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Smart Sensor Fusion for Radiation Detection Using Machine Learning

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ABSTRACT: In the present age, human beings are surrounded by many dangerous radiations. These radiations badly affect human health, and especially, these rays are very harmful for children, pregnant woman's and elderly people those who are constantly exposed to radiation in a long period of time. It will interface with body organs and which will cause many diseases from simple infection to deadly diseases such as eye infections, headache, skin tanning, skin burns, brain tumours, breast cancer and skin cancer. There is a need for system which can detect the intensity of the rays around us. This system detects the harmful radiation surrounded by the human using the modern technology and algorithms for human protection and this model will be developed by adding improvements and enhancements. It will do real-time monitoring dataset is collected by automated sensor using machine learning and early threat detection contributing to enhanced safety measures in various environments by alerting humans about the danger zones based on high radiation frequency by visual or voice signal.

KEYWORDS: Radiation Detection, Realtime Monitoring, Sensor Networks, Threat Detection and Alerting, Pattern Recognition.

I. INTRODUCTION

Now a days technology is developed in many sectors and the usage of smart devices is also increased and everyone is surrounded with smart devices such as smart phones, laptops, microwave ovens and cell towers etc. which will help people to work smarter and gain complete control over their lives. These devices make life easier and worth ling but there are some disadvantages also there, no one can overlook about the drawbacks by using these devices when the usage of devices is increased. Generally, these devices will emit rays that are electromagnetic waves also called as electromagnetic radio waves around us. These waves are very harmful for the human body especially for pregnant ladies, children and elderly people those who are constantly exposed to radiation from long period of time.

In the present age, the technology has grown in wide range of fields. The technology is majorly developed with wireless communication such as smart phones, routers etc. These devices emit different radiation rays which are harmful to the human beings. It will effect the health of humans and these are harmful to children, pregnant women's and elderly people those who are constantly exposed to radiation in a long period of time. It will interface with body organs and which will cause many diseases from simple infection to deadly diseases such as eye infections, headache, skin tanning, skin burns, brain tumours, breast cancer and skin cancer. The ever-increasing adoption of wireless communication has created a very complex situation of electromagnetic radiation (EMR) exposure. With new technologies such as 5G, the number of devices will increase exponentially and operate on a broader frequency spectrum However, it is very important to identify beforehand, if any, harmful or adverse effects resulting from increased exposure of human beings.

Generally, these rays are not visible to eyes but they interfered with body organs and causes many diseases from simple skin diseases to harmful deadly disease's such as Brain tumors, skin cancers and breast cancers etc. There is a need for a system for detection of harmful radiation surrounded by the human and alert the person to protect from the harmful high frequency radiation by taking some safety measures.

This study will introduce a real time monitoring smart system to detect the high frequency electromagnetic non-ionizing radiation waves from diff sources of radiation and alert the person based on analysis of real time dataset and using decision trees algorithms for making decision by classifying the radiations and alert the people by visual signal.

It will help to protect ourselves from the radiation by taking some safety measures. This IOT enabled intelligent

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system is developed by using Esp32 for Connecting the devices and ElctroMagnetic field detector sensor for collecting the live dataset and a display unit to visualize the output on screen to user. These results will give high accuracy and adaptive results for detection electromagnetic waves and alert the user by visual signal

EXISTING SYSTEM

They develop an IOT enabled intelligent system using Machine Learning. This system was developed by using Arduino Microcontroller for radiation monitoring and warning by classifying the radiation and their effects on infants only.

DISADVANTAGES

1. Arduino having limited Memory and processing power not sufficient to load data from multiple sources of radiation.
2. In Arduino there are limited number of libraries to download.

II. PROPOSED SYSTEM

In this system we proposed a system model that can identify and detect the harmful radiation surrounded by the person from different sources and alert the human by giving a visual signal which helps to protect from the radiation exposure, developed by focusing on effects of radiation on human. For that we proposed a probabilistic modeling and machine learning approach using SVM and Random Forest Algorithm.

The proposed system explains about the detection of radiation in different locations using the smart sensors. The sensors are used to detect the level of radiation whether it is low, medium and high. The hardware components are mostly used in the proposed system to detect the radiation levels of the electronic devices that are harmful and cause high radiation. Some of the hardware sources are used in this system to detect the gamma rays, x-rays, ultra violet rays that are emitted from the electronic devices. These rays are detected by the sensor, which is integrated with the other hardware components like seed studio, led display. The led display gives the output of the radiation level in the electronic devices.

