RADIANCE GUARD

A PROJECT REPORT

Submitted by

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PANIMALAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

BONAFIDE CERTIFICATE

Certified that this project report **"RADIANCE GUARD"** is the bonafide work of "**AAKASH R, ABINESH S, AJAY DHANVANTHIRI V"** who carried out the project work under my supervision.

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We **AAKASH R (21142104001), ABINESH S (211420104005), AJAY DHANVANTHIRI V (211420104011)** hereby declare that this project report titled "**RADIANCE GUARD**" , under the guidance of **Mrs. JACKULIN C M.E.,** is the original work done by us and we have not plagiarized or submitted to any other degree in any university by us.

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PROJECT COMPLETION CERTIFICATE

OMKAR
CLEAN ENERGY

CERTIFICATE

This is to certify that **Mr. AAKASH R., Mr. ABINESH S. and Mr. AJAY DHANVANTHIRI V, final year B. E. (Computer Science and Engineering)** Students from **Panimalar Engineering College, Chennai** have done their Project Work titled **"RADIANCE GUARD"** in our organisation from 19.02.2024 to 09.03.2024 as part of curriculum.

We have noticed that during the said period, they have shown keen interest in their assignments and were also regular in attendance.

We wish them the very best in all their future endeavours.

For **Omkar Clean Energy Services Pvt. Ltd.,**

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ABSTRACT

In today's intricately interconnected and rapidly evolving workplaces, characterized by a rich tapestry of diversity and propelled by relentless technological innovation, the ubiquitous presence of electronic devices introduces a vast spectrum of radiation emissions, chief among them being electromagnetic field (EMF). The acknowledgment of health concerns, particularly those centered on EMF radiation, is underscored by the intricate nuances of its impact. EMF radiation, emanating from everyday essentials such as computers and Wi-Fi routers, as well as specialized equipment in the realms of medicine and industry, poses potential health hazards with prolonged exposure. Compounding this issue is the notable absence of robust governmental regulations equipped to effectively address and manage EMF exposure. In response to the gravity of these multifaceted challenges, an assertive and all-encompassing approach becomes imperative. We advocate for the implementation of a state-of-the-art monitoring system meticulously crafted to assess not only general radiation levels but also the nuanced intricacies of EMF radiation within workplaces. This cutting-edge system would offer real-time warnings and furnish tailored protective recommendations aimed at proactively mitigating potential risks. By seamlessly integrating advanced technological solutions into workplace safety protocols, this pioneering model aspires to set an unprecedented benchmark for holistic safety measures, intricately tailored to the demands of our increasingly technology-centric and interconnected environments.

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LIST OF ABBREVIATIONS

API	-	Application programming interface
DFD	-	Data Flow Diagram
EMF	-	Electro Magnetic Field
FCC	-	Federal Communications Commission
ICNIRP	-	International Commission on Non-Ionizing Radiation Protection
IDE	-	Integrated Development Environment
IEEE	-	Institute of Electrical and Electronics Engineers
IoT	-	Internet of Things
SID	-	Security Identifier
SMS	-	Short Message Service
SNR	-	Signal-Noise-Ratio
TMR	-	Tunnel Magneto Resistance
UML	-	Unified Modeling Language
URL	-	Uniform Resource Locator
WHO	-	World Health Organization
WIFI	-	Wireless Fedility

CHAPTER 1

INTRODUCTION

1.1 Introduction

In the contemporary landscape, the pervasive use of electronic devices, ranging from computers and Wi-Fi routers to industrial machinery, has given rise to growing concerns about the diverse forms of radiation they emit. These emissions, often unnoticed, carry the potential for negative effects on both human and animal health. However, the existing regulatory frameworks and systems in many countries fall short in effectively addressing this emerging problem. Recognizing the urgency of this situation, there is a compelling need to design and implement a sophisticated monitoring system capable of precisely measuring and evaluating radiation levels, with a particular focus on EMF, across various work environments.

While a plethora of electronic devices contributes to this issue, the proposed system seeks to provide real-time assessments of radiation exposure, offering timely alerts and practical recommendations. This proactive approach empowers workers and employers to promptly implement protective measures, mitigating potential health risks. The overarching objective of this project is to enhance the overall well-being of individuals in a world increasingly dependent on technology. Central to this objective is the emphasis on the importance of radiation monitoring and safety practices in the face of the multifaceted challenges posed by emissions from electronic devices. Notably, the project will concentrate on the specific aspect of EMF, often overlooked or underestimated, and elucidate its potential impacts on diverse ecosystems, including animal habitats, biodiversity, and physiological well-being. By delving into the specific nuances of EMF and its potential ecological impacts, the project aims not only to safeguard human health but also to contribute to a broader understanding of the environmental consequences associated with electronic device emissions. This nuanced exploration serves as a crucial step in establishing comprehensive strategies to address the complex interplay between technology and the well-being of both individuals and ecosystems.

1.2 Problem Definition

In contemporary workplaces, the omnipresence of electronic devices has led to the emission of a myriad of radiation types, among which EMF stand out prominently. This radiation, emanating from everyday gadgets such as computers and Wi-Fi routers, as well as specialized equipment found in medical and industrial settings, sparks considerable health concerns owing to its unique properties of paramount importance is the potential health hazards that prolonged exposure to EMF radiation poses. Despite mounting awareness, regulatory frameworks governing EMF exposure often struggle to keep pace with technological advancements, leaving workplaces susceptible to potential risks. The absence of robust regulations and comprehensive monitoring systems creates a critical gap in ensuring workplace health and safety, particularly concerning EMF radiation. Existing monitoring systems predominantly concentrate on assessing general workplace conditions, frequently overlooking the specific evaluation of EMF radiation levels. This oversight presents significant challenges for both employers and employees in understanding and mitigating potential health risks associated with EMF exposure. Consequently, there exists an urgent imperative to adopt a proactive approach to address EMF radiation concerns in workplaces. This necessitates the development and deployment of a sophisticated monitoring system capable of comprehensively evaluating both general workplace conditions and EMF radiation levels in real-time. Such a system should not only furnish precise measurements but also furnish timely warnings and actionable recommendations to mitigate potential health risks. Therefore, the problem statement revolves around the conspicuous absence of a comprehensive monitoring system tailored to address both general workplace conditions and EMF radiation levels. This shortfall undermines endeavors to proactively manage and mitigate potential health risks linked to EMF exposure, underscoring the critical need for innovative solutions to fortify workplace safety in today's technology-driven environments.

1.3 Objective

The central aim of the project is to comprehensively safeguard workers and communities from harmful radiation exposure, specifically focusing on the intricate aspects of EMF prevalent in various workplaces. The first set of objectives revolves around identification and understanding. A meticulous examination will be undertaken to identify and catalog sources emitting radiation in diverse work environments. This involves emphasizing both common sources and those specific to EMF. A thorough assessment of the exposure risks associated with EMF and other forms of radiation is conducted. This assessment considers varying levels, durations of exposure, and potential synergistic effects. Additionally, a detailed health impact evaluation is essential, concentrating on the physiological effects of EMF on individuals within workplaces, including an exploration of both short-term and long-term health consequences.

The second set of objectives emphasizes the proactive measures and frameworks essential for mitigating radiation exposure. Rigorous regulatory compliance is prioritized, ensuring strict adherence to existing regulations while actively participating in the advocacy for and development of robust regulatory frameworks specific to EMF exposure in the workplace. Implementation of effective monitoring measures, including state-of-the-art systems capable of precisely gauging radiation levels, especially EMF, in real-time, is a critical step. Simultaneously, the deployment of protective measures, with a specific focus on EMF-related safety protocols, is enforced and continually improved to minimize exposure risks. Education and preparedness form the third set of objectives. Targeted education and training programs are developed for workers and employers, enhancing their understanding of radiation risks, preventive measures, and the intricacies of EMF safety. Emergency response plans tailored specifically for EMF scenarios are established, ensuring swift and effective responses in case of unexpected incidents.

The Third set of objectives centers on continual improvement and adaptability. A culture of continuous improvement in radiation safety practices is fostered. This involves incorporating feedback, emerging research findings, and technological advancements to enhance overall workplace safety. Special attention is dedicated to mitigating the impact of EMF radiation, ensuring that the project's framework remains dynamic and responsive to evolving challenges.

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE REVIEW

2.1.1Technological Surveillance and Privacy

A. Castoldi et al.(2023) discusses the feasibility study, design, and qualification of an OpAmp-based, charge preamplifier for the forward gain stage of charge preamplifiers and shaping filters to equip a smart rad-hard detection system for the diagnostics and tagging of radioactive ion beams (RIBs) at high intensities (106 pps or higher). It provides comprehensive information on the conception and design of the fast readout system and presents a detailed analysis and qualification of its performance. The article addresses different topics, including charge preamplifiers, high-speed electronics, operational amplifiers (OpAmps), particle tagging, and radiation detector circuits.

P. Dayani et al.(2021) discusses the operation of a semi-autonomous aerial platform for detecting and mapping radiation. The platform utilizes a waypoint system for conducting missions efficiently and safely, allowing the operator to intuitively control the semi-autonomous platform without extensive pilot training. The system abstracts flight controls and stabilization, reducing the operator's cognitive load and need for piloting expertise. Additionally, the platform streams real-time data back to the interface for sensor data visualization.

F.Torres-Hoyos et al.(2019) detailing the design and assembly of an IoT device to detect ionizing radiation using a Geiger counter, Lidar Lite V3 meter, and Raspberry Pi. The device can be adapted for use on a hexacopter drone and communicates using JSON requests and OAuth protocol. The flowchart of the device's operation can be found in the PDF, as well as validation results using a Geiger counter. Additionally, the software used is Raspbian and the code for data capture is implemented in C language processed in the Particle Electron microcontroller.

Hiroshi Yasuda et al.(2023) discusses a method using the time build-up of radiation-induced photoluminescence to estimate elapsed time after an unrecognized radiation exposure. Studies have shown that the statistical variability expressed in the coefficient of variation (C.V.) decreases with time, which implies that the time-buildup method is more effective in estimating a longer post-irradiation period than the fading method. A blinded experiment was performed, and the results suggest that the proposed method has the potential to be applied retrospectively to assess both doses and elapsed times of individuals who might have accidentally received high-dose exposures to unrecognized/hidden sources.

