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# ExamGuard: An IoT-Based RF Activity Monitoring System for Examination Hall Security

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## Abstract

Final examinations are an important method of assessing students' achievement and maintaining examination integrity. However, maintaining examination integrity when students go to the toilet, can be challenging. Examination monitoring at Politeknik Balik Pulau is mainly conducted manually. It is difficult to continuously monitor areas outside the supervision. This project proposes an Internet of Things-based supplementary monitoring system for examination supervisors. ExamGuard will detect the presence of RF activity associated with nearby wireless transmissions. This proposed system combines a wideband RF antenna, an RF Power Detector (AD8361) and ESP32 microcontroller to detect overall RF signal activity associated with nearby wireless transmissions. When the detected RF power exceeds a predefined threshold an alert is triggered and the detection information is sent to a web-based dashboard for real-time monitoring of RF activity. The system also logs the detection events in a MySQL database for monitoring and reporting purposes. Development is based on the Rapid Application Development model which consists of four phases, Requirements Planning, User Design, Rapid Construction and System Testing. The evaluation will include RF threshold calibration, detection range, dashboard response time and false alarm rate. The proposed system is intended to provide a low-cost supplementary monitoring to support examination security without interfering with wireless connections or accessing users' private data.

**Keywords: Internet of Things; radio frequency detection; mobile device monitoring; examination security; ESP32; RF power detection**

## Introduction

Final examinations play an important role in the academic assessment system of higher education institutions because they are used to evaluate students' achievement of intended course learning outcomes. In accordance with the examination policies and procedures of Politeknik Balik Pulau (PBU), final exams are administered centrally in the Main Hall. Mobile phones and other electronic communication devices are not allowed in the exam hall. Before an exam starts, students can leave their mobile phones in a designated storage box.

Access to information and communication services has expanded due to the quick development of mobile technology and artificial intelligence. Mobile phones can be abused during exams to access the Internet, contact with outside parties or get help through online and artificial intelligence programs, despite the fact that these technologies offer substantial educational benefits. Recent studies have revealed growing student use of AI chatbots for assessment-related activities, raising renewed concerns about academic integrity and the adequacy of existing assessment practices (Gruenhagen et al., 2024).

At present, examination monitoring at PBU mainly depends on manual observation by examination supervisors. While manual observation works well in the exam hall, it is not as successful in locations that are not under direct control, such as toilets. In particular, toilet breaks pose a potential vulnerability because privacy considerations may prevent continuous visual observation by examination supervisors (Sindre & Lervik, 2019; Mhlanga, 2019). This makes it possible for a student who is carrying a mobile phone to use it secretly. This issue has also been acknowledged in the Malaysian context, where it has been shown that exam monitoring and toilet-visit procedures are essential defences against exam fraud (Jamil Azhar et al., 2024).

Previous studies have demonstrated the feasibility of using radio frequency (RF) signals to detect active mobile devices in restricted and examination environments (Nazari et al., 2019; Ismail et al., 2024). More recent work has also explored real-time mobile phone detection for secure environments (Rajalingam et al., 2025). However, there is still a need for a low-cost and non-intrusive solution that can provide real-time information on suspicious wireless activity without accessing personal device data or intentionally interfering with wireless communication. In order to meet this demand, ExamGuard uses RF signal-level detection to detect wireless activity connected to adjacent mobile devices and provide notifications to examination supervisors via an Internet of Things-based monitoring platform.

This project measures the RF activity associated with nearby wireless transmissions utilizing an ESP32 microcontroller and an AD8361 RF Power Detector. The technology sends a detection signal to a web-based dashboard for examination supervisors and initiates an alert when the measured RF signal surpasses a predetermined threshold. The system's goals are to enhance oversight, lower the possibility of academic dishonesty and uphold the fairness and integrity of PBU exams.

The objectives of the project are to (i) develop an Internet of Things (IoT)-based system to monitor RF activity from nearby wireless transmissions using an ESP32 microcontroller and an AD8361 RF Power Detector for supplementary examination monitoring (ii) create a web-based monitoring dashboard for real-time notifications and data visualization and (iii) store and manage detection logs for reporting and monitoring.