ADVANTAGES

1. It is useful for all age groups.
2. Result helps to take safety measures to protect from the radiation and highly accurate algorithms taken into consideration.

III. LITERATURE SURVEY

[1] Dinh Tien Hung, Cao Van Hiep, [2020] proposed A Confident Configuration for an Environmental Radiation Monitoring System which addresses the need for monitoring environmental radiation levels. In this the traditional Methods was Discussed such as fixed monitoring stations, Data Analytics. The Hardware Components are also included like radiation detectors, communication devices. They address challenges related to regulatory compliance, data privacy. They can suggest a brand-new fault diagnostic tool that is especially made for nuclear radiation monitoring systems and include specifications for its parts, construction, and principles of operation.

[2] Muhammad Saifullah, Imaran Sarwar [2022] proposed A Iot Enabled Intelligent System for Radiation Monitoring and Warning Approach using Machine Learning. In this Integration of Iot technology in radiation Monitoring System was explored. In the Authors have Implemented Iot-based solutions for Environmental monitoring. In this the Machine learning Algorithms were included such as supervised learning algorithms and unsupervised learning algorithms. The writers most likely go over the rationale for creating such a system, stressing the significance of effective and safe surveillance in locations where human presence may be hazardous or unfeasible.

[3] Andriy Holloway, Vasyl Taluk [2018] proposed A Development of Background Radiation Monitoring System based on Arduino Platform. In this the accessible solutions for background radiation monitoring addressed. They focus on background radiation monitoring System using the Arduino platform. They may describe the mobility, sensors, communication, and autonomous navigation capabilities of the smart surveillance robot, as well as its overall design and features. The difficulties in identifying and diagnosing defects in intricate monitoring systems are probably discussed by the writers, who also stress the significance of prompt and efficient fault detection in preserving system safety and dependability.

[4] Chase Wolfberry, [2019] proposed A Network Detection of Radiation Sources Using Localization-based

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Approaches. In this The Importance of potential threats posed by Radiological incidents are addressed. This provides insights into the state-of-the-art in radiation detection methods. The study may also include case studies or experimental results showing. The device's performance in a range of dangerous or radiation-prone situations. It is probable that the writers tackle worries about the possible health hazards linked to extended exposure to electromagnetic radiation from these devices. In order to examine the many sources of electromagnetic radiation, they proposed different systems.

[5] Lixiao Wang, Yuxi Zhang, [2020] proposed A Phase less Inverse Source Method Based on Near-Field Scanning for Radiation Diagnosis and Prediction of PCB's. Addresses the need for advanced methods in radiation diagnosis, printed circuit boards. Near-Field Scanning Techniques are included. Like microscopy, electromagnetic imaging Optical microscopy. The approach for creating the defect diagnosis equipment, including any algorithms, machine learning strategies, or signal processing techniques used, may also be covered in the article. The paper is proposed by using many different types of algorithms and the different methods in their implementation.

[6] KA Pradeep Kumar, G.A. Shanmugha Sundaram [2020] proposed Advances in a gamma Radiation Detection Systems for Emergency Radiation Monitoring. This contains the detailed information about the critical need for advanced gamma radiation detection systems for emergency monitoring applications. In this the discussion happened on handheld devices, wearable sensors. The Integration with IoT with Wireless Communications were enhanced here. The authors most likely suggest using distributed mobile sensor networks—a set of sensors placed on mobile platforms like cars or drones—for the accurate and efficient detection of radioactive materials.

[7] Luning Chen, Yishan Jing, Qian Zheng, and Feng Xiao presented a work titled "Fault diagnosis Device for Nuclear Radiation Monitoring System" at the [2019] IEEE 4th Advanced Information Technology, Electronic and Automation Control Conference (IAEAC 2019). The requirement for trustworthy problem diagnostic methods in nuclear radiation monitoring systems to guarantee accurate and continuous functioning is probably the topic of this research. In addition, the writers can offer case studies or experimental findings that show how well the suggested gadget performs in identifying and repairing issues and the problems faced with actual radiation monitoring systems.