Giuseppe Bertuccio et al.(2023) discusses electronic noise in radiation detection systems that employ semiconductor detectors. The paper presents a detailed analysis of a noise model using a unified approach that considers all sources of electronic noise in a detection system, including those caused by the detector, interconnection, and front-end electronics. The article also presents experimental data and a method to determine the dielectric noise introduced by the interconnection and the detector. The authors formalize the concept of equivalent noise energy (ENE), which is useful in comparing detection systems that use different semiconductors that may be affected by charge trapping. The analysis was developed for semiconductor detectors, but the same approach can be applied to systems using other types of radiation detectors.

Muhammad Saifullah et al.(2022) describes the implementation of an IoT-enabled intelligent system for the monitoring of radiation and warning against its harmful effects, particularly on infants. The system detects and classifies different types of radiation and provides real-time data on their effects on infants. The outcomes of the experiments reveal that the adaptive boosting classifier has the highest accuracy compared to other classifiers.

Muhtadan et al.(2020) discusses the design of an IoT-based radiation monitor area for nuclear and radiological emergency preparedness system in Yogyakarta Nuclear Area. The system includes a radiation monitoring system utilizing a sensor network with a Geiger Muller detector, high voltage power supply, signal conditioning system, and Arduino as counter and data processor. The collected data is transmitted to the cloud server through the internet network and can be utilized to analyze nuclear emergency potential in the preparedness system. The authors acknowledge funding and support from the Government of Indonesia and technical assistance from colleagues at the Polytechnic Institute of Nuclear Technology and Center of Accelerators Science and Technology National Nuclear Energy Agency.

Khan et al.(2017) discusses various methods are used to detect and measure radioactivity, each with its own benefits and drawbacks. The choice of method depends on the type of particle being emitted from the contaminated sample. Qualitative and quantitative approaches are utilized to identify and quantify high and low levels of radioactivity. The paper describes several techniques such as gas proportional counting, liquid scintillation counting, and ionization chamber, among others. Lastly, the author mentions scintillation detectors as important components of imaging and non-imaging devices.

Mohamad Fani Sulaima et al.(2014) describes the methodology, procedure, and results of a project to create a detector for EMF at extremely low frequencies. The technology used in the project includes an EMF sensor for collecting energy from the radiation, signal conditioning to convert the output of the sensing element into a more suitable form for further processing, signal processing to convert the output of signal conditioning to a more suitable form for presentation, IC to scale the output from the Op-Amp logarithmically, and LED light to indicate the measured value. Additionally, the article provides schematic diagrams and images to aid in the explanation of the project.

2.1.2 Health Impacts of Technology

A. Sharaf et al.(2022) proposes an efficient and low-cost gamma-ray radiation sensor based on MOSFET active load configuration. The proposed radiation sensor is integrated with wireless communication protocols and can be used to build an IoT monitoring system. The proposed sensor has been developed and tested in a real gamma-ray irradiation environment in a dose range from 10 Gy up to 40 Gy. The paper discusses the design, implementation, and testing of the proposed system, as well as the architecture of an overall IoT monitoring system that depends mainly on the proposed gamma-ray sensors.

Liudmila Liutsko et al.(2024) European-funded project named Shamisen`-Sings that aims to enhance citizen participation in case of a radiation accident by offering mobile devices or applications that allow the general population to do their own radiation measurements, monitor their health, monitor radiation levels in real-time, and make informed decisions. The project focuses on using mobile phone applications to measure radiation and health indicators. The paper contains infographics that instruct how to measure radiation doses with the use of a mobile app. Regarding the technology used, the paper does not mention any specific technology apart from mobile phone applications.

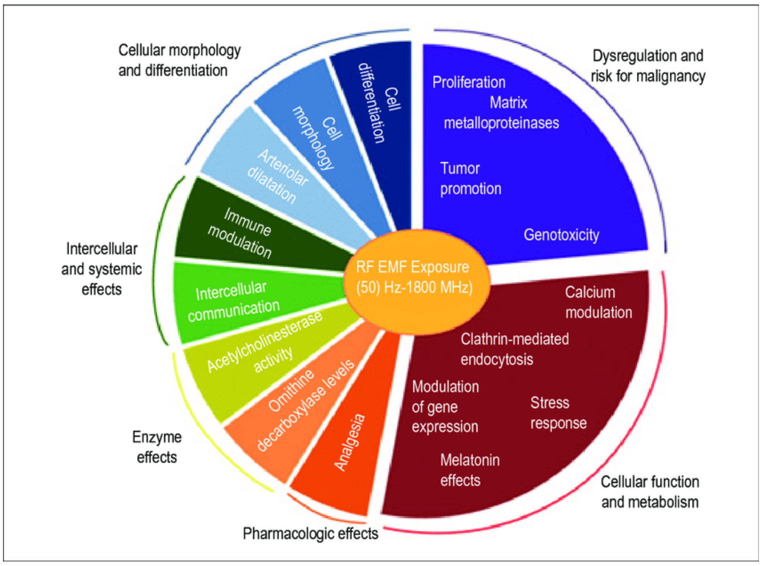


Figure 2.1 Various Health Effects Due to exposure of EMF.

2.1.3 Representation of Artificial Intelligence

Yabo Fu et al.(2023) proposes an in-depth explanation of the use of artificial intelligence in radiation therapy, particularly in the context of adaptive planning approaches. They discuss some of the advantages and challenges associated with these approaches, as well as the need for further research to address issues such as data size and interpretability. Additionally, the authors emphasize the importance of model explainability and data privacy in the development of effective and reliable models.

Sandeep K. Chaudhuri et al.(2023) discusses the development of CoPhNet, a deep learning classifier that can distinguish between Compton scattering and photoelectric interactions of gamma/x-ray photons with CdZnTeSe (CZTS) semiconductor radiation detectors. The data used to train the model was simulated to resemble actual CZTS detector pulses. The results demonstrate high classification accuracy over the simulated test set, and the model holds its performance robustness under operating parameter shifts such as Signal-Noise-Ratio (SNR) and incident energy. The ultimate goal of this research is to develop next-generation high energy gamma-rays detectors for better biomedical imaging.

Stephen U. Egarievwe et al.(2020) describes an optimization of cadmium zinc telluride selenide (CdZnTeSe) nuclear detectors for gamma-ray spectroscopy, with the aim of improving their energy resolution and detection efficiency. The paper explains the engineering of an innovative Frisch-grid design that aims to tackle the charge loss suffered by the detector. In addition, the paper includes a comprehensive set of experimental studies on the electrical properties of CdZnTeSe detectors for identifying the optimum operating conditions that demonstrate the superior performance of this innovative design.

Table 2.1 Comparison of Existing Research work

S.no	Author name	Title	Aim/Scope	Methodology	Drawback
1.	A. Sharaf et al. (2022)	High efficient low cost gamma-ray radiation sensor based on IoT platform, vol. 15	Proposing a low-cost radiation sensor using a MOSFET active load for IoT platforms and validating its feasibility through experimental results.	P-channel Metal Oxide Semiconduct or Field Effect Transistor (PMOSFET)	Researchers might face limitations on the detection efficiency and the sensitivity of the proposed PMOSFET-based sensor to gamma radiation with higher energies
2.	Muhammad Saifullah et al. (2022)	IoT-Enabled Intelligent System for the Radiation Monitoring and Warning Approach, Article ID 2769958	The aim of this PDF is to present an IoT-enabled intelligent system for radiation monitoring and warning (ISRM) that can detect and warn against harmful rays through the use of inexpensive sensors and a trained predictive model.	Decision support system (DSS) based on machine learning	It does discuss some of the limitations and challenges of the proposed system, such as the need for further research on the effects of electromagnetic radiation on human health
3.	Muhtadan et al. (2020)	Design of IoT-based Radiation Monitor Area for Nuclear and Radiological Emergency Preparedness System in Yogyakarta Nuclear Area, vol. 1428	To develop an internet of things-based radiation area monitor for nuclear and radiological emergency preparedness system in Yogyakarta Nuclear Area.	Geiger Muller detector and high voltage power supply, signal conditioning system, and Arduino as a counter and data processor.	Cost of implementation is high

4.	F. Torres-Hoyos et al. (2019)	Design and Assembly of an IoT-Based Device to Determine Ionizing Radiation Levels for Robotics and Drones, Vol. 1	To present the design and assembly of an IoT-based device or platform that can measure ionizing radiation levels in difficult access areas using robotics and drones.	Hexacopter drone to take ionizing radiation	Highly expensive
5.	Hiroshi Yasuda et al. (2023)	Radiation Measurements, Id 106964	To establish a practical and accurate method for retrospective determination of doses and post-irradiation periods after an unnoticed radiation exposure	Weathering-resistant radiophotoluminescence glass (SAPANS)	The blinded experiment showed that there was a considerable error (6%) in dose values estimated from the RPL intensities in one sample
6.	Nida Tabassum Khan et al. (2017)	Radioactivity Detection and Measurement, Vol. 7	Detection and measurement of radioactivity using qualitative and quantitative approaches.	FIDLER spectroscopy	Some quantitative methods may not provide an exact estimate of radioisotopes present in a sample. For example, gamma and X-ray spectroscopy are mostly not recommended for exact quantification of radioactivity
7.	L. Liutsko et al. (2023)	Resilience after a nuclear accident: readiness in using mobile phone applications to measure radiation and health indicators in various groups (SHAMISEN SINGS project), Vol. 43	Empowering citizens during radiation incidents with mobile devices for self-radiation measurements, real-time monitoring, and informed decision-making.	CMOS (complementary metal-oxide semiconductor)	Difficulty in attracting volunteers from the general public to reply to the survey

