor and collect data from the environment	remotely monitor, in real time,the air quality and the ionizing radiation level of the surrounding environment
Rahmat et al	Network-Oriented Radiation Monitoring System (NORMS)	a multi-functional pocket radiation monitoring system capable of detecting and storing gamma ray and neutron data and then sending the data through a wireless connection to a remote central facility upon.	to detect and notify of unauthorized nuclear activities in real-time.
Souad Boumaiza et al,	Predicting Health Effects of Electromagnetic Pollution in Algeria Using Fuzzy Logic	fuzzy algorithm is proposed to predict the health effects on exposed subjects from the input variables..	treating the effects of electromagnetic field on public health.

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Research Methodology

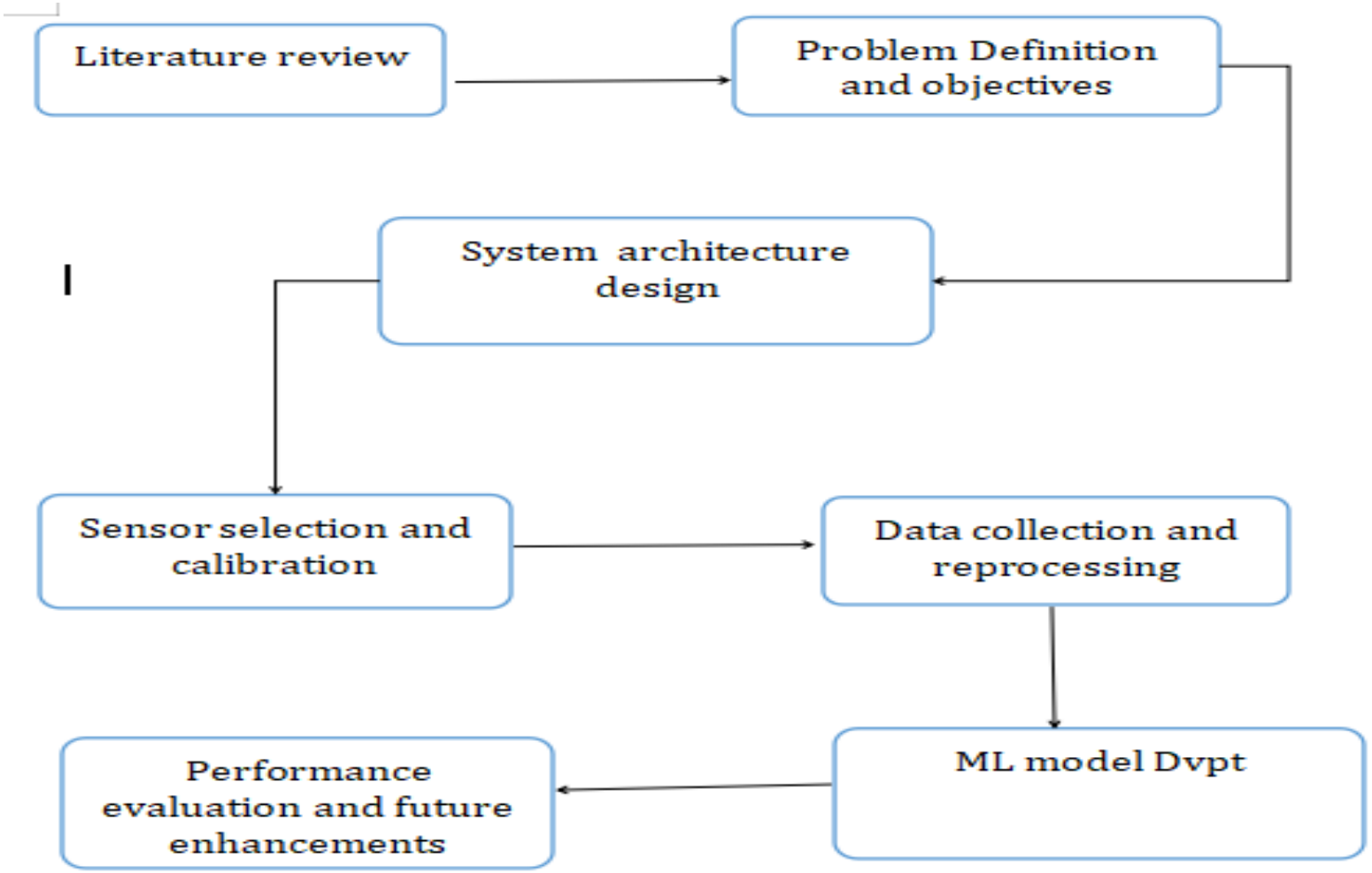

Fig4. Overview of the research steps

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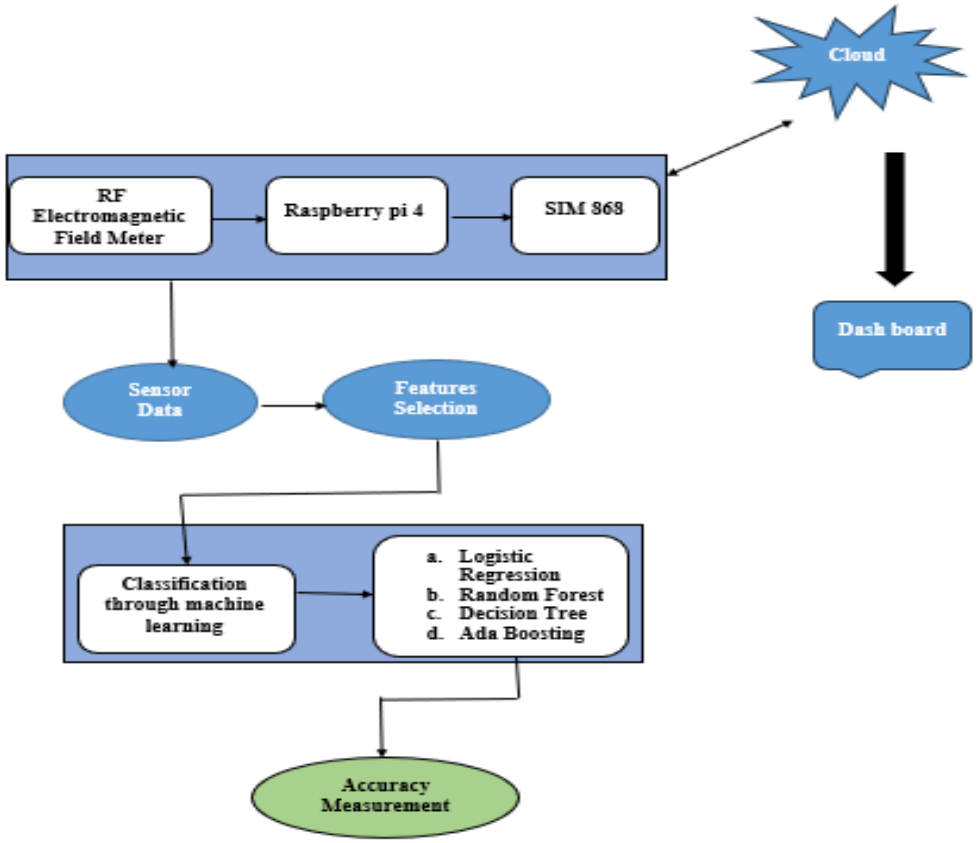
- Overall design of the system's hardware integration
- The layered architecture of the system

