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EVALUATING THE EFFECTIVENESS OF AN ACTIVE MOBILE PHONE DETECTION SYSTEM IN AN ACADEMIC ENVIRONMENT

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ABSTRACT

The growing use of mobile phones in academic environments has prompted serious concerns about their ability to distract students and compromise the integrity of exams. This study evaluates the effectiveness of an Active Mobile Phone Detection System (AMPDS) that has been implemented in an academic environment. The overall objective of the research is to determine the ability of the device to sense active mobile phones at a distance of 4 meters and its suitability in preserving discipline and reducing distraction. Other objectives of the research include testing device's sensitivity under real-world conditions and determining its impacts on schools. The methodology employed involved the modeling and installation of the detection system in a controlled environment, where it was evaluated under diverse scenarios, such as mobile phone models, network setups, and human behavioral patterns. Some of the key parameters that were measured consisted of the detection rate, false alarm incidents, and levels of signal interference. The findings indicated that the AMPDS could identify active mobile phones with high accuracy, albeit with some interference from environmental circumstances. The finding suggests the possibility of having such a system implemented for mobile phone regulation in schools, particularly inside classrooms and exam halls. Moreover, the study contributes to the body of knowledge by providing empirical findings on mobile phone detection technologies in academic settings. Its usefulness could further be extended to potential application in schools, policy-making on mobile phone control, and potential future improvements in detection precision and range optimization.

Keywords: Mobile Phone Detection, Academic Environment, Examination Integrity, Signal Detection, Detection Accuracy

INTRODUCTION

The proliferation of mobile phones has revolutionized communication and education, offering students access to lecture materials, e-books, and collaborative tools (Ataro *et al.*, 2016). However, their misuse in academic settings, particularly during examinations, has raised significant concerns about academic integrity (Nazari et al., 2019). Students increasingly exploit mobile phones to cheat by exchanging messages, accessing unauthorized materials, or recording exam content (Ataro et al., 2016). This malpractice undermines the credibility of assessments and creates unfair academic competition (Simiuy et al., 2016).

Misuse of mobile-phones is another-latest-threat to the information-dependent-businesses and to the education-sector. Many-businesses depend on keeping information protected and build fortresses that called secure-facilities to protect their investment. Features like Bluetooth, USB, micro USB, high-resolution-cameras, microphones and internet make cellular phones perfect for stealing data and also for cheating in examinations by students (Nicholas, 2011).

New-useful-features make cellular-phones today very versatile, such as, for example, that they can store huge amount of data in deferent-formats, and connect with almost any storage-medium or computer.

The need for mobile phone detection systems in academic institutions is critical to curb cheating and maintain examination integrity. Traditional methods, such as manual inspections, are invasive, time-consuming, and ineffective, as students often conceal devices (Ataro et al., 2016).

According to Bawarith et al., (2017) cheating, using a mobile phone is the most popular way among the students by texting their friends for answers or by searching the information through the electronics notes and search engine. To prevent this from happening, many mobile phones and jammers had been invented by the researchers in many forms of prototype. However, their prototype has limitation of about 1.5 meters to 2 meters of detection range. For instance, Mbaocha's (2012) intelligent detector could identify GSM signals within 1.5 m but failed to distinguish multiple devices (Ataro et al., 2016). Similarly, Kanwaljeet et al. (2014) developed a robot to detect RF signals, though it lacked directional precision (Ataro et al., 2016). This has caused a problem for the invigilators to detect which area that the active mobile phone is present in a specific small range.

In order to widen the signal detection range, antenna is usually being used. The common types of antenna design are the micro strip antenna, single-dipole antenna and multi-band dipole antenna. Micro strip antenna consists of patch, substrate and ground plane. This antenna has various advantages such as simple to design, easy to modify according to needs, inexpensive and lightweight. Even so, it suits low bandwidth and low power application (Zhang, 2017).