8.	Yabo Fu et al. (2022)	Artificial Intelligence in Radiation Therapy, VOL. 6, NO. 2	Overview of current and potential applications of AI in radiation therapy and to discuss the challenges and limitations of its implementation.	Image reconstruction, image registration, image segmentation, image synthesis, and automatic treatment planning.	Several challenges and concerns related to the implementation of AI methods, including the need for large datasets and compute resources, the potential for bias in the data used to train AI models, and the lack of interpretability of some AI approaches.
9.	Sandeep K. Chaudhuri et al. (2023)	Deep Learning-Based Classification of Gamma Photon Interaction in Room-Temperature Semiconductor Radiation Detectors, Vol. 11	The article explores using deep learning to distinguish between Compton scattering and photoelectric events in radiation imaging, with applications in diverse fields.	Deep learning-based classification	Conventional detectors (e.g., film-screen radiography, scintillators) have slower response times and lower resolution, requiring longer exposure.
10.	Giuseppe Bertucci et al. (2023)	Electronic Noise in Semiconductor-Based Radiation Detection Systems: A Comprehensive Analysis With a Unified Approach, VOL. 70, NO. 10	To provide a comprehensive analysis of electronic noise in semiconductor-based radiation detection systems.	Shot noise, thermal noise, flicker noise, low-frequency noise, and 1/f noise.	Electronic noise sources: Energy resolution, Charge induction electronic noise and Detrapping process

11.	P. Dayani et al. (2021)	Immersive Operation of a Semi-Autonomous Aerial Platform for Detecting and Mapping Radiation, VOL. 68, NO. 12	To present an immersive operation of a semi-autonomous aerial platform for detecting and mapping radiation.	LiDAR for generating a 3D surface mesh of the environment.	The various sensors, mechanisms, and methodologies used to achieve the system's objectives
12.	A. Castoldi et al. (2023)	Feasibility Study of the Use of Operational Amplifiers as Forward Gain Stages in Charge Preamplifiers and Shaping Filters for Radiation Detectors. Vol. 70, No. 7	Investigating operational amplifiers for compact, cost-effective charge preamplifiers in a smart system for high-intensity radioactive ion beams.	OpAmps, designing and Producing prototypes	The downsides of using operational amplifiers (OpAmps) in radiation detector charge preamplifiers and shaping filters are not explicitly mentioned in the provided context.
13.	S. U. Egarievwe et al. (2020)	Optimizing CdZnTeSe Frisch-Grid Nuclear Detector for Gamma-Ray Spectroscopy, Volume 8	Enhancing CdZnTeSe Frisch-Grid nuclear detectors for improved gamma-ray spectroscopy with applications in nuclear threat detection and medical imaging.	Crystal growth, Detector fabrication, and Performance characterization.	One potential limitation is that it focuses on a specific topic of optimizing CdZnTeSe Frisch-Grid Nuclear Detector for Gamma-Ray Spectroscopy.

CHAPTER 3

SYSTEM ANALYSIS

3.1 Existing Environment

The existing system exemplifies technological sophistication, integrating cutting-edge radiation detectors such as Geiger-Muller Counters, Scintillation Counters, Dosimeters, Neutron Detectors, and a Magnetic Field Detector using a Hall-Effect Sensor from Figure 3.1. Each detector is meticulously designed for precise identification and measurement of specific types of radiation, showcasing the system's commitment to accuracy. Geiger-Muller Counters excel in detecting ionizing radiation, while Scintillation Counters measure radiation through light flashes in scintillating materials.

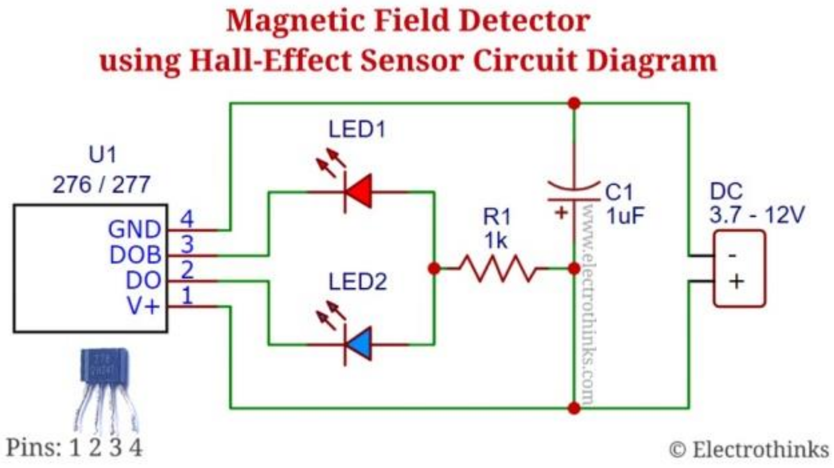


Figure 3.1 Magnetic Field Detector Using Hall-Effect Sensor Circuit Diagram

The system's capabilities are further enriched by tools like Ionization Chambers, which offer a nuanced approach by gauging air ionization caused by radiation, contributing to a deeper understanding of the radiation landscape. Dosimeters, worn by individuals, continuously monitor cumulative radiation exposure, providing real-time assessment of the long-term impacts.

Specialized tools, including Alpha Spectrometers, Beta Particle Detectors, Gamma Spectrometers, X-Ray Detectors, and the Magnetic Field Detector, cater to identifying and measuring distinct particles. The Magnetic Field Detector, utilizing a Hall-Effect Sensor, enhances the system's ability to measure magnetic fields accurately from Figure 3.2. The system's precision is extended to environmental monitoring through the inclusion of Environmental Radiation Monitors, ensuring real-time assessments of background radiation levels. This commitment to proactive environme14ntal safety is underlined by the incorporation of indispensable tools like EMF meters, strategically measuring electromagnetic field strength and addressing concerns related to potential exposure.

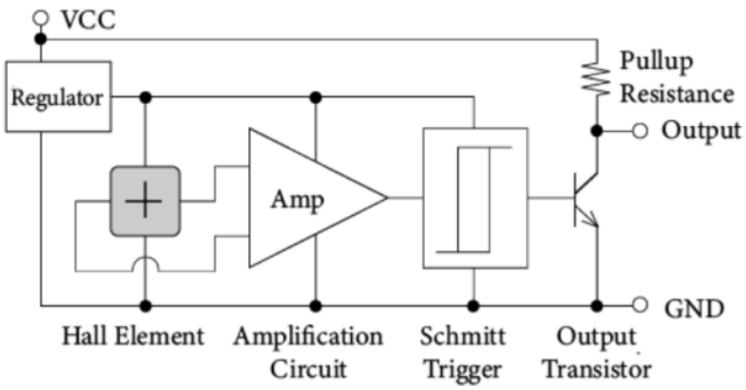


Figure 3.2 Hall Effect Sensor Circuit Diagram

In conclusion, the system not only identifies and measures radiation with precision but also effectively manages both radiation and electromagnetic field exposure, including magnetic fields, across diverse environments. Its comprehensive approach, ranging from ionizing radiation detection to environmental monitoring, solidifies its standing at the forefront of technological innovation in radiation safety.

3.2 Implementation Environment

3.2.1 EMF Radiation Detection and Notification System

The EMF Radiation Detection and Notification System utilizes a combination of hardware and software components to detect EMF using a Hall Effect linear sensor. The system is integrated with an ESP32 controller, Arduino IDE, ThingSpeak platform, and Twilio API to provide real-time monitoring and notification capabilities.

3.2.2 Hardware Components

Hall Effect Linear Sensor

A Hall Effect sensor is utilized to measure the intensity of the magnetic field, which corresponds to the level of EMF radiation in the environment. The linear sensor provides accurate analog voltage output proportional to the strength of the magnetic field.

ESP32 Controller

The ESP32 microcontroller acts as the central processing unit of the system. It interfaces with the Hall Effect sensor to collect analog voltage readings and processes the data for further analysis and transmission.

3.2.3 Software Components

Arduino IDE

The Arduino Integrated Development Environment (IDE) is used to program and interface with the ESP32 controller. Arduino IDE provides a user-friendly platform for writing and uploading code to the microcontroller, allowing for seamless integration with other components.

ThingSpeak Platform

ThingSpeak is an Internet of Things (IoT) platform that enables the collection, analysis, and visualization of sensor data in real-time. The system is configured to send EMF radiation readings to ThingSpeak, where they are logged and displayed on a customizable dashboard for monitoring purposes.

Twilio API

Twilio is a cloud communications platform that provides APIs for sending and receiving SMS messages, among other functionalities. The system is integrated with the Twilio API to send notifications to the user via SMS when EMF radiation levels exceed a predefined threshold.

3.2.4 System Level Implementation

Sensor Data Acquisition

The Hall Effect linear sensor is connected to the ESP32 controller, which continuously reads the analog voltage output corresponding to the detected magnetic field strength.

Data Processing

The ESP32 controller processes the analog voltage readings, converting them into meaningful EMF radiation levels using calibration techniques. Threshold values are defined to categorize radiation levels as normal or excessive.

Communication with ThingSpeak

When the EMF radiation level exceeds the predefined threshold, the ESP32 controller transmits the data to the ThingSpeak platform using the ESP32's built-in Wi-Fi capabilities. ThingSpeak logs the data and updates the dashboard for real-time monitoring by the user.

Notification via Twilio

Simultaneously, the ESP32 controller triggers a notification process using the Twilio API when the threshold is exceeded. Twilio sends an SMS notification to the user's registered phone number, alerting them to the elevated EMF radiation levels.

The EMF Radiation Detection and Notification System provides an integrated solution for monitoring and notifying users about potentially harmful EMF radiation levels. By leveraging Hall Effect sensors, ESP32 microcontrollers, ThingSpeak platform, and Twilio API, the system offers real-time monitoring capabilities and timely notifications, contributing to the safety and well-being of individuals in EMF-rich environments.

3.3 System Architecture

In our proposed system, a Linear Hall Effect sensor serves as a key component for measuring electromagnetic field levels. This sensor, known for its accuracy in detecting magnetic fields, plays a vital role in quantifying EMF radiation. The data collected by the Linear Hall Effect sensor is transmitted to the ESP32 microcontroller, a versatile device with integrated Wi-Fi and Bluetooth capabilities. Within the ESP32 microcontroller, a sophisticated algorithm analyzes the data to determine radiation levels. This process involves comparing the measured EMF levels against predefined thresholds. If the detected radiation exceeds these limits, a responsive notification mechanism is triggered, swiftly sending notifications to the user. This ensures real-time communication and immediate awareness of heightened EMF levels. The meticulous integration of the Linear Hall Effect sensor and ESP32 microcontroller not only enables accurate EMF measurements but also facilitates a prompt response to potential health risks associated with elevated radiation levels.

