

## ORIGINAL RESEARCH

# Workplace and human resource safety monitoring using internet of things

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## ABSTRACT

The subject of safety and security of Human Resource (HR) of corporate organizations is a major concern due to the sudden rise in crimes, accidents and various hazards associated with workplaces and the society in recent times. This paper proposes a system for monitoring HR activities and movements in the workplace in real time. The proposed system employs the use of Internet of Things (IoT) wearable devices which are made up of Arduino Uno microcontroller, wireless Radio Frequency Sensors (RFS), Radio Frequency Identification (RFID) tags/readers and Global Positioning System (GPS) modules. The system aims at tracking, locating and keeping the log of the activities and movements of employees at any instant thereby providing information required by employers and security agencies to ensure timely intervention in case of emergency and urgent evacuation.

**Key Words:** GPS, IoT, Radio Frequency Identification, Sensors, Wearable Technology

## 1. INTRODUCTION

Safety and security play an important role in the workplace; hence it is necessary to constantly monitor work environment and activities of HR in order to prevent accidental losses, kidnapping and other societal vices. Every organization is expected to have safety assurance experts who are saddled with the responsibility of checking and confirming whether the workplace is safe and secure for the employees to carry on with their daily tasks. In recent times, several countries have prioritized the need to ensure and guarantee safe and secure work environment by proposing and enacting laws, regulations and policies tailored towards environmental care and human safety. In spite of all these efforts, the number of industrial accidents has been on the increase in the last few decades and the current scenarios in the industry have not improved. It tends to be a more dangerous environment rather

than a safe one even with a wide range of modern technologies. Recently, safety experts and industrial unions have been demanding sophisticated instrumentation for monitoring the workplace environment and control of environmental risk parameters in the danger-prone areas. The overall success of industries and organizations is closely related to the safety and wellbeing of its human resources and infrastructure.<sup>[1,2]</sup>

International Labor Organization (ILO) reported that about one hundred and fifty-one labourers face workplace accidents every fifteen seconds. According to ILO reports, globally, a striking three hundred and seventeen million non-fatal workplace-related accidents and occupational hazards occur every year and about three hundred and twenty-one thousand workers die annually from workplace-related mishaps. Workplace accidents are a major problem affecting businesses all over the world and over US \$170b are lost annually to

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workplace hazards.<sup>[3,4]</sup>

In spite of safety regulations and rules, accidents do occur on a daily basis in the workplace. In recent times, the rising spate of terrorism, kidnapping and insurgency have affected in no small measure the safety of the workplace. For example, in Nigeria, several workers have been kidnapped and many of them killed in the course of their duty. Government and organizations are incurring on a daily basis huge financial loss occasioned by the death of well-trained employees and difficulties caused by inability to replace lost skilled manpower. The workplace is daily bombarded with several hazards such as chemical exposure, equipment mishaps, fatigue, heat stroke and fatal falls, indeed the list is inexhaustible.<sup>[5]</sup> Even with the enactment of robust regulations and extensive training alongside conventional personal safety equipment, safety practices and regulations do not inform workers when external environments suddenly turn dangerous.<sup>[1]</sup>

The evolution and recent developments in the field of Real Time Location System (RTLS) have led to its usage for many purposes. The identification, traceability and real-time tracking of people and goods have always been difficult, because of the heterogeneity of platforms and technologies used by various actors of the system. The advent of the Internet of Things (IoT) and cloud computing bring a new approach, enabling the collection, storage and transfer of information on logistics flow for better cooperation and interoperability.<sup>[6-8]</sup> IoT is the network of physical objects such as devices, vehicles, buildings and other items embedded with electronics, software, sensors and network connectivity that enables these objects to collect and exchange data. It can be expressed further as an internetwork of physical objects embedded with sensors, computers, connectivity and actuator that enables the objects to acquire data, transform it into knowledge, make intelligent decision and generate physical actions to manipulate the environment. The introduction of IoT and smart, connected devices are now giving rise to the evolution of a smart workplace which is expected to ensure the safety and security of the HR and at the same time protects and ensure the profitability of the capital investment.<sup>[9]</sup>