## Methodology

This study is built utilizing the Rapid Application Development (RAD) paradigm, as illustrated in Figure 1. This model facilitates iterative prototyping and integration of hardware and software components. The development process begins with identifying the requirements of the examination monitoring system and designing the proposed IoT architecture.

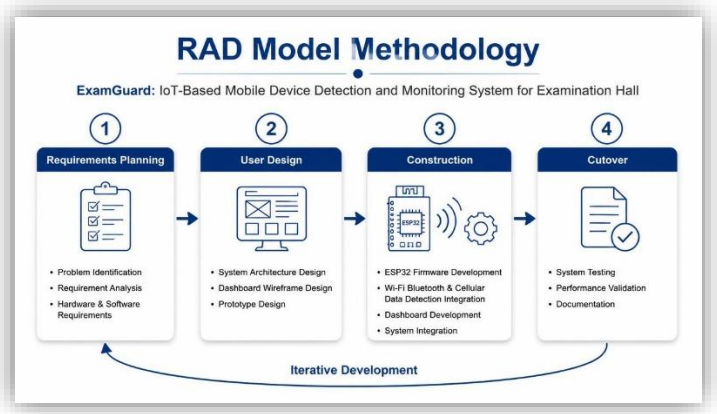



Figure 1: RAD Model

The ESP32 microprocessor, AD8361 RF Power Detector and wideband RF antenna make up the primary hardware. Nearby radio frequency signals are picked up by the RF antenna and the AD8361 transforms the RF power into an analogue voltage. After processing the voltage, the ESP32 compares it to a predetermined threshold. The system delivers the detection data to a web-based monitoring dashboard and initiates an alert when the detected RF level over the threshold.

The web dashboard is designed to show the number of detected devices, detection history, sensor location and detection time. A MySQL database is used to store detection records for monitoring and reporting purposes. The system is developed and integrated using Arduino IDE, Visual Studio Code, XAMPP, MySQL, HTML, CSS, JavaScript, PHP and GitHub. The completed prototype is evaluated through RF threshold calibration, Wi-Fi, Bluetooth and cellular data detection tests, detection range measurement, dashboard response time measurement and false alarm rate evaluation. The system only detects the presence of active RF signals and does not jam, block, intercept or access communication data from mobile devices.

## Results and Discussion

As the current project is still at the development and proposal stage, the latest proposal does not provide completed experimental measurements. Therefore, numerical performance results should not be stated until the prototype has undergone the planned testing process.

The expected output is a working IoT-based prototype capable of detecting RF signals generated by Wi-Fi, Bluetooth and cellular data transmissions from nearby mobile devices. When the detected RF level exceeds the predefined threshold, the system is expected to activate an alert and display the detection information through the web-based dashboard. The system is also expected to maintain detection logs and generate reports for examination monitoring purposes. Figure 2 illustrates the schematic design of the ExamGuard RF Activity Monitoring System.

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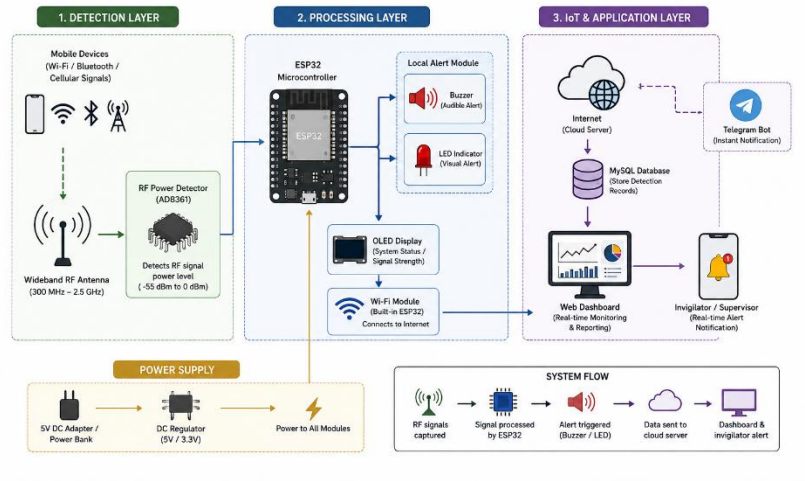



Figure 2: Schematic Design of the ExamGuard RF Activity Monitoring System

The web-based dashboard provides a centralised interface for monitoring detected RF activity. The proposed interface displays information such as detection time, sensor location and detection history. The system allows examination supervisors to review detection events in real time. The dashboard also provides a basis for maintaining detection records for subsequent monitoring and reporting as presented in Figure 3.