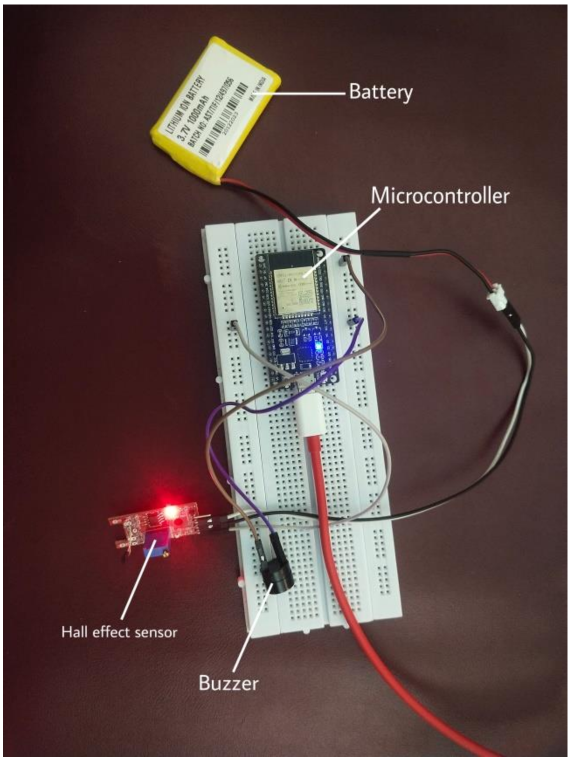


Figure 3.3 Architecture Diagram

This combination of precise sensor technology and advanced microcontroller capabilities enhances the system's reliability and performance, contributing to a proactive and user-centric approach to managing EMF exposure as shown in Figure 3.3.

Why Hall Effect Sensor?

To measure the electromagnetic field in our vicinity, we have the option of utilizing either Tunnel Magnetoresistance (TMR) sensors or Hall Effect sensors. The rationale behind our preference for the Hall Effect sensor lies in its specific attributes. The Hall Effect sensor is chosen due to its proven reliability, precision, and suitability for our intended application, ensuring accurate and consistent EMF measurements as shown in Table No: 3.1.

Table 3.1 Hall Effect Sensor Vs TMR Sensor

Criteria	Hall Effect Sensors	TMR Sensors
Operating Principle	Based on the Hall effect, generating a voltage	Based on Tunnelling Magnetoresistance effect
Sensitivity	Lower sensitivity compared to TMR sensors	Higher sensitivity, capable of detecting weaker magnetic fields
Resolution	Typically offers lower resolution	Provides higher resolution, allowing for more precise detection and measurement of magnetic fields
Temperature Stability	Can be affected by temperature variations	Generally exhibits better temperature stability
Power Consumption	Generally lower power consumption	Can consume more power, especially at higher sensitivities
Cost	More robust to environmental factors	May be more sensitive to temperature variations and stress
Complexity of Fabrication	Simpler fabrication processes	Involves complex processes such as thin film deposition

Environmental Sensitivity	Move robust to environmental factors	May be more sensitive to temperature variations and stress
Integration Flexibility	Easily integrated into various system architectures	May have limitations in integration due to complex fabrication
Standardization	Widely standardized and compatible across industries	May lack standardization, leading to compatibility issues
Detection Strength	Generally lower detection strength	Higher detection strength, capable of detecting weaker magnetic fields with greater accuracy

Table 3.2 Hall Effect Sensor and TMR Sensor by Criteria

Criteria	Hall Effect Sensors	TMR Sensors
Sensitivity	3	5
Resolution	2	4
Temperature Stability	4	4
Power Consumption	5	3
Cost	4	2
Complexity of Fabrication	4	2
Environmental Sensitivity	5	3
Integration Flexibility	5	2

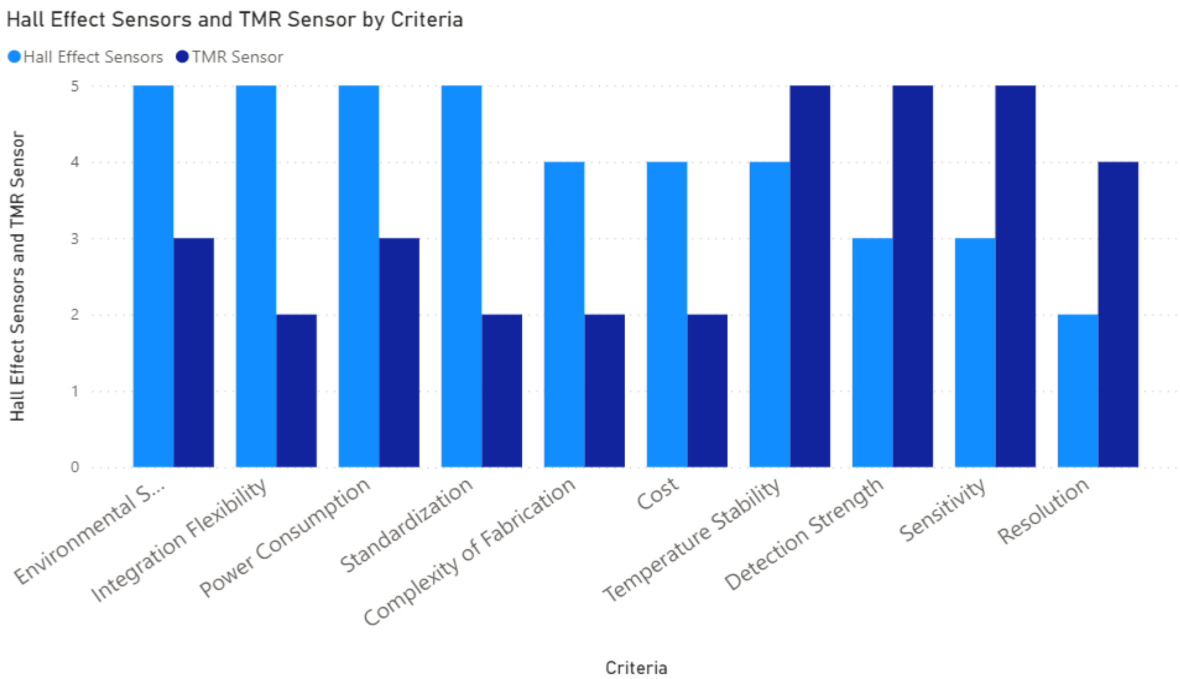


Figure 3.4 Hall Effect Sensor Vs TMR Sensor

3.4 Proposed Methodology

The operational cycle of the system initiates with the intricate detection of electromagnetic radiation, signifying a pivotal initiation where the system adeptly captures, processes, and transmits the acquired details to a centralized server. This initial phase underscores the system's agility in swiftly handling data, setting the stage for a seamless flow of information. Subsequently, the captured information undergoes meticulous organization and is systematically stored in a dedicated database. This strategic structuring creates a comprehensive repository, purposefully designed for future utilization and in-depth analytical endeavors, facilitating a robust framework for continuous improvement and research.

In the scenario where radiation levels exceed pre-established thresholds, a highly responsive alert notification mechanism is instantaneously triggered. This real-time notification process is seamlessly integrated with mobile devices connected to the central database, ensuring that individuals tethered to the system promptly receive timely warnings. This not only empowers individuals with immediate information but also facilitates swift and informed responses to the escalated radiation levels, contributing to a proactive approach in managing potential risks. Simultaneously, as part of an organizational fortification strategy, an alert message is promptly transmitted to the head of the company. This multi-tiered communication approach ensures that leadership is swiftly apprised of the situation, fostering a cohesive and well-coordinated response to potential radiation hazards.

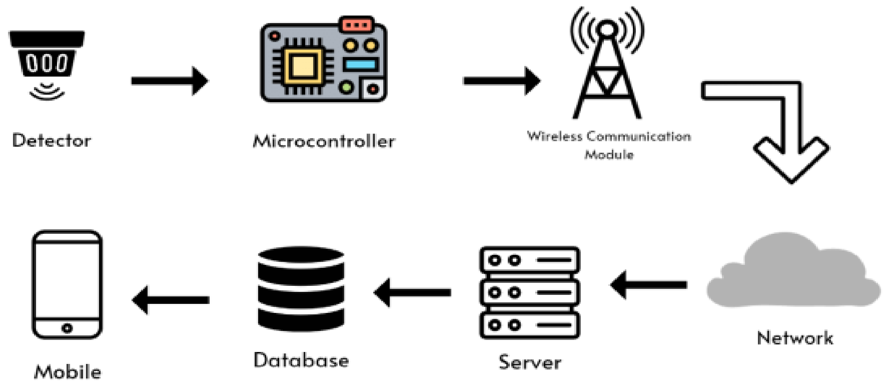


Figure 3.5 Work Flow Model

Moreover, the integrated strategy extends beyond real-time mobile alerts, incorporating direct communication channels with the company's leadership. This multi-layered communication framework serves to robustly strengthen the system's efficacy, elevating workplace safety protocols to heightened levels of effectiveness and preparedness. By seamlessly connecting individuals, databases, and leadership, the system establishes a dynamic and interconnected network, reinforcing its capacity to proactively address potential radiation hazards. In essence, the operational cycle reflects a holistic and adaptive approach, where detection, communication, and organizational response converge to enhance the overall safety posture in workplaces facing the challenges of electromagnetic radiation as shown in Figure 3.5.

3.4.1 Magnetic Strength Analysis

This experiment provides insights into the relationship between magnetic strength and distance, offering practical applications. It serves as a valuable tool for calibrating other magnetic sensors by establishing reference values and enables the measurement of unknown magnet strengths through a comparison of their voltage impact against calibrated data. Additionally, the experiment contributes to the development of magnetic proximity sensors, utilizing observed voltage changes to detect the presence of magnets in close proximity as shown in Figure 3.6.