IoT has sensors at the core of their functionality. Using internet of things (IoT) to connect things, service, and people for intelligent operations has been discussed and deployed in many industry domains such as smart city, smart energy, healthcare, food and water tracking, logistics and retail, and transportation. However, scarce information is available for IoT usage in industrial automation domain for reliable and collaborative automation with respect to monitoring the movement of HR in the workplace and provision of data to management for employee safety and security.<sup>[2]</sup>

In most cases, workplace accidents are preventable if the status of employee is continuously monitored. By adopting technology with the help of IoT devices and hybrid solutions, one can monitor and send across safety information which includes employee's biometrics.<sup>[8,9]</sup> This will help companies reduce their insurance cost through enhancing workplace safety in a smart and effective manner. Since workplace safety is a top concern, development and collaboration of IoT technologies will be critical for companies and organizations to invest in.

This research developed a system for the real-time monitoring and tracking of the activities of HR in the workplace by using a hybrid of various positioning technologies and methods in order to cover the different workplace environments and scenarios. The work takes into cognizance the peculiarity of the various workplace scenarios and proposed the most suitable technologies and methods after comparing them with existing systems.

## 2. RELATED WORKS

Ref. [10] presents a hybrid positioning system comprising GPS and RFID technologies. The merits of GPS and RFID positioning systems were reviewed and harnessed to complement each other in the development of a hybrid system. Existing literatures revealed high performance and acceptability of GPS in outdoor navigation while RFID was found to perform very well in indoor environment. If the device goes out of the coverage of GPS it switches over to RFID system which is made up of RFID tags and readers. The RFID tags stores data and this is accessed by the reader through wireless communication. The hardware part of the project is RFID tags, RFID reader, graphic LCD, GPS system and microcontroller. Passive RFID tags are installed on the road sides while the readers are installed in the vehicles. Once the reader gets close to any fixed tag, the reader will read the tag data and communicate this to the controller using the UART module. The controller displays the current location of the vehicle on the graphic LCD based on the latest information received from the reader. In places where there is access to the GPS, current location data are received from the GPS module and displayed on the graphic LCD. However, the research was only limited to passive RFID tags which are incapable of functioning in the absence of a reader and the output uses a graphic display which is not Internet-enabled and hence the location cannot be viewed online.

Refs. [11,12] present the development of a system that caters for the tracking, safety and security of military men on the battlefield. The authors were motivated by concerns regarding the safety of soldiers on the battlefield and their inability to communicate with the control room when they are in dan-

ger. There exist inadequate coordination and planning of war strategies due to lack of information about personnel on the field and absence of soldier-to-soldier communications. The position of the soldier on the field is calculated from the geometric relationships based on the data received wirelessly from the RF transceiver. Two units were designed namely: the base station unit and the soldier unit. A 32 bits ARM7 TDMI CPU, Microcontroller with 512kb high speed flash memory, Biosensors, GPS receivers, PC running Visual Basic for the front end. A major limitation of the work was that there was no provision made for monitoring the soldiers when they are in place where there is no line of sight to the satellite.

The authors in [13] present a GPS system for object tracking. The research was motivated by the need for location awareness, object tracking and navigation. The advent and development of GPS by the US Department of Defense made the technology primarily for military purposes but the liberalization of GPS technology has opened it up for use in other areas of human endeavours. The authors explored the concept of GPS technology with the aim of understanding its peculiar features and applications. A detailed comparison of different navigation algorithms such as localization algorithms, Particle Filter (PF) and Kalman Filter (KF) algorithms was carried out. Object tracking technologies such as RFID, GPRS, WSN, GPS and GIS were also reviewed. From the review of various literatures, the authors were able to reveal basic methods for object tracking on GPS which are: object tracking using GPS, object tracking using GPS and GSM and object tracking using RFID. The authors contributed to knowledge by presenting an interesting review of GPS, localization improvement algorithm and Kalman filter algorithm and their application in object tracking. The limitation of the research is that discussions were only theoretical and no practical design or implementation carried out.

Ref. [14] presents an RFID and RTLS-based HR monitoring system. The authors were motivated by the need to adopt the use of RFID technology for human activities monitoring considering its successful utilization in other areas such as fleet management, vehicle tracking, asset tracking and so on. Also, there is the need to properly and objectively assess and evaluate the performance of employees and to get rid of the subjective nature of the traditional method of assessment. The methodology adopted include distance measurement, location estimation and development of the location optimization model. The research used a hybrid of two popular distance measurement of Time of Arrival (TOA) and Received Signal Strength Indicator (RSSI) techniques. The research contributed to knowledge by providing an online RFID personnel hourly duty and availability monitoring system. However, no provision was made for some jobs that

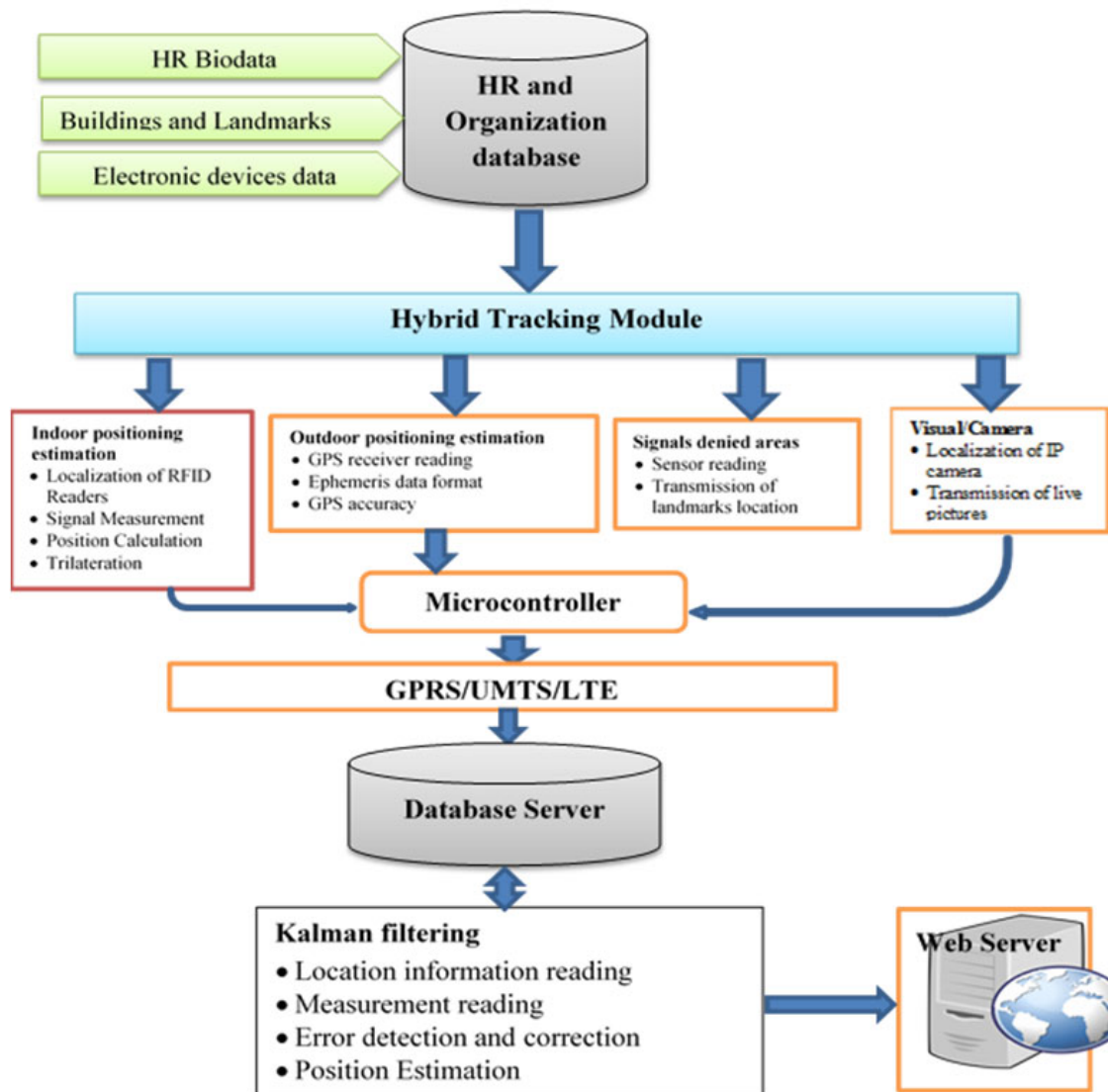
do not require that people should be within a building and the proposed system lacks mobile application.

The Ref. [15] presents the design of a framework for combating human trafficking and kidnapping using smart objects and Internet-of-Things. The research was motivated by the incessant and alarming incidences of kidnapping, abduction, human trafficking and societal violence. The research provided a framework for real-time ubiquitous monitoring of human location and recognition. It proposed a model for the heterogeneous positioning system using smart technologies. A rich literature on positioning and IoT systems is presented in the research. The proposed framework was not implemented, so it could not be evaluated for its effectiveness and efficiency in combating the menace of human kidnappers and traffickers.

Ref. [16] presents the use of IoT in for safety and efficient monitoring of underground miners. The research used different sensors network based on MEMS to monitor the surrounding parameters of underground mines and values are transferred to ARM7 Microcontroller Unit. When a critical condition is detected, alert is given by the system and the same statistics is communicated to webserver by initiating ESP8266 module based on Wi-Fi communication. The detected variations in the values are displayed on webserver page that makes easier for the underground control center to monitor and to take essential instantaneous action to prevent severe damage.

### 3. ARCHITECTURE OF THE PROPOSED SYSTEM

The architecture of the proposed system as shown in Figure 1 comprises of three sub-systems namely: HR and workplace database, localization and positioning data generation and hybrid location filtering and estimation engine. The HR and workplace database comprises of the personal information of every HR in the organization, the physical structures, important landmarks and all the IoT devices specifications. The localization and positioning data generation subsystem is made up of the wearable IoT devices, the transmission media which is made up of the hybrid tracking module, GPS, GSM, microcontroller, indoor, outdoor, signal-denied areas and visual camera estimation subsystems. The GSM network can either be Universal Mobile Telecommunication Service (UMTS) or Long-Term Evolution (LTE) depending on the type of GSM service available at the time of transmission. The hybrid location engine comprises of database server, Kalman filtering system which carries out the location information and measurement reading, error detection, correction and position estimation. The web server is used for online display and monitoring of HR activities.



**Figure 1.** Proposed System Architecture

#### 4. SYSTEM DEPLOYMENT

The type and specification of the IoT devices used for the research depend on the workplace environment in which the HRs are located. In the indoor environment, passive RFID was used and for the outdoor environment; camera, RF sensors and GPS modules were used for monitoring and tracking of HRs. The positioning algorithms used for the research were Time of Arrival (ToA), Received Signal Strength Indicator (RSSI), Trilateration and Kalman Filtering. A hybrid of ToA and RSSI was used for signal measurement, position calculation and sensors localization while Trilateration and Kalman Filtering were used in position estimation, error detection and correction. Due to the heterogeneous nature of the working environments, that is, outdoor and indoor, the details of the hardware and software functional requirements and technical specifications used for the research are stated

as follows.

##### 4.1 Hardware Specifications

**a. Outdoor Environment:** The location of HR is monitored by using the SIM908 GPS module. Outdoor environment provides direct access to the satellites hence the use of GPS which has been found to perform very well in satellite navigation. SIM908 GPS has an industry standard interface that allows seamless tracking of variable assets at any time within signal coverage. It has a super long standby time made possible by the use of Li-Ion batteries. Other notable features of the module is the possession of a Quad-Band GSM/GPRS functionality which enables it to combine GPS and GSM for satellite navigation. The module signal reception sensitivity is very high due to the possession of sixty six acquisition receiver and twenty two tracking receiver channels. Figure 2 shows the pictures of the devices.

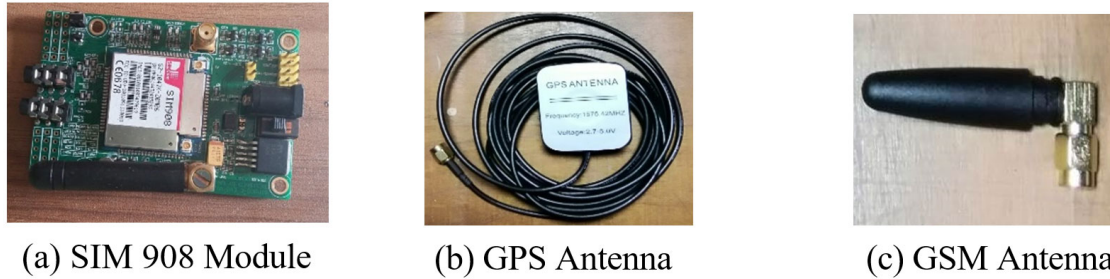


Figure 2. Outdoor Monitoring Devices

**b. Indoor Environment:** Long range RFID reader with supports for multi-detection and high baud rate antennas and passive tags are used for the monitoring of the location of HR in the indoor environment. The reader supports multi-detection, offers a high baud rate from 9600 bps to 115,200

bps and can detect a tag up to a distance of 150m. Figure 3 shows the pictures of RFID devices while Table 1 and Table 2 depicts the technical specifications for the indoor tracking devices.



Figure 3. Indoor Monitoring Devices

Table 1. Specifications of Long Range UHF Integrated RFID Reader

Item	Specification
Operating temperature	-40°C to 85°C
External interface	2 RJ45 socket, 1 Mini USB type socket
Network Protocols supported	TCP/IP, SNMP, DHCP, DNS
Communication Frequency	865.6 Mhz – 867.6 Mhz
Transmission power	4W ERP
Receive Frequency	433.92MHz
RF Input	60 Ohm BNC
Antennas	4 ports for 4 read points, multistatic topology, circular or linear polarization, reverse polarity TNC connectors

Table 2. Specifications of Passive tag

Item	Specifications
Communication Frequency	860 – 960 Mhz and 902Mhz – 928Mhz
Sensitivity	-17dBm
Supported Standards	GS1 EPC Class 1 Gen 2 Version 2 ISO 18000-63
Antenna power	1 dBi linear (along long axis of the tag)
Supported Temperature	-30°C to + 90°C
Recommended Bending Radius	60mm
Dimensions	92 mm × 24 mm × 1.5 mm
Weight	< 2g

forest, riverside and difficult terrains. Due to topographic structures of these places and aerial blockages caused by trees and other tall objects, GPS signals are non-existent. Also, the environment does not allow installation of RFID readers hence the use of battery-powered and weather-resistant Radio Frequency (RF) proximity sensor reader. RF proximity sensor reader uses Ultra High Frequency (UHF) RFID technology and has a low power consumption rating. The presence of high sensitive customized double-antenna sensor tag makes it suitable for the detection and reading of the presence of passive RFID tags once it comes within its coverage area. Figure 4 shows the proximity sensor and its internal circuit.



Figure 4. Proximity Sensor

**c. Signal-denied environments:** These are areas such as

**d. HR Identity Authentication:** In order to prevent identity theft or situations whereby tracking devices get to wrong

hands and impostors, camera is used to authenticate the real identity of the person wearing the tracking device. Hikvision IP cameras are installed in strategic locations for capturing visual images of persons in transit within the coverage area of the testbed. The indoor cameras are used inside buildings while outdoor cameras are hung on masts and other tall objects for good aerial view. The captured images are compared with the images of HR stored in the database in order to know the exact person in transit. Figure 5 shows the picture of the Hikvision IP indoor and outdoor cameras. The technical specifications for the indoor and outdoor cameras used in the research are stated in Table 3 and Table 4 respectively.



(a) Indoor Camera (b) Outdoor Camera

Figure 5. Hikvision Cameras

Table 3. Specifications of Hikvision DS-2 Fixed Network Indoor Camera

Item	Specifications
Image Sensor	1/3" Progressive Scan CMOS
Max. Resolution	2688 × 1520
Storage	Built-in micro SD/SDHC/SDXC card slot, up to 128 GB
Infrared Lens	11
General features	Line crossing detection, intrusion detection and face detection, Motion detection, video tampering alarm, exception (network disconnected, IP address conflict, illegal login, HDD full, HDD error)
External Interface	1 RJ45 100M self-adaptive Ethernet port
Network protocols supported	TCP/IP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, PPPoE, NTP, UPnP™, SMTP, SNMP, IGMP, 802.1X, QoS, IPv6, UDP, Bonjour, SSL/TLS
Frame rate	2688 × 1520@30fps

Table 4. Specifications of Hikvision Varifocal WDR IP Camera

Item	Specifications
Image Sensor	1/3" Progressive Scan CMOS
Power Supply	12 VDC, 5.5 mm coaxial power plug; PoE (802.3af, class 3)
Shutter Speed	1/3 s to 1/100,000 s
Angle Adjustment	Pan: 0° to 355°, tilt: 0° to 90°, rotate: 0° to 355°
General features	Anti-flicker, three streams, heartbeat, mirror, privacy masks, password reset via e-mail, pixel counter, HTTP listening
External Interface	Ethernet 10Base-T/100Base-TX, IEEE 802.11g, IEEE 802.11n
Video quality/frame rate	50Hz: 25fps (2688 × 1520, 2560 × 1440, 2304 × 1296, 1920 × 1080, 1280 × 720) 60Hz: 30fps (2688 × 1520, 2560 × 1440, 2304 × 1296, 1920 × 1080, 1280 × 720)

**a. Microcontroller and hybrid tracking device:** Arduino Uno Rev3 is a member of ATmega328P family of microcontrollers. Rev3 is the most robust, documented and widely used member of the Arduino Uno series. It has an operating voltage of 5V with clock speed of 16MHz, a typical one is shown in Figure 6. The twenty input/output pin is made up of fourteen digital and six analog input/output pins respectively. With a length of 68.6mm, width of 53.4mm and weight of 25g, it is very useful for the development of wearable device.

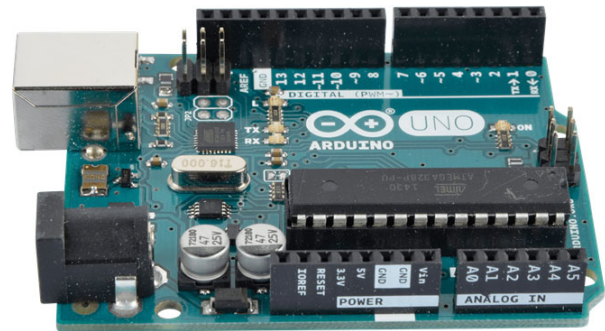


Figure 6. Arduino Uno Rev3

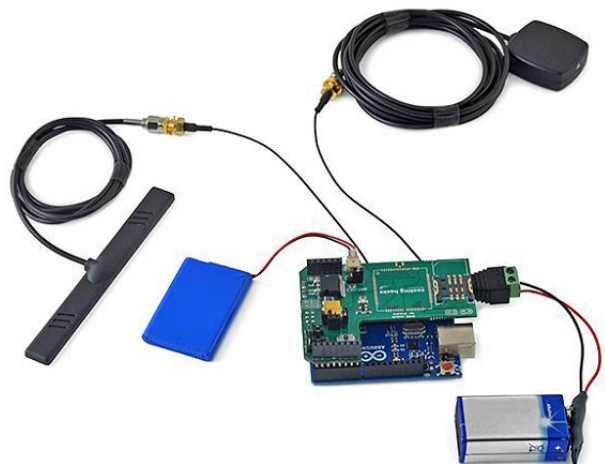


Figure 7. Hybrid Tracking Module

**b. Web Server:** HP ProLiant ML10 Server hosts the Windows 10 operating system, the web applications and the proposed system. It is a dual core processor server with 4GB RAM and 1TB SATA hard disk drive.

**4.2 Software Requirements**

Python programming language, MySQL, XAMPP and Google Map API are used for the development of the system. Python is used for development of the back-end web application and this includes the use of python libraries for facial recognition, position estimation and IoT devices communication.

MySQL is used for the creation of databases for HR bio-data, physical infrastructure and IoT devices. The ability of MySQL to perform very well in real-time applications makes it suitable for use as the database for location information readings and position estimation data generated by the system.

Google MAP is connected to the MySQL database using Maps JavaScript API for the display of real time position of HRs on the map.

XAMPP is the all-in-one local web server package which contains Apache web server, PHP which is used for the development of the front-end web application and MySQL which is the database.

### 4.3 Testbed

The testbed used was a microcosm of the real-world working environment. It is the western campus of Adekunle Ajasin University, Akungba-Akoko, Nigeria. It is situated within the following satellite coordinates (7.482926N, 5.737127E), (7.485909N, 5.766927E), (7.477880N, 5.737084E) and (7.475679N, 5.766220E). Figure 8 shows the aerial view of the testbed as given by Google map.

Indoor location and position monitoring is carried out by RFID readers and indoor IP cameras which are installed at the entrances of selected buildings for the measurement of

the entry and exit of HRs (Figure 9a). Outdoor location and position monitoring is carried out by using GPS satellites and outdoor IP cameras which are mounted on communication masts within the university premises to capture images of HR on motion (Figure 9b). Proximity sensors are installed in areas where RFID readers could not be installed due to environmental factors and which are at the same time barred from GPS signals.



Figure 8. Map of Adekunle Ajasin University, Akungba-Akoko

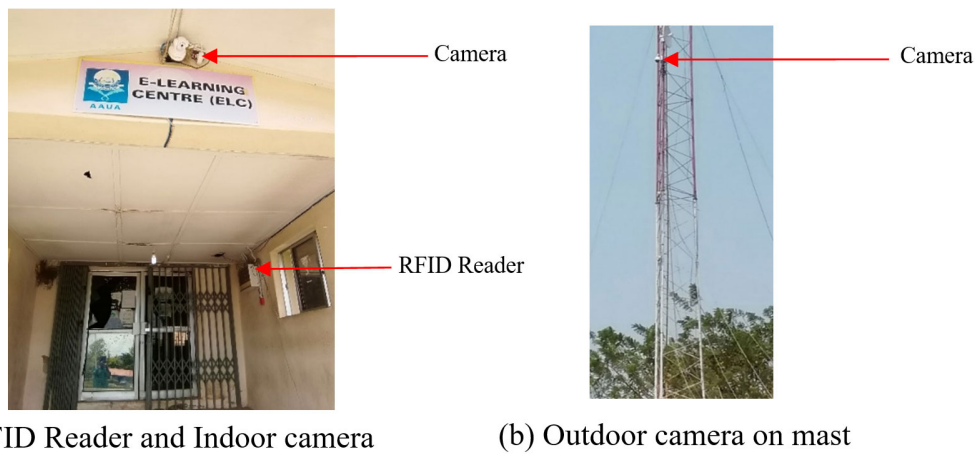


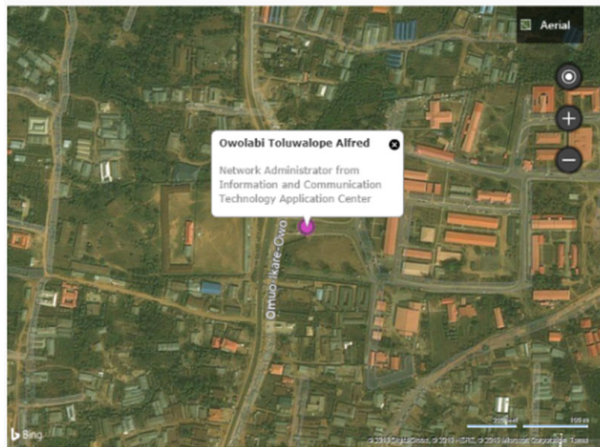
Figure 9. Location of RFID Reader, Indoor and Outdoor Cameras

## 5. RESULTS AND DISCUSSION

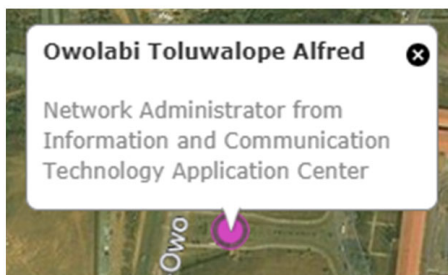
### 5.1 HR Instant Location Tracking

HR managers need to know the instant location and whereabouts of any HR at any point in time in case of any emergency or hazard, this is achieved by activating the real time page of the system and by clicking on the HR name in the profile tab, instant location of the HR is shown on the map. The snapshot is shown in Figure 10.

The ‘GPS marker’ shows the presence of HR at the location. The identity and details of the HR whose location is represented by that marker is obtained by hovering the mouse pointer over the GPS marker, thereby displaying the details of the HR as shown in Figure 11.



**Figure 10.** Location of RFID Reader, Indoor and Outdoor Cameras



**Figure 11.** Identity of Tracked HR

**5.2 Instant Location of all HRs**

In order to know the number of HRs that are present in the workplace at an instant and their respective locations, HR managers obtain this by clicking on Profile tab and pick the ‘ALL ACTIVE HRs’ button. The output shown on the map in Figure 12 is the physical location of all HRs that are within the experimental testbed at an instant time.



**Figure 12.** Locations of Active HRs

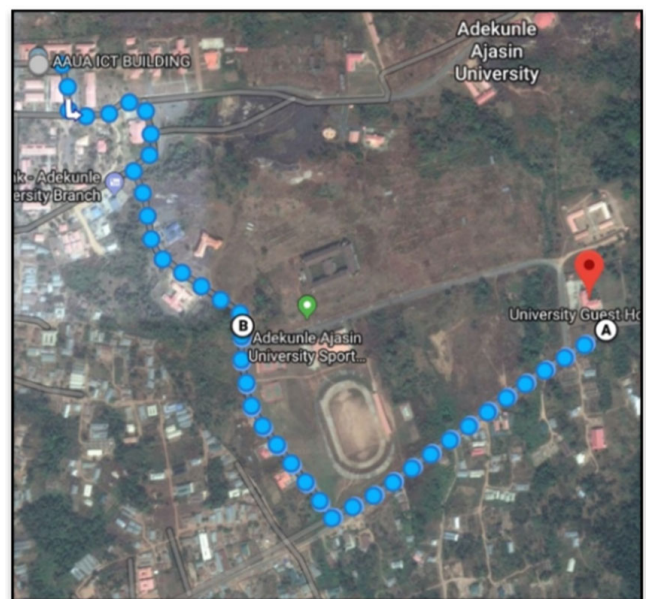
By placing the mouse pointer on the GPS markers, the identity of the HRs depicted by the GPS markers are revealed as demonstrated in Figure 11. The instant locations and identities of HRs in Figure 12 are shown in Table 5.

**Table 5.** HRs Location and