[8] Authors G. Rohith, Varun Kumar, Bharath, and V.S.G. Naga Raju submitted a work titled "SMART SURVEILLANCE ROBOT FOR HAZARDOUS AND RADIATION AFFECTED FIELDS" in the International Journal of Computer Research and Technology (IJCRT) Volume 11, Issue 5, May [2023]. This research probably presents a new robotic system intended for exploration and surveillance in settings influenced by radiation and danger. Overall, by offering a workable solution for remote surveillance and monitoring in difficult environments, this research probably advances the fields of robotics and safety engineering while also improving efficiency and safety in tasks like environmental monitoring, nuclear facility maintenance, and disaster response.

[9] The development and application of a silicon photomultiplier (SiPM)-based detector for high-resolution measurements in pulsed radiation fields is the subject of an initial study published in the paper "SiPM-based detector for high-resolution measurements in pulsed radiation fields: preliminary findings" by L. Pavelic, I. Lackovic, M. Suric Mihic, and I. Prlic. The study, which was published in the [2019] proceedings of an IEEE conference (ISBN: 978-1-7281-4164-0), probably deals with the necessity for precise and reliable radiation detection techniques, especially in environments with pulsed radiation fields. The SiPM-based detector's design and implementation are probably described by the authors, who also emphasize its benefits over more conventional radiation detection technologies like solid-state detectors and photomultiplier tubes (PMTs).

[10] At the 23rd Euromicro Conference on Digital System Design (DSD) in [2020], a paper titled "Design of Radiation Hardened RADFET Readout System for Space Applications" was presented by Marko Andjelkovic, Aleksandar Simevski, Junchao Chen, Oliver Schrape, Zoran Stamenkovic, Milos Krstic, Stefan Ilic, Luka Spahic, Laza Kostic, Goran Ristic, Aleksandar Jaksic, Alberto J. Palma, Antonio Lallena, and Miguel Angel Carvajal. The research and design of a reliable RADFET (Radiation-Sensitive Field Effect Transistor) readout device intended especially for space applications is probably the main emphasis of this paper. The article probably goes into great length regarding the technical aspects of the design process, such as system architecture, radiation hardening, RADFET sensor integration, and data acquisition methods, given the context of the Euromicro Conference on Digital System Design.

[11] Authors Naren, Anubhav Elhence, Vinay Chamola, and Mohsen Guizani published a paper titled "Electromagnetic Radiation Due to Cellular, Wi-Fi and Bluetooth Technologies: How Safe Are We?" in Volume 8 of IEEE Access in [2020]. The topic of electromagnetic radiation emitted by widely used technologies like Bluetooth, Wi-Fi, and cellular networks is probably covered in this paper. The exposure levels, and the biological impacts seen in humans and other creatures, they might go over the literature and research studies that have already been done on the topic.

[12] Sensors published a study by Robert R. Flanagan, Logan J. Brandt, Andrew G. Osborne, and Mark R. Deinert titled "Detecting Nuclear Materials in Urban Environments Using Mobile Sensor Networks" in [2021]. The difficulty of finding radioactive materials in urban settings, which is essential for protecting public safety and security from possible nuclear

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threats, is probably addressed in the study. The design and implementation of such a sensor network, including sensor selection, network configuration, and data fusion techniques, are probably covered in the paper. Furthermore, the study probably assesses how well the suggested system performs and it is developed by using high accuracy.

[13] A novel approach to monitoring radioactive environments using unmanned vehicles is presented in the paper "A low-cost radiation detection system to monitor radioactive environments by unmanned vehicles" [2021] authored by Andrea Chierici, Andrea Malizia, Daniele di Giovanni, Francesca Fumian, Luca Martellucci, Pasquale Gaudio, and Francesco d'Errico. The article, which was published in the European Physical Journal Plus in 2021, probably highlights the necessity of effective and affordable radiation detection devices, especially in situations when human intervention could be dangerous. The authors most likely suggest a system architecture that enables remote monitoring of radioactive areas by integrating radiation detection sensors onto unmanned vehicles. The approach used to design the system, including sensor selection, integration with unmanned vehicle platforms, and data processing algorithms, should be covered in the paper.