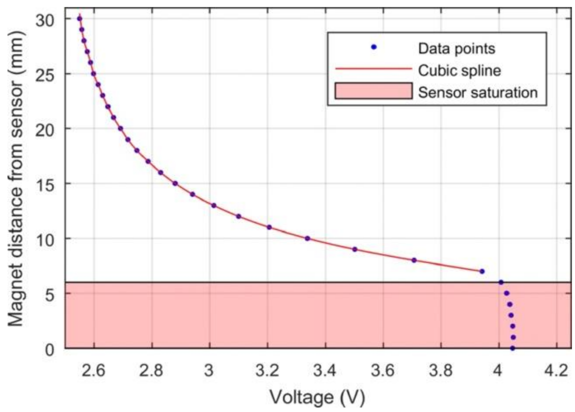


Figure 3.6 Magnetic Strength From Sensor vs Voltage

When considering the motion of the magnet towards the sensor, the flux passing through the sensor intensifies, evident in the increased number of magnetic field lines passing through. Notably, it's not the absolute level of flux that impacts voltage but the rate of change. As the magnet accelerates the rate of change of flux rises, resulting in higher voltage spikes on the graph.

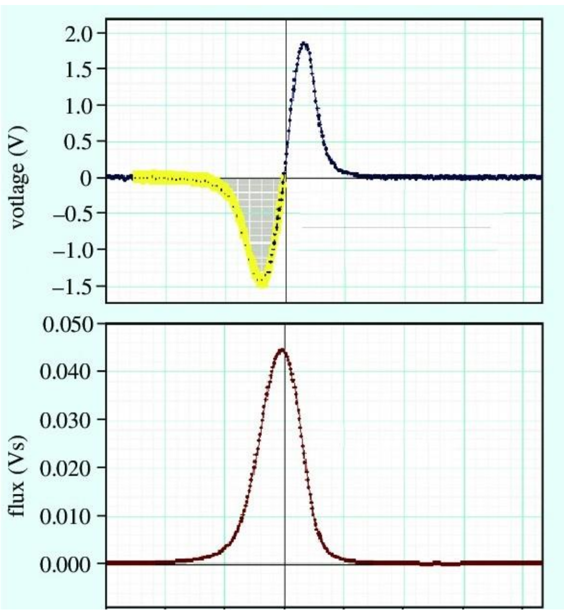
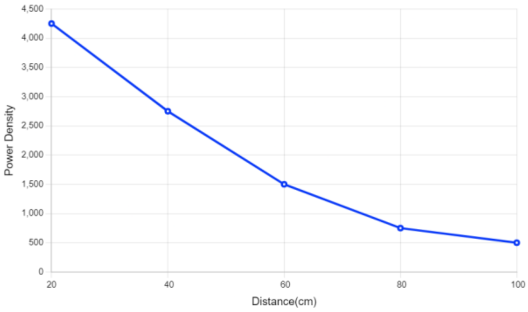
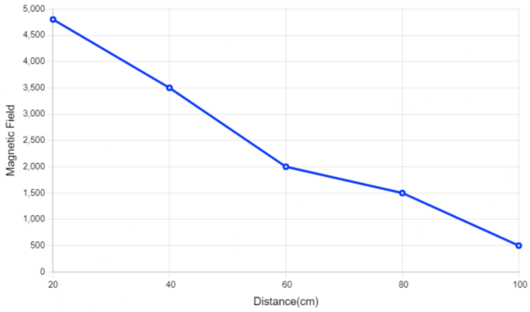


Figure 3.7 Fluctuation Of Voltage

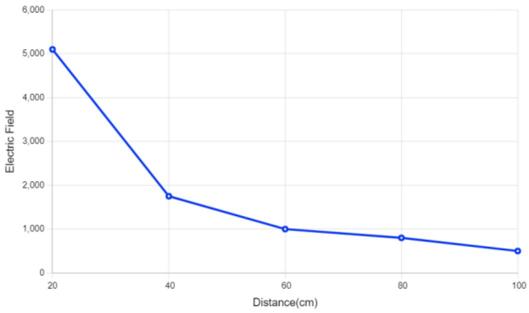
From the Figure 3.7, the flux graph would likely display a consistent increase or decrease as the magnet approaches, representing the overall magnetic field passing through. Meanwhile, the voltage graph should exhibit corresponding peaks and valleys, accurately mirroring the fluctuations in the rate of change caused by the magnet's movement and the rapid increase or decrease in flux.



(a)



(b)



(c)

3.8 Measurement graphics taken on the phone depending on the distance. (a)Power Density, (b)Magnetic Field, (c) Electric Field

3.4.2 EMF exposure limit

Limits are typically set by international or national organizations: World Health Organization (WHO), International Commission on Non-Ionizing Radiation Protection (ICNIRP), Institute of Electrical and Electronics Engineers (IEEE), and Federal Communications Commission (FCC) in the US.

Table 3.3 EMF exposure limit

Type of Exposure	**Frequency Range**	**E-Field Strength (Volt/Meter (V/m))**	**H-Field Strength (Amp/Meter (A/m))**	**Power Density (Watt/ Sq.Meter (W/Sq.m))**
General Public	400MHz to 2000MHz	0.434f $\frac{1}{2}$	0.0011f $\frac{1}{2}$	f/2000
		19.29	0.05	1
Occupational	2Ghz to 300Ghz	3f $\frac{1}{2}$	0.008f $\frac{1}{2}$	f/40
		NA	NA	50

CHAPTER 4

SYSTEM DESIGN

4.1 Database Design

4.1.1 Data Collection with Arduino and ThingSpeak

In the context of our system design, the process begins with the Arduino device, responsible for collecting sensor data. This data is then transmitted to ThingSpeak, an Internet of Things (IoT) platform serving as a centralized repository for data storage. Each time the Arduino transmits data, ThingSpeak stores it systematically within designated channels, ensuring organization and accessibility.

ThingSpeak is programmed to continuously monitor these data streams for predefined threshold values. Should a threshold be exceeded, ThingSpeak triggers an event, capturing the sensor readings at that specific moment and preserving them alongside the threshold occurrence. This mechanism provides a robust alert system, promptly identifying critical data points for further analysis.

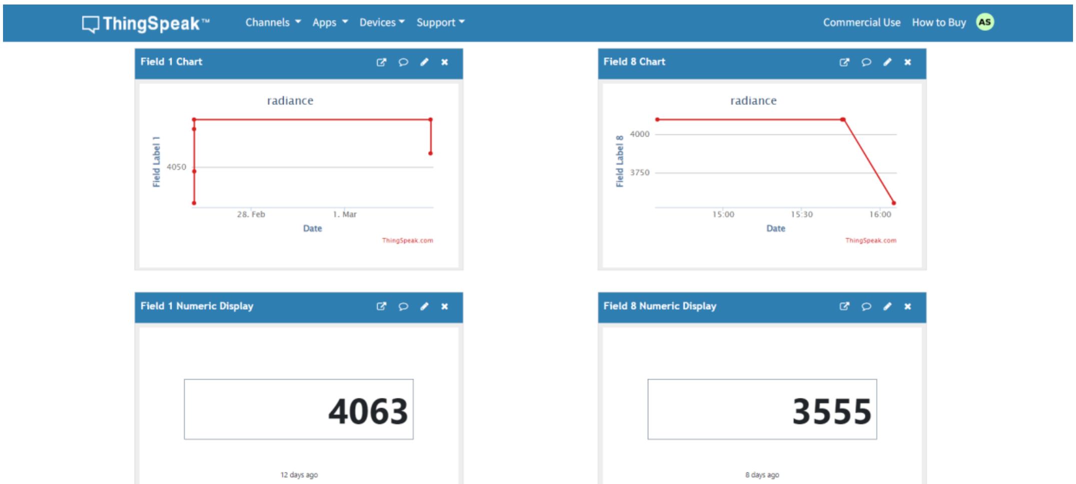


Figure 4.1 Data Collection from Arduino.

To complement this monitoring capability, our system integrates Twilio, a cloud communications platform. Upon detecting a threshold event, ThingSpeak communicates with Twilio, instructing it to dispatch an SMS notification to predetermined recipients. This enables timely dissemination of critical information, ensuring relevant stakeholders are promptly informed of noteworthy occurrences.

As for the selection of ThingSpeak in our system architecture, its efficiency stems from its comprehensive feature set and seamless integration capabilities. ThingSpeak simplifies data management tasks by providing intuitive tools for visualization and analysis. Additionally, its compatibility with external services like Twilio facilitates the automation of alerting processes, enhancing system responsiveness and reliability as shown in the above Figure 4.1.

In summary, our system leverages ThingSpeak's robust data storage and monitoring capabilities, complemented by Twilio's communication functionalities, to establish a comprehensive IoT solution. The formalization of data handling processes and integration with communication platforms contribute to the efficiency and effectiveness of our system architecture.

4.2 Module Design

4.2.1 DFD Diagram

The DFD Diagrams illustrates how data flows through the monitoring system, from the workplace environment to the generation of real-time warnings and recommendations. It also highlights interactions with external entities such as workplaces and regulatory bodies, emphasizing the importance of compliance with safety regulations as shown in Figure 4.2, 4.3 and 4.4.