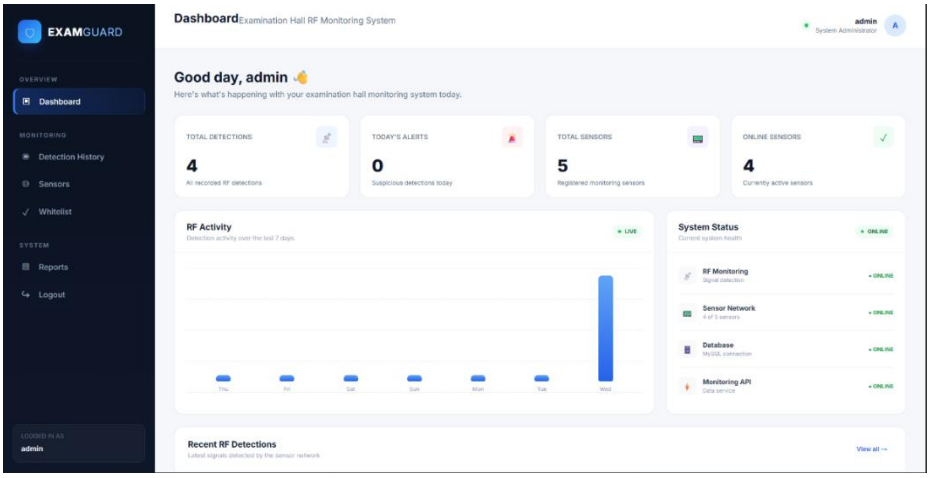



Figure 3: ExamGuard Web-Based Monitoring Dashboard

The planned evaluation focuses on several key performance parameters, including RF threshold calibration, Wi-Fi, Bluetooth and cellular signal detection, detection range, dashboard response time and false alarm rate. These parameters are intended to assess the system's detection capability, monitoring coverage, real-time response and reliability. The measurement approach and purpose of each evaluation parameter are summarised in Table 1.

Table 1: Planned Performance Evaluation

| Test Parameter | Measurement | Purpose |
|---|---|---|
| RF threshold | RF level required to trigger an alert | Establish suitable detection threshold |
| Detect RF activity associated with Wi-Fi | Detection of active Wi-Fi transmission | Evaluate RF detection capability |
| Detect RF activity associated with Bluetooth | Detection of active Bluetooth transmission | Evaluate RF detection capability |
| Detect RF activity associated with cellular transmission | Detection of active cellular transmission | Evaluate RF detection capability |
| Detection range | Maximum effective detection distance | Determine monitoring coverage |
| Dashboard response time | Time from detection to dashboard notification | Evaluate real-time monitoring |
| False alarm rate | Unwanted alerts during testing | Evaluate detection reliability |

## Conclusion

ExamGuard proposes an IoT-based RF monitoring system to overcome the shortcomings of human examination supervision in locations outside of direct observation, such as examination toilets. The system detects overall RF signal activity associated with nearby wireless transmissions by combining a wideband RF antenna, an ESP32 microprocessor and an AD8361 RF Power Detector. For monitoring and reporting purposes, detection data is sent to a web-based dashboard and kept in a MySQL database.

The proposed RF detection hardware, real-time web interface and detection recording system address the three primary project goals. The planned evaluation will assess RF threshold calibration, detection range, dashboard response time, and false alarm rate. The system has several limitations. It cannot identify the exact device, device owner, or specific source of the detected RF signal. It may also fail to detect devices that are powered off or have wireless connectivity disabled.

Overall, ExamGuard presents a low-cost and scalable approach to supplementary examination monitoring. The system is designed to give examination supervisors more real-time information without interfering with wireless communications or gaining access to private device data. Its estimated hardware and development costs are RM128.

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