[14] The design and fabrication process of a CdMnTe-based nuclear radiation detection system is presented in the paper [2019] "Design and Fabrication of a CdMnTe Nuclear Radiation Detection System," which was written by Stephen U. Egarievwe, Mordecai B. Israel, Alex D. Banks, Mebougna L. Drabo, Keiandrea L. Dunning, Vintrell J. Cook, Frederick D. Johnson, Shaunay M. Palmer, Utpal N. Roy, and Ralph B. James. With CdMnTe, a semiconductor material known for its appropriateness in radiation detection applications due to its high atomic number and broad bandgap, the system is probably intended to provide accurate and efficient nuclear radiation detection. The approach and techniques used in the design and fabrication process, such as material selection, sensor configuration, and manufacturing procedures, are probably covered in the article.

IV. METHODOLOGIES

In this paper we are discussing about the Decision Tree Algorithm. This algorithm provides more accuracy than other machine learning algorithms (i.e.) Support vector machine and the other algorithms like the Random forest algorithm. These algorithms are used for the identification of the results in the implementation.

Support Vector Machine Algorithm:

"Support Vector Machine" (SVM) is a supervised machine learning algorithm which can be used for both classification and regression challenges. However, it is mostly used in classification problems. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiates the two classes very well.

The algorithm states about the finding of the different vector algorithms that are used for the classification. The support vector machines are used for the development of the different machines that are used for the identification of the values that are occurred in the different graphs and the other grids. The support vector machine algorithm is mostly used in the finding of the basic classifications and the differences between the dimensions in the graphs.

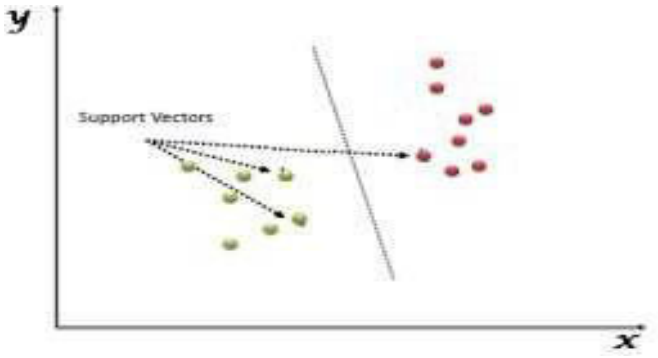

Fig 1: Graphical model of Support vectors

The above graphical model states about the machines that are implemented by using the support vectors. The accuracy, consistency, efficiency and the other required elements information is observed in the graphical model of the support vector machines.

Random Forest Algorithm:

Random forest is a supervised machine learning Algorithm that is used widely in classification and regression

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problems. It builds decision trees on different samples and takes their majority vote for classification and average in case of regression. One of the most important features of the Random Forest Algorithm is that it can handle the data set containing continuous variables as in the case of regression and categorical variables as in the case of classification. It performs better results for classification problems.

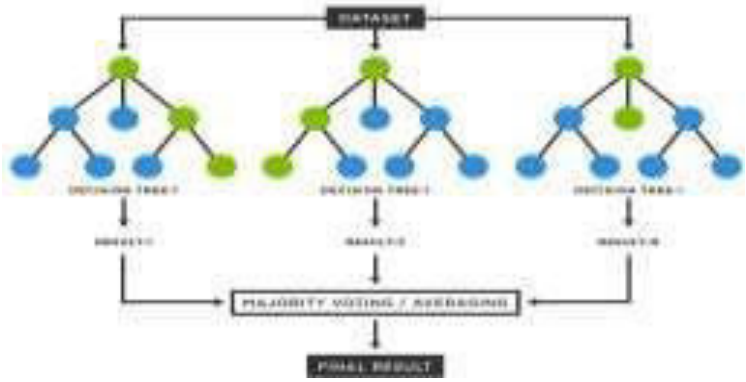

Fig 2: Representation of random datasets

The random datasets are represented in the above figure. These datasets are divided into sub categories by using the random forest algorithm. This algorithm states about the classification of the datasets into different and various sub groups. They are mainly divided on the basis of priority. This algorithm is developed on the efficiency of the different data sources and the other models that are implemented in the random datasets.

V. SYSTEM ARCHITECTURE

The system architecture represents the components that are used in the implementation of the project. The main sources that are used for the development of the proposed system are represented in the system architecture. Almost the implementation of the project is observed in this block representation of the system.