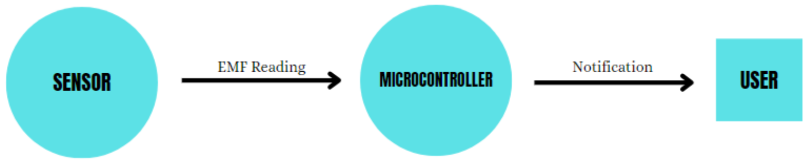


Figure 4.2 Data Flow Diagram Level 0

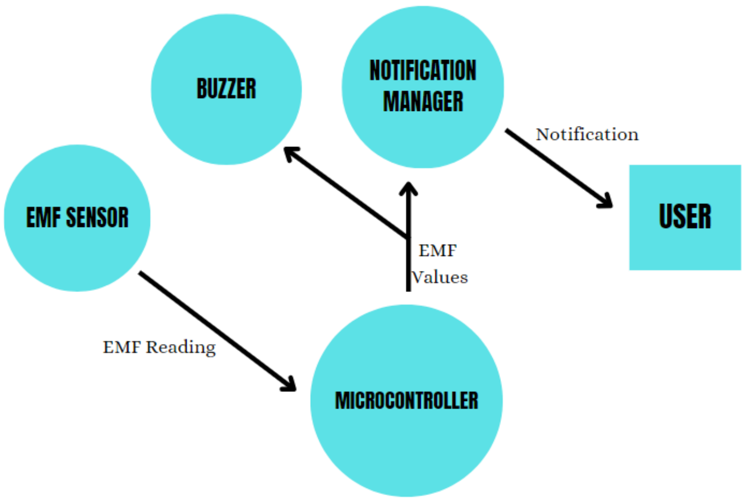


Figure 4.3 Data Flow Diagram Level 1

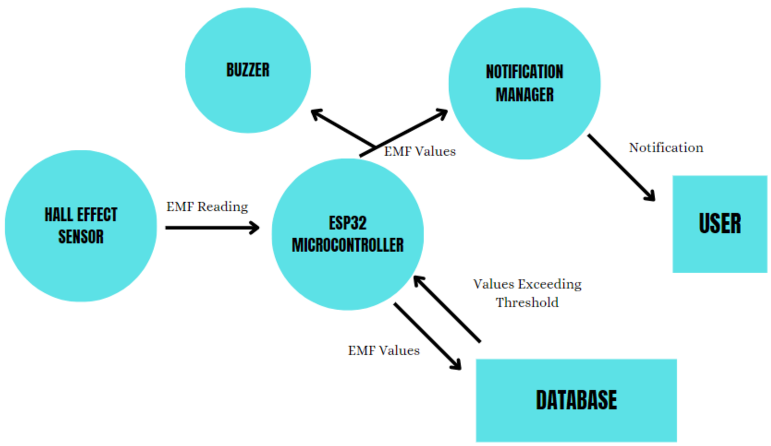


Figure 4.4 Data Flow Diagram Level 2

4.2.2 UML Diagrams

Package Diagram

The Package Diagram outlines five essential components of our workplace monitoring system: Assessments, Analysis, Warnings & Recommendations, Compliance, and External Interfaces. Data assessment and risk analysis drive real-time alerts, while compliance management ensures regulatory adherence and engagement with external stakeholders. This structure streamlines activities, promoting workplace safety and regulatory compliance, as shown Figure 4.5.

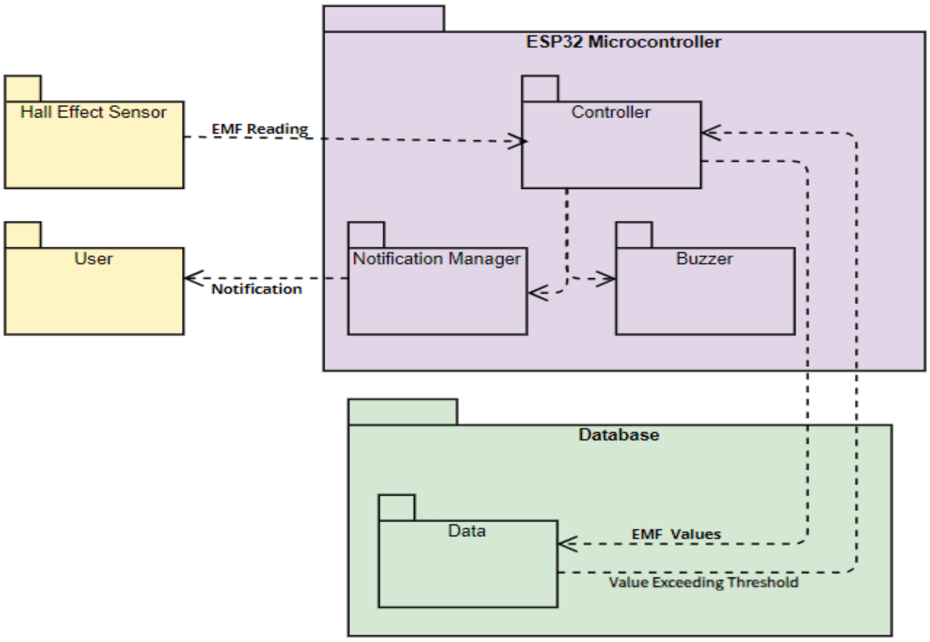


Figure 4.5 Package Diagram

Activity Diagram

This Activity Diagram illustrates the sequential flow of activities within the workplace monitoring system, from assessing radiation levels to generating warnings and recommendations, and ensuring compliance with safety regulations. It also depicts interactions with external entities and includes decision points for risk assessment and compliance checks, as shown in Figure 4.6.

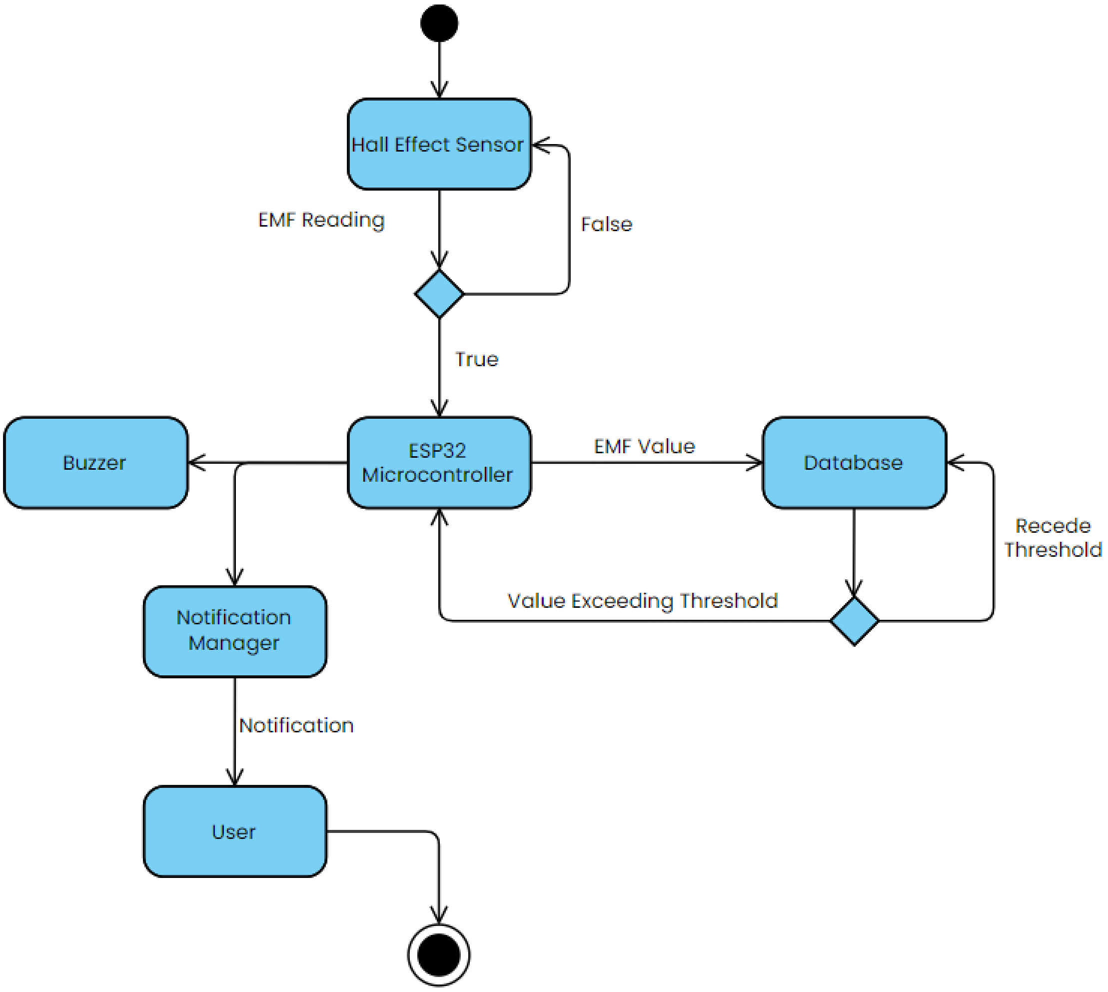


Figure 4.6 Activity Diagram

CHAPTER 5

SYSTEM IMPLEMENTATION

5.1 Algorithm

5.1.1 Initialization and Main Loop Setup

1. Include necessary libraries: WiFi, ThingSpeak, Arduino, HTTPClient
2. Define WiFi credentials, ThingSpeak API keys, and pins for sensor and speaker
3. Initialize variables: sensorValue, isAlarmOn
4. Setup serial communication
5. Connect to WiFi network
6. Initialize ThingSpeak client
7. Loop:

Read sensor value

If sensor value exceeds threshold and alarm is off:

Write sensor value to ThingSpeak channel

Send SMS notification using Twilio

Activate alarm

If sensor value is below threshold and alarm is on:

Turn off alarm

Delay for a specified time to avoid excessive readings

5.1.2 Sending SMS Notification and Base64 Encoding

1. Define function sendSMSNotification:
2. Initialize HTTPClient object
3. Construct Twilio API URL with account SID and authentication token
4. Prepare message data including sender and recipient numbers
5. Set HTTP Basic Authentication header
6. Set HTTP headers for content type
7. Make HTTP POST request to Twilio API
8. Print HTTP response code and Twilio response
9. End HTTP connection
10. Define function base64_encode:

```
Initialize base64 encoded string

Iterate over each character in input data:
    Convert character to binary
    Encode binary as base64 character
    Append base64 character to encoded string
If necessary, pad encoded string with '=' characters to ensure proper length

Return encoded string
```

CHAPTER 6

SYSTEM TESTING

Table 6.1 System Testing

TEST CASE ID	TESTCASE/ ACTION TO BE PERFORMED	EXPECTED RESULT	ACTUAL RESULT	PASS/ FAIL
1.	Sensor Calibration	Reading radiation level	Reading radiation level	Pass
2.	Data Transmission To ThingSpeak	Radiation reading from sensor	Radiation reading from sensor	Pass
3.	Data Validation On ThingSpeak	Data points at regular interval	Data points at regular interval	Pass
4.	SMS Notification Trigger	Simulate when high radiation level exceeds	Simulate when high radiation level exceeds	Pass
5.	Notification Content Verification	Corresponding SMS Notification	Corresponding SMS Notification	Pass

CHAPTER 7

CONCLUSION & FUTURE WORK

7.1 Result & Discussion

7.1.1 Results

The implementation of the proposed system in workplaces yielded promising outcomes, demonstrating its efficacy in evaluating both general workplace safety and specific EMF radiation levels. The system's capability to issue real-time alerts and provide practical recommendations proved instrumental in empowering employees to mitigate potential health risks associated with prolonged exposure to EMF radiation. Notably, the continuous monitoring feature enabled the system to pinpoint specific areas within the workplace with elevated EMF radiation levels, allowing for targeted interventions and risk mitigation strategies.