Technological solutions, like radio-frequency (RF) detectors, offer a non-invasive alternative by identifying active mobile signals within restricted areas (Nazari et al., 2019). However, existing systems face limitations, including short detection ranges (1 – 4 meters) and susceptibility to signal interference (Sitati et al., 2016). For instance, Sitati et al. (2016) developed a capacitor-based RF detector with a 4-meter range, while Nazari et al. (2019) highlighted the challenges of distinguishing multiple frequency bands in crowded environments.

Furthermore, Farooq et al. (2022) introduced a mobile phone detection system using Software Defined Radio (SDR) technology. The SDR-based system offered high sensitivity and configurability, but its implementation was costly and required technical expertise beyond what most academic institutions could afford. To improve detection accuracy and signal classification, machine learning has been integrated into newer systems. Patel and Sharma (2021) proposed a deep learning model trained to identify mobile phone signals from background noise. Their experimental results indicated that the model could effectively detect active phones within a 4-meter radius, aligning with the goal of confined area monitoring.

The research problem centers on optimizing detection accuracy and range while minimizing false alarms. Current systems often fail to differentiate between legitimate signals (e.g., Wi-Fi) and unauthorized mobile transmissions (Ataro et al., 2016). Additionally, devices in silent or flight modes evade detection, necessitating complementary technologies like magnetic-field scanners (Ataro et al., 2016). This study aim to evaluate the effectiveness of an active mobile phone detection system in academic environments by: (1) assessing detection accuracy within a 4-meter radius, (2) analyzing system responsiveness to various phone models and signal strengths, and (3) exploring practical deployment challenges. The scope of this study focuses on RF-based detection systems in examination halls, excluding jamming technologies due to ethical and regulatory constraints. Limitations include environmental interference from nearby electronic devices and the inability to detect phones in offline modes (Nazari et al., 2019). Addressing these gaps will contribute to scalable, cost-effective solutions for academic institutions, particularly in developing regions where resources are constrained (Sitati et al., 2016).

MATERIALS AND METHODS

Materials

The items in the block diagram (Fig. 1.0) below are the components that are used to make an active mobile phone detection system functional in a school. The block diagram (Fig. 1.0) illustrates a system that employs magnetic detection and RF detection in mobile phone detection.

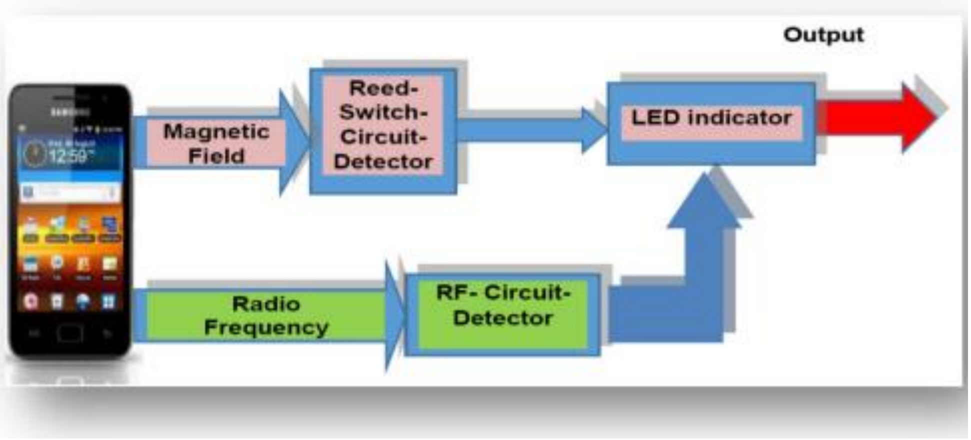

Figure 1: combination of magnetic detection and RF detection (Ataro et al., 2016)