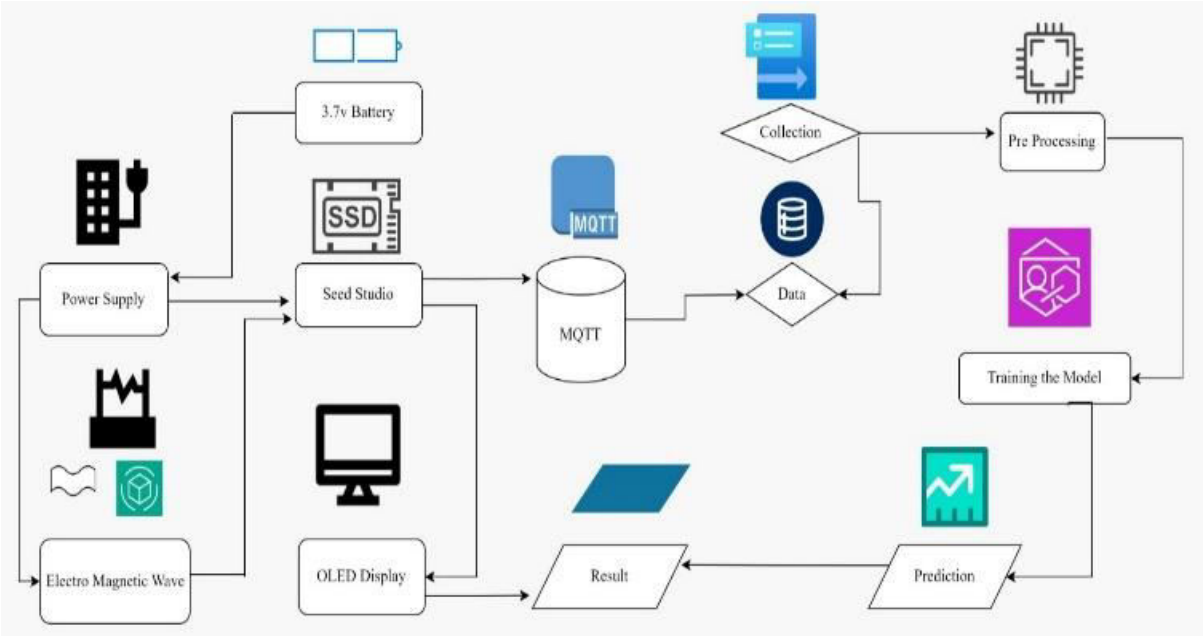

Fig 3: System architecture

Smart sensor fusion for radiation detection and alerting in IoT system architecture involves integration of sensor data from different sources of electromagnetic radiation and identify the high radiation levels based on processing of data and alert the person by sending a alert message on display unit. This is done by real time monitoring and detection high radiation levels.

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Electromagnetic wave Sensor is detecting the radiation levels used non-ionized electromagnetic radiation from different Sources Such as smart phone, cell towers, microwave ovens, etc. Sensor data is collected continuously & transferred to processing unit with in IOT architecture based on Analysis of radiations levels after preprocessing alert the person if there is abnormal radiation.

VI. RESULTS

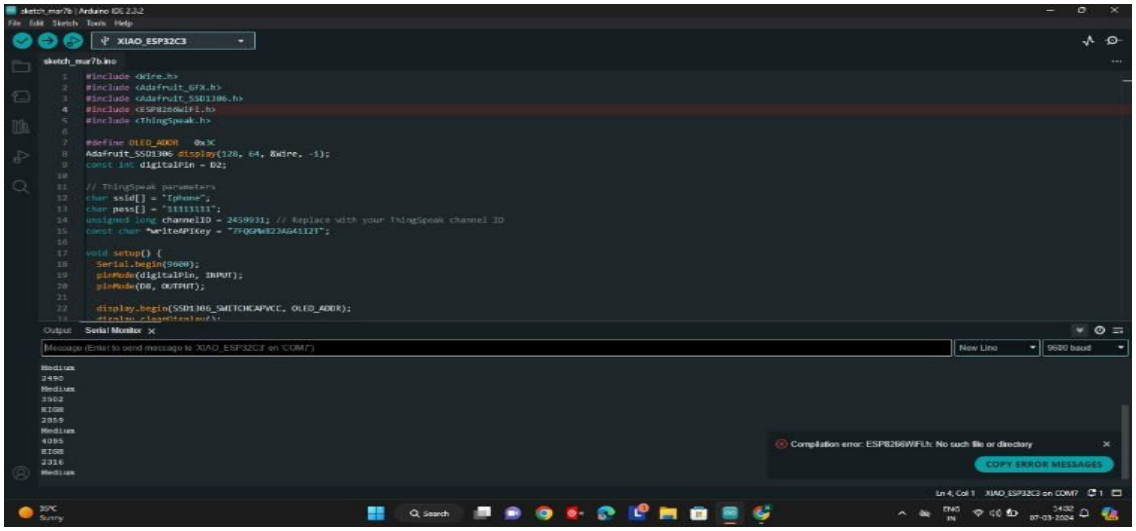

Fig 4: Connection between Arudino IDE and USB cable

The above figure shows the values displayed on the screen when we connected with USB cable to our system.

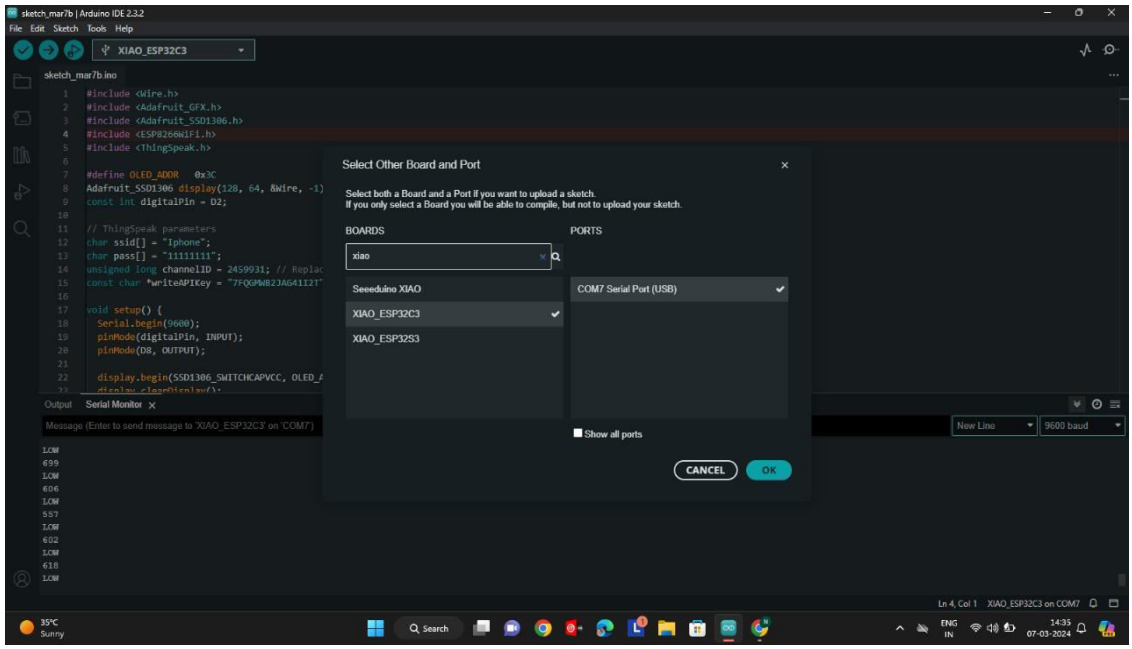

Fig 5: Integration with seed studio

The above figure is selecting the XIAO_ESP32C3 to connect with the usb cable to detect or
Sense the radiation levels or rays.
There are three test cases in this system
1.High
2.Low

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3.Medium
For different stages there are different levels of emission of radiation.

VII. CONCLUSION AND FUTURE ENHANCEMENT

By analyzing the results, we concluded that Random Forest turned out to be best classifier for prediction of heart attack using Machine learning and this model generates accurate results with high accuracy. We choose four popular classifiers considering their performance for the project. We collect data by magnetic field detector. In order to compare the classification performance of four learning algorithms, classifiers are applied on same data and results are compared on the basis of misclassification and correct classification rate, it can be concluded that Logistic Regression is the best as compared to Support Vector Machine, Decision Tree Techniques.

Determined the prediction accuracy of each algorithm and apply the proposed system for the area it needed. All these can be taken into consideration and even more reliable and more accurate algorithms can be used. We can make use of more learning techniques and Deep Learning techniques to predict heart attack chances with less time and more accuracy. Then the project will be more powerful to depend upon and even more efficient to depend upon.

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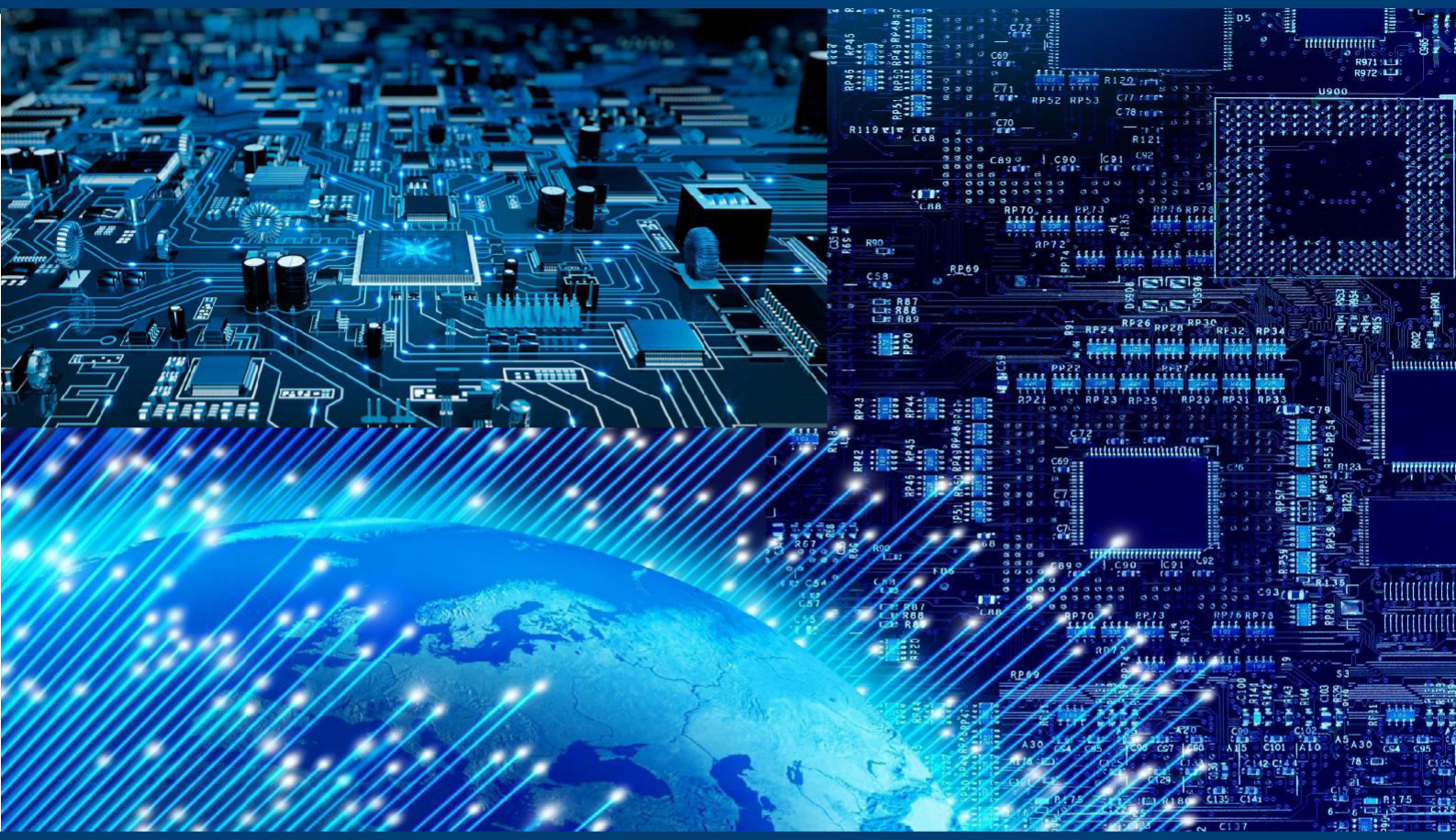

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