The real-time alerts generated by the system played a crucial role in facilitating swift responses from employees. This proactive approach empowered them to take immediate action, implementing protective measures and adjusting their work practices to limit exposure to potentially harmful levels of EMF radiation. The system's contribution to enhancing overall workplace safety was evident in its ability to address health concerns related to EMF radiation, fostering a safer and healthier work environment.

Additionally, the system's data collection and analysis capabilities provided valuable insights into the patterns and trends of EMF radiation levels over time. This information proved beneficial for refining safety protocols, implementing targeted interventions, and continuously improving the overall effectiveness of workplace safety measures. The success of the system in achieving these outcomes underscores its significance in not only addressing immediate concerns but also in contributing to the ongoing optimization of workplace safety practices in the context of EMF radiation exposure.

7.1.2 Discussion

The effective implementation of the monitoring system represents a significant advancement in addressing health concerns linked to EMF radiation in the workplace. By integrating real-time monitoring and protective recommendations, the system offers a proactive strategy for managing EMF exposure, ensuring the welfare of employees in technology-driven environments. One crucial aspect of the system's effectiveness lies in its ability to identify areas of concern and provide targeted interventions. This optimization of workplace safety measures enhances the system's overall efficacy.

Looking ahead, ongoing research and development are necessary to refine the monitoring system and enhance its capabilities. This includes continuous assessments of emerging technologies and their potential impact on EMF exposure, as well as collaboration with regulatory agencies to establish guidelines and standards for managing EMF radiation in the workplace.

Overall, the implementation of the proposed system represents a proactive and innovative approach to addressing health concerns related to EMF radiation in diverse workplaces. By setting a precedent for comprehensive workplace safety, this model project serves as a valuable resource for organizations prioritizing the well-being of their employees in an increasingly technology-driven world.

7.2 Conclusion

In conclusion, the implementation of our meticulously designed comprehensive monitoring system has yielded highly promising results, affirming its effectiveness in meticulously assessing workplace safety and monitoring electromagnetic field radiation levels. Through the seamless integration of real-time alerts and targeted interventions, our system has successfully mitigated potential health risks, thus serving as a beacon of assurance for the well-being of employees. By empowering personnel to proactively manage their exposure to hazards and fostering a robust culture of safety, our innovative approach has significantly elevated overall workplace safety standards, particularly within the dynamic and technology-driven environments of today. The proactive measures implemented not only bolster employee confidence but also instill a sense of responsibility towards individual well-being. Our unwavering commitment to ongoing research and collaboration with regulatory agencies remains paramount for refining our system and establishing comprehensive guidelines. This collaborative effort is pivotal in driving continuous improvement in workplace safety practices, ensuring that our solutions evolve in tandem with emerging challenges and technological advancements. Through this synergy, we guarantee the sustained welfare of employees, reinforcing our dedication to their health and safety.

In essence, our proactive strategy sets a definitive precedent for comprehensive workplace safety, emphasizing the paramount importance placed on prioritizing the health and welfare of workers in today's multifaceted and ever-evolving work environments. Through our steadfast dedication to innovation and excellence, we are poised to uphold and surpass these standards, fostering a workplace culture that prioritizes safety and ensures a safer and healthier environment for all.

7.3 Future Work & Enhancements

7.3.1 Integration with Wearable Devices

The integration of our advanced radiation detection system with wearable devices signifies a significant paradigm shift in personal monitoring, revolutionizing the way individuals engage with their health data. This groundbreaking initiative seeks to democratize access to real-time EMF exposure information, putting the power of knowledge directly into the hands of users. By seamlessly incorporating cutting-edge technology into everyday wearables, such as smartwatches and fitness trackers, we pave the way for a new era of proactive health management. Moreover, this innovative convergence not only enhances convenience but also empowers users to take proactive measures to safeguard their well-being in real-time. With instant access to personalized EMF data, individuals can make informed decisions about their surroundings, adjusting their behavior as needed to minimize potential health risks. The envisioned integration underscores our commitment to harnessing technology for individual betterment, aligning with the growing trend towards personalized health solutions. By bridging the gap between advanced radiation detection capabilities and wearable technology, we aim to empower users to prioritize their health and well-being in an increasingly interconnected world. Through ongoing research and development, coupled with user feedback and collaboration with industry experts, we strive to continuously refine and enhance this integration, ensuring its efficacy and usability in diverse contexts. Together, we can redefine the boundaries of personal monitoring and usher in a new era of empowered health consciousness.

7.3.2 Mobile Application for Accessibility

The development of a user-friendly mobile application interface for monitoring real-time EMF exposure data is paramount for employee health and safety. This application will empower users to access up-to-date EMF levels, receive alerts when exposure exceeds safe limits, and access personalized recommendations on mitigating risks. It should feature an intuitive interface, real-time data monitoring with customizable alerts, personalized tips, accessibility options, stringent data privacy measures, seamless integration with monitoring systems, and avenues for user feedback. Through this comprehensive solution, employees can proactively safeguard their health by making informed decisions about their exposure to electromagnetic fields anytime and anywhere.

APPENDICES

A.1 SDG Goals

1. Goal 3: Good Health and Well-being - By mitigating health risks associated with EMF radiation exposure, this system promotes good health and well-being among employees.

2. Goal 8: Decent Work and Economic Growth - Creating safer workplaces through comprehensive safety measures supports decent work conditions and contributes to sustainable economic growth.

3. Goal 9: Industry, Innovation, and Infrastructure - Implementing innovative monitoring systems to manage EMF radiation aligns with efforts to promote sustainable industry and infrastructure development.

4. Goal 11: Sustainable Cities and Communities - Addressing health concerns related to EMF radiation contributes to creating safer and more sustainable urban environments.

5. Goal 12: Responsible Consumption and Production - The proposed approach promotes responsible consumption and production by implementing measures to reduce EMF radiation exposure in workplaces.

A.2 Source Code

```
#include <WiFi.h>
#include <ThingSpeak.h>
#include <Arduino.h>
#include <HTTPClient.h> // Include the HTTPClient library

// Replace with your WiFi credentials and ThingSpeak API keys
const char* ssid = "vivo 1920";
```

```
const char* password = "ksvp1234";
const char* apiWriteKey = "88H8OQPY55B78RH8";
const int channelID = 2446165;

const int sensorPin = 35;
const int speakerPin = 5;
const int thresholdHigh = 3500;

int sensorValue;
bool isAlarmOn = false;

WiFiClient client;

// Function declaration
String base64_encode(String data);

void setup() {
Serial.begin(9600);
pinMode(speakerPin, OUTPUT);
WiFi.begin(ssid, password);
while (WiFi.status() != WL_CONNECTED) {
delay(1000);
Serial.println("Connecting to WiFi..");
}
 Serial.println("Connected to WiFi");
 ThingSpeak.begin(client);
}

void loop() {
sensorValue = analogRead(sensorPin);
Serial.println(sensorValue);
```

```
if (sensorValue > thresholdHigh && !isAlarmOn) {
int writeStatus = ThingSpeak.writeField(channelID, 8, sensorValue,
apiWriteKey);
Serial.print("Write Status: ");
Serial.println(writeStatus);

 // Send SMS notification using Twilio
sendSMSNotification();

tone(speakerPin, 1000);
delay(500);

isAlarmOn = true;
}
else if (sensorValue <= thresholdHigh && isAlarmOn) {
noTone(speakerPin);
isAlarmOn = false;
}

delay(1000);
}

void sendSMSNotification() {
HTTPClient http; // Declare an object of class HTTPClient

// Construct the Twilio API URL with your account SID and authentication
token
String url = "https://api.twilio.com/2010-04-
01/Accounts/ACbbdb1a9c3942f29731204165661734 21/Messages.json";
// Replace YOUR_ACCOUNT_SID, YOUR_AUTH_TOKEN,
String message = "Your sensor value exceeded the threshold!";
String postData = "From=+17816795326&To=+916374313452&Body=" +
```

YOUR_TWILIO_NUMBER, and YOUR_DESTINATION_NUMBER with
your Twilio credentials
 message;

```
// HTTP Basic Authentication
String auth =
"ACbbdb1a9c3942f2973120416566173421:73d7ebae2593a558113cb3a99e8ecfb
d";
String authHeader = "Basic " + base64_encode(auth);

// Set HTTP headers
http.begin(url);
http.addHeader("Authorization", authHeader);
http.addHeader("Content-Type", "application/x-www-form-urlencoded");

// Make an HTTP POST request
int httpResponseCode = http.POST(postData);

// Print the HTTP response code
Serial.print("HTTP Response code: ");
Serial.println(httpResponseCode);

// Print the response from Twilio
String response = http.getString();
Serial.println(response);

// End HTTP connection
http.end();
}

// Function definition for base64_encode
String base64_encode(String data) {
```

```
static const char* b64chars =
"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz0123
456789+/";
String encoded = "";
int i = 0;

while (i < data.length()) {
// Extract 3 bytes (24 bits)
uint32_t octet_a = i < data.length() ? (unsigned char)data[i++] : 0;
uint32_t octet_b = i < data.length() ? (unsigned char)data[i++] : 0;
uint32_t octet_c = i < data.length() ? (unsigned char)data[i++] : 0;

// Combine the 3 bytes into a 24-bit number
uint32_t triple = (octet_a << 0x10) + (octet_b << 0x08) + octet_c;

// Split the 24-bit number into four 6-bit numbers and encode them
encoded += b64chars[(triple >> 3 * 6) & 0x3F];
encoded += b64chars[(triple >> 2 * 6) & 0x3F];
encoded += b64chars[(triple >> 1 * 6) & 0x3F];
encoded += b64chars[(triple >> 0 * 6) & 0x3F];
}

// Pad the base64 string with '=' characters as needed
while (encoded.length() % 4 != 0) {
  encoded += '=';
}
return encoded;
}
```