Magnetic Detection

Cell phones generate micro magnetic fields because of their electronic circuits (e.g oscillators and speakers). These fields are detectable by magnetic sensors, regardless of whether the phone is in airplane or silent mode (Arya & Vinod, 2021). The characteristics of magnetic detection are as follows:

i. Magnetic Field: Mobile phones generate extremely weak magnetic fields due to the flow of electric current through their circuits (e.g., during a voice call or use of Wi-Fi or mobile data (Ataro et al., 2016). The detection equipment is capable of detecting variations in the surrounding magnetic fields. A magnetic field sensor, such as a Hall effects sensor, is able to detect such variations, especially when the device is on or being used for transmission.

ii. Reed Switch Detector Circuit: A reed switch is an electromechanical device that makes or breaks its contacts when it is exposed to a magnetic field. The device may be used as a trigger in the detection circuit. When brought close to the magnetic field from a mobile phone specifically from its speaker or internal coil the reed switch makes its contacts, thus energizing the circuit (Simiuy et al., 2016).. This technique is an easy and power-conserving way of ascertaining if a magnetic source, such as a cellular telephone, is nearby.

Radio Frequency (RF) Detection

This system identifies radio frequency signals emitted by mobile phones while communicating (e.g., Wi-Fi, cellular networks, and Bluetooth). It is able to detect active transmissions like phone calls, SMS, or data use (Jamila et al., 2023). The RF detection system includes the following components:

i. Radio Frequency (RF): Mobile phones emit RF across a range of frequencies, for example, GSM 900/1800 MHz, and 3G, 4G, and Wi-Fi frequency bands. The system would be configured to detect these frequencies through antennas or RF sensors. Detection of RF signals is a direct method to check if a mobile phone is currently transmitting, which is suitable for detection of both active and unauthorized use in classrooms (Jamila et al., 2023).

ii. RF Circuit Detector: It is a detector device employed to pick up electromagnetic signals of radio frequency ranges that are widely used by mobile telecommunication devices. Its constituent elements consist of: an RF signal pickup antenna, band-pass filters for eliminating unwanted frequencies, amplifiers for amplifying weak signals, and detection circuits (such as diode detectors) for converting RF to a usable level of voltage (Simiuy et al., 2016). As soon as the mobile phone emits RF, the circuit can detect it and respond accordingly.

iii. LED Indicator: The visual warning system of the circuit. The RF or magnetic circuit, upon detecting the presence of a phone, activates the LED (Edwin et al., 2016).

Other materials used to build and set up the active mobile phone detection system include the following:

i. Mobile Phone: A device for wireless communication that sends or receives RF-signals. The system aims to detect its presence. This study used a Samsung Galaxy Ace S5830 smartphone running Android 2.2 OS as a test tool. Android is an operating system based on Linux for touchscreen mobile devices like smartphones and tablets (Sujith, 2014).

ii. Battery 9V: The 9-volt battery, in its most common form, came out for early transistor radios. It has a shape like a rectangular prism with smooth edges and a snap connector at the top that fits one way (Edwin et al., 2016).

Combining magnetic and RF detection offers a strong way to spot mobile phones in school settings. However, to use it well, though calibration and ethical considerations are necessary for optimal implementation.

Figure 2: Smartphone Samsung Galaxy Ace S5830

Figure 3: 9V DC Battery (Edwin et al., 2016)

Methodology (Step by Step Method)

This section describes our process to design, construct, and evaluate an active mobile phone detection system for an academic environment. We planned our strategy to ensure the system's effectiveness, reliability, and practical use. The methodology began with a continuity test of all electronic components to ensure they were functional and free from factory defects.

Circuit Diagram Design and Modification

In this step, the circuit diagram used for the project was adopted from an existing design previously developed by another source. However, to improve its suitability for our objectives, we implemented minor alterations. We adjusted some component values and incorporated a pre-amplifier into the original design.

Fig. 4 displays the modified circuit diagram. We maintained the core concept from the original design, but our modifications enhanced the circuit's performance for this study. This resulted in improved overall functionality and dependability.

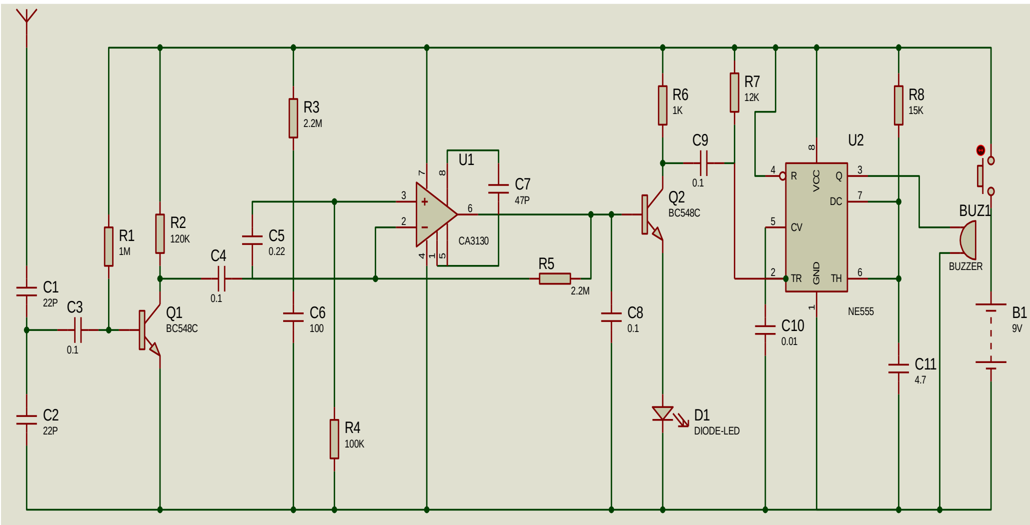

Figure 4: Circuit Diagram of Mobile Phone Detector Muftahu, S. (2018)

The circuit in Fig. 4 shows how these components are interconnected. The antenna receives RF signals emitted by nearby mobile phones (in the range of 0.9–3 GHz). These signals are filtered and fed into a transistor-based amplifier. Once a threshold voltage is achieved, the circuit activates the LED indicator, signaling phone detection.

Circuit Assembly on Breadboard

In order to conduct an experimental test, the circuit was initially put together on a breadboard. To guarantee precise detection, this step made it simple to tune component values, troubleshoot issues, and make adjustments. This non-soldered setup allowed for easy modifications and troubleshooting, enabling a functional prototype of the circuit to be tested before final implementation. Fig. 5 illustrates the physical arrangement:

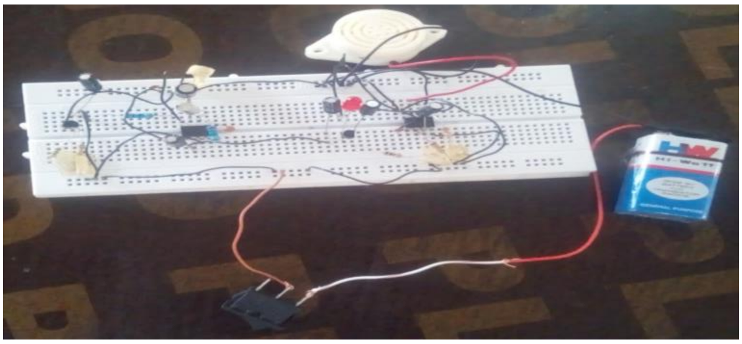

Figure 5: Bread board layout showing the arrangement of discrete components Muftahu, S. (2018)

Circuit Assembly and Soldering on Vero Board

The confirmed circuit was permanently put together on a Vero board following successful breadboard testing. To minimise signal loss and guarantee solid electrical connections, components were soldered with care. This stage guaranteed a robust and dependable hardware configuration appropriate for additional integration and casing. Fig. 6 illustrates the physical arrangement:

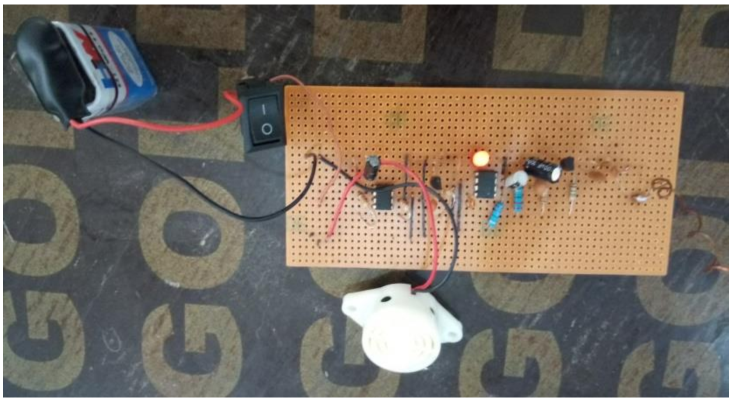

Figure 6: Vero board layout showing the arrangement of discrete components Muftahu, S. (2018)

Circuit Enclosure and Casing

The assembled circuit was housed in a durable plastic casing to protect it from physical damage and external interference. Openings were made for the antenna, LED indicators, buzzer, and power switch. Finally, the casing was closed and labeled appropriately to enhance usability and provide information on the circuit's function. This step ensured the final product was both functional and professionally packaged for operation or demonstration. Fig. 7 illustrates the physical arrangement:

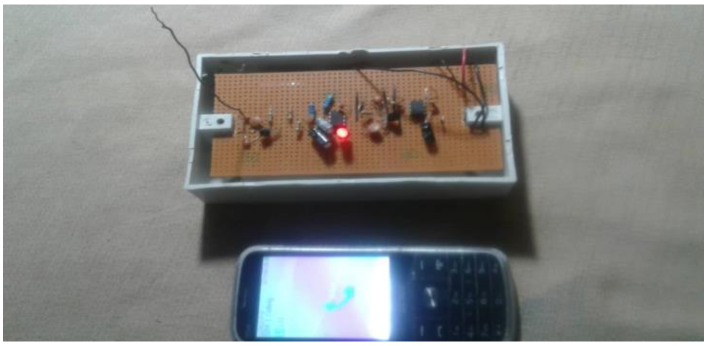

Figure 7: Mobile phone detector inside Casing Muftahu, S. (2018)

RESULTS AND DISCUSSION

Result

The electrical components were used to design an optimized detector circuit and tested accordingly. The circuit in detection mode can detect the radio frequency (RF) from 0.9 to 3GHz which is the RF signal range required for cell phone operation, and the LED will start blinking. The test results are analyzed and verified using cell phones. From the result obtained, it shows that, each component has a certain value when there is no signal near the detection area or when there is no activated cell phone as shown in table 4.1. The reason is that the battery supplies the voltage, and that voltage flows through the circuits of all the components. In the presence of a signal, the voltage of each component varies due to variations in the supply voltage due to differences in the power consumption of each component. Some of the components used in the device are active, while others are passive.

Table 1: Voltage Values across each Component

S/N	COMPONENTS	VOLTAGE in mV (When no signal)	VOLTAGE in mV (When signal)		
1	Buzzer	1.78	3.5	2.75	1.78
2	LED	1.0	88	88.8	90
3	C1	4.80	6.5	6.7	6.8
4	C2	1.50	4.35	4.5	4.8
5	C3	2.10	3.96	3.98	4.1
6	NE 555	6.32	5.80	5.72	5.62
7	C4	3.8	4.5	4.6	4.8
8.	C5	6.5	420	430	450
9.	C6	1.3	3.8	4.0	4.5
10.	C7	3.0	3.8	3.9	4.2
11.	C8	1.5	5.0000	5.200	5.900
12.	C9	1.8	13.9	14.1	14.3
13.	C10	1.6	4.9	5.2	5.4
14.	C11	1.6	5.9	6.03	6.13

Discussion

The testing result of the cell phone detector shows that if no calls were received and no messages (SMS/WhatsApp) were sent to the cell phone near the detector, the red LED did not light up and no emission was observed. However, when a call is received or an SMS or WhatsApp message is sent, the red LED lights up and continues to flash until the communication between the two phones ends. We also observed that the intensity of the red LED illumination decreased as the phone moved away from the detector and eventually disappear.

Also, the detector response depends not only on the distance but also on the phone type/model. Based on cell phone detector test results, three types of cell phones (Techno F1, Nokia 200 and Samsung Galaxy Ace S5830) were found to cause LED flashing within a distance of 4m.

However, the Infinix 556 phone caused the LED to blink at a range of 2m. This is because some phones have high shielding that cannot be easily detected, and some phones cause the red LED to flash momentarily higher intensity than others at the same distance. Its performance validates the concept of using active RF signal detection as a tool for enhancing discipline and academic integrity in educational institutions. However, the study also highlights the need for environmental calibration and future integration with signal filtering techniques or directional antennas for better accuracy.

The effective range of the detector (2–4 meters) aligns with findings from Osahon & Adebayo (2020), who specified 3 – 4 meters as optimal for coverage for each room. The failure of the present study to detect phone calls during an idle or airplane mode is consistent with limitation noted by Ataro et al. (2016) and Nazari et al. (2019). Environmental calibration need supports the claim by Osahon and Adebayo (2020) that, detection systems should be adapted to the architectural and environmental features of learning settings.

The present research reports a novel observation regarding the influence of various models of mobile phones (Techno, Nokia, Samsung against Infinix) on detection range and LED brightness. This specificity was not addressed by earlier research. Most of the prior researches are associated with detection systems in terms of sound (Audio buzzer). However, the current research creatively adds detection via LED light illumination, hence making it more convenient in the conventional learning setting. The inclusion of WhatsApp message detection in this study is a remarkable achievement, particularly given that previous research focused largely on normal phone calls or SMS.

CONCLUSION

The integration of mobile phone detection systems in academic environments presents a promising solution to curb unauthorized phone usage, particularly in examination halls and other restricted areas. The studies review demonstrated that both Radio-Frequency (RF) detectors and Reed-switch-based scanners offer viable and cost-effective methods for detecting mobile phone activities, even when devices are in silent or flight modes. The RF detector, with a range of up to 4 meters, effectively identifies incoming/outgoing calls, SMS, and data transmissions, while the Reed-switch scanner detects phones via magnetic fields, including those switched off. These systems address critical challenges such as academic cheating, privacy invasion, and security threats in sensitive locations.

Despite their advantages portability, affordability, and simplicity the current prototypes have limitations, including restricted detection ranges and susceptibility to environmental noise. Future enhancements could focus on extending operational range, improving signal discrimination, and adapting the technology for modern networks (e.g., 4G/5G and Bluetooth). Additionally, combining these detectors with institutional policies and awareness campaigns could foster a holistic approach to mitigating mobile phone misuse in academic settings.

RECOMMENDATIONS

i. Technical Improvements: This includes a. the increase of detection range of RF-based systems to 15+ meters using advanced sensors (e.g., MEMS technology). b. Develop directional detection capabilities to pinpoint phone locations and reduce false alarms. c. Enhance compatibility with newer communication technologies (4G/5G, Bluetooth) and encrypted signals. d. Optimize antenna design and noise-reduction algorithms to improve accuracy.
ii. Policy and Implementation: The policy implementation includes a. Integrate detectors with existing exam protocols (e.g., scanning at entry points) to minimize physical inspections. b. Conduct periodic student/staff awareness programs on the consequences of cheating and phone misuse. c. Explore hybrid solutions, such as jamming signals in exam halls while allowing emergency communications.
iii. Research Directions: comprises these: a. Investigate methods to detect preloaded content on phones without network connectivity. b. Test detectors in diverse environments (e.g., hospitals, government facilities) to validate scalability.

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