Overall design of the system's hardware integration



The layered architecture of the system

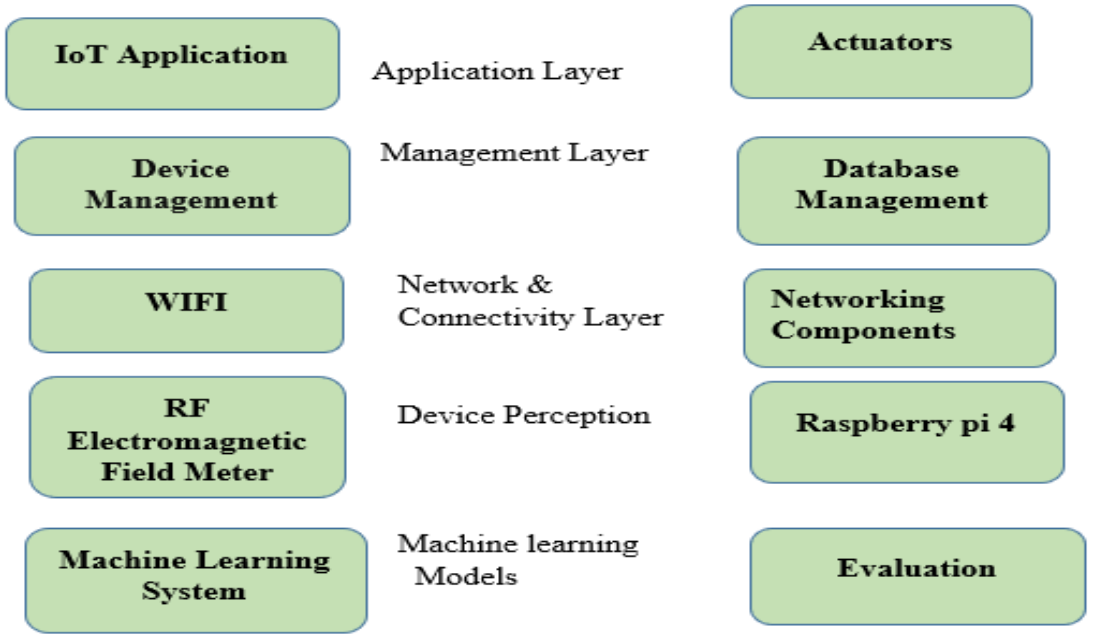


Fig9. Overview of the Block Diagram from Vivado IP Integrator

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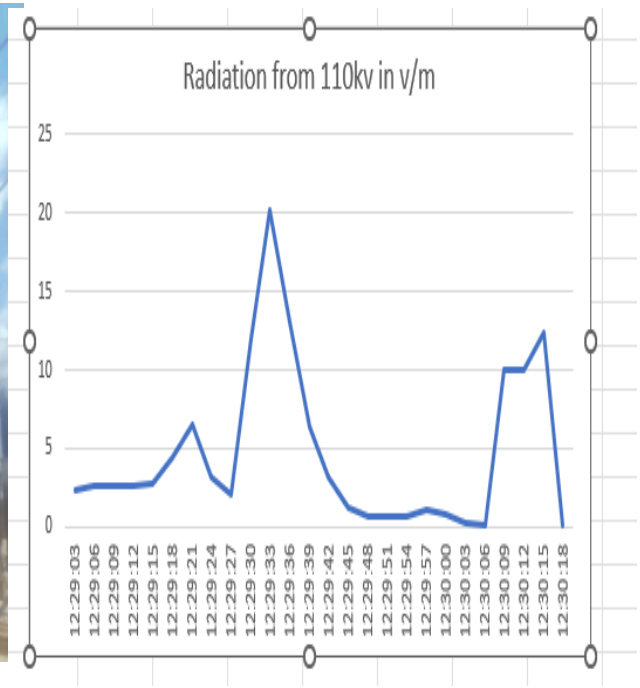
- High voltage transmission lines 110kv
- Medium voltage transmission lines 15Kv
- Model evaluation

High voltage transmission lines 110kv

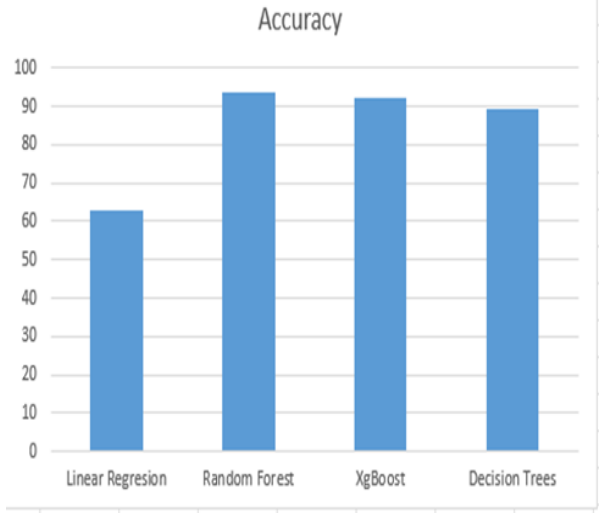


- The ratio of placing the post insulator is 1Kv is corresponding to 1cm
- The post insulator is sited at 110cm from the conductor
- radiations from collected under the HV transmission lines transmission lines were stronger compare to the radiations from MD transmission lines
- The radiation intensity decreases significantly as you move away from a radiation source
- The inverse square law expresses the relationship: Intensity $\propto 1/(\text{Distance})^2$

Medium voltage transmission lines 15Kv

- The post insulator for medium voltage transmission lines 15Kv is positioned at 15cm from the conductor
- the radiations from the MV transmission lines transmission lines were not stronger compare to the radiations from HD transmission lines

Model evaluation



Model Evaluation

```
[ ] result = Model1.score(test_data, test_labels)
    print("Accuracy for Model1: %.2f%%" % (result*100.0))

    result = Model2.score(test_data, test_labels)
    print("Accuracy for Model2: %.2f%%" % (result*100.0))

    result = Model3.score(test_data, test_labels)
    print("Accuracy for Model3: %.2f%%" % (result*100.0))

    result = Model4.score(test_data, test_labels)
    print("Accuracy for Model4: %.2f%%" % (result*100.0))
```

```
Accuracy for Model1: 63.09%
Accuracy for Model2: 93.49%
Accuracy for Model3: 92.29%
Accuracy for Model4: 89.61%
```

The model adopted by this study uses different ML models and the research proved that the Random Forest is the best with an accuracy of 93.49 amongst others such us decision trees, logistic regression and XgBoost.

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CHALLENGES, CONCLUSION AND RECOMMENDATION

Challenges

- Delay of components
- Accessibility of data collection

Summary

An IoT-AI based smart device for radiation monitoring and prediction of electrical power transmission lines was designed.

Recommendation

- Model performance can be enhanced through hypertuning and optimization techniques
- An intuitive and user-friendly interface for operators and maintenance personne

Acknowledgement

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Collaborator

ChezdA

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Thank you

Questions