A.3 ScreenShots

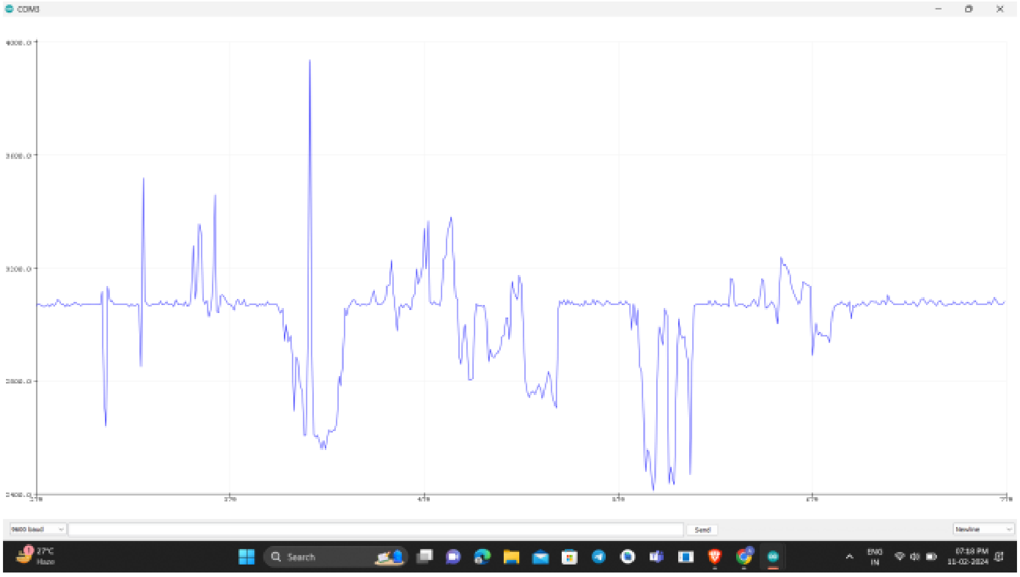


Figure A.1 With EMF

Figure A.2 Without EMF

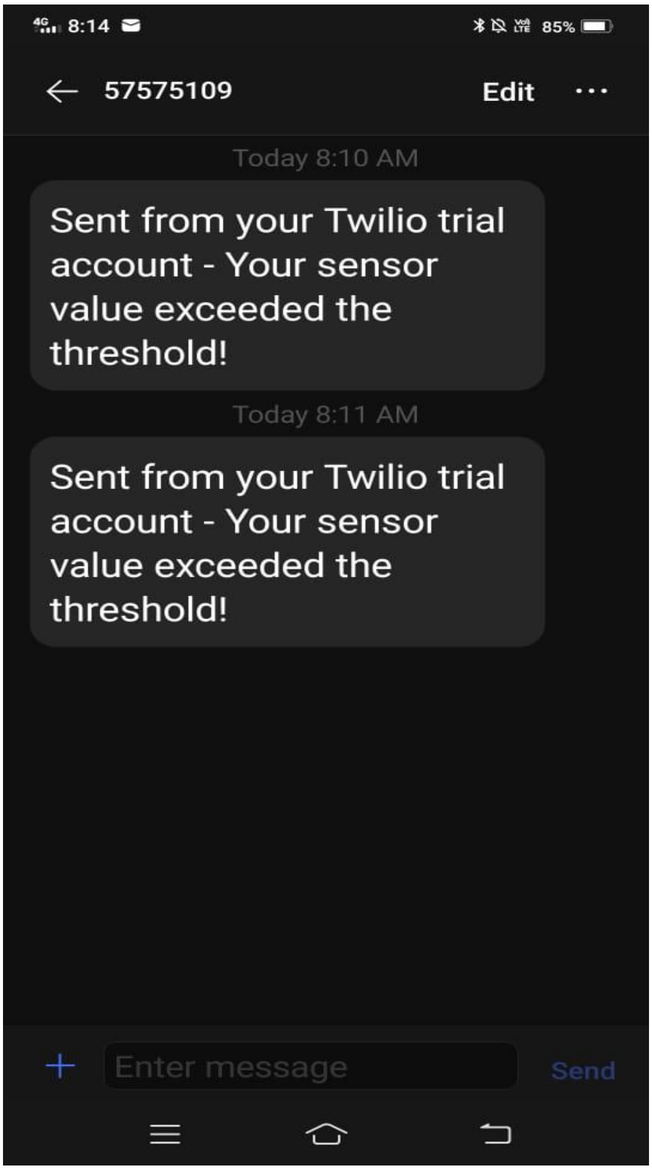


Figure A.3 Notification Screenshot

A.4 Plagiarism Report

RE-2022-211233-plag-report

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REFERENCES

1) Devra Davis, Linda Birnbaum, Paul Ben-Ishai, Hugh Taylor, Meg Sears, Tom Butler, Theodora Scarato, Wireless technologies, non-ionizing EMF and children: Identifying and reducing health risks, Current Problems in Pediatric and Adolescent Health Care, Volume 53, Issue 2, 2023, 101374, ISSN 1538-5442, https://doi.org/10.1016/j.cppeds.2023.101374

2) Chen, H.; Liu, Q.; Li, Y.; Huang, C.; Zhang, H.; Xu, Y. Research on the Method of Near-Field Measurement and Modeling of Powerful Electromagnetic Equipment Radiation Based on Field Distribution Characteristics. Energies 2023, 16, 2005. https://doi.org/10.3390/en16042005

3) Agbakhamen Eco, Prof. Okeke Gerald Ndubuisi. Biological hazard of electromagnetic radiation: A Comprehensive analysis using mobile phones as a case study, Vol. 2 No. 01 (2024): IPHO-Journal of Advance Research in Science And Engineering.

4) Kaur, P.; Rai, U.; Singh, R. Genotoxic Risks to Male Reproductive Health from Radiofrequency Radiation. Cells 2023, 12, 594. https://doi.org/10.3390/cells12040594

5) Leszczynski, Dariusz. "The lack of international and national health policies to protect persons with self-declared electromagnetic hypersensitivity" Reviews on Environmental Health, 2022. https://doi.org/10.1515/reveh-2022-0108

6) M. Kai, T. Homma, J. Lochard, T. Schneider, J.F. Lecomte, A. Nisbet, S. Shinkarev, V. Averin, T. Lazo; CRP, 2020. Radiological protection of people and the environment in the event of a large nuclear accident: update of ICRP Publications 109 and 111. ICRP Publication 146.Ann. ICRP 49(4).

7) María Ángeles Ontalba, José Ángel Corbacho, Antonio Baeza, José Vasco, José Manuel Caballero, David Valencia, Juan Antonio Baeza, Radiological Alert Network of Extremadura (RAREx) at 2021:30 years of development and current performance of real-time monitoring, Nuclear Engineering and Technology, Volume 54, Issue 2, 2022, Pages 770-780, ISSN 1738-5733, https://doi.org/10.1016/j.net.2021.08.007.

8) Arpit Patel et al,A review on Radiation Detectors for Various Radiation Detection Applications, 2023,J. Rad. Nucl.Appl.8, No. 2, 93-111 / http://www.naturalspublishing.com/Journals.asp.

9) Ahmad, M.I.; Ab. Rahim, M.H.; Nordin, R.; Mohamed, F.; Abu-Samah, A.; Abdullah, N.F. Ionizing Radiation Monitoring Technology at the Verge of Internet of Things. Sensors 2021, 21, 7629. https://doi.org/10.3390/s21227629

10) A. Sharaf a,M. Zorkany , M. Shiple b High efficient low cost gamma-ray radiation sensor based on IoT platform Volume 15, Issue 4, December 2022, 100463 www.journals.elsevier.com/journal-of-radiation-research-and-applied-sciences

11) Muhammad Saifullah , Imran Sarwar Bajwa , Muhammad Ibrahim, and Mutyyba Asghar IoT-Enabled Intelligent System for the Radiation Monitoring and Warning Approach, Volume 2022, Article ID 2769958,https://doi.org/10.1155/2022/2769958.

12) Muhtadan , Adi Abimanyu , Rizqi Akmali , Mahrus Salam , Design of IoT-based Radiation Monitor Area for Nuclear and Radiological Emergency Preparedness System in Yogyakarta Nuclear Area, 1428 (2020) 012050, doi:10.1088/1742-6596/1428/1/012050.

13) F. Torres-Hoyos, R. Baena-Navarro, J. Vergara-Villadiego & A. Pérez Gómez, Design and assembly of an IOT based device to determine Absorbed dose of gamma and UV radiation in skin, ISSSD 2019, Volume 1.

14) Hiroshi Yasuda * , Chryzel Angelica B. Gonzales, Soheil Aghabaklooei, Radiation Measurements, Volume 166, August 2023, 106964, www.elsevier.com/locate/radmeas.

15) Nida Tabassum Khan, Radioactivity: Detection and Measurement, Volume 7 • Issue 2 • 1000135, DOI: 10.4172/2155-9937.1000135.

16) F.N. Flakus, Detecting and measuring ionizing radiation, IAEA BULLETIN, VOL 23, No 4,https://www.iaea.org/sites/default/files/publications/magazines/bulletin/bull23-4/23405043136.pdf.

17) Liudmila Liutsko, Deborah Oughton, Yevgeniya Tomkiv , Paola Fattibene , Sara Della Monaca , Cristina Nuccetelli , Aya , Takashi Ohba , Yuliya Lyamzina, Koichi Tanigawa , Natallia Novikava, Vadim Chumak, Philippe Pirard, Sylvie Charron, Dominique Laurier, Pascal Croüail , Thierry Schneider, Joan Francesc Barquinero, Adelaida Sarukhan and Elisabeth Cardis, Resilience after a nuclear accident: readiness in using mobile phone applications to measure radiation and health indicators in various groups (SHAMISEN SINGS project), : Liudmila Liutsko et al 2023 J. Radiol. Prot. 43 041511, https://iopscience.iop.org/article/10.1088/1361-6498/ad115a/pdf.

18) Yabo Fu, Hao Zhang, Eric D. Morris, Carri K. Glide-Hurst, Suraj Pai , Alberto Traverso, Leonard Wee , Ibrahim Hadzic , Per-Ivar Lønne , Chenyang Shen , Tian Liu, and Xiaofeng Yang, Artificial Intelligence in Radiation Therapy ,VOL. 6, NO. 2, FEBRUARY 2022, https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9521554

19) B. Blake Levitt, Henry C. Lai and Albert M. Manville II ,Low-level EMF e ects on wildlife and plants,25 November 2022, Vol 10, ISSN=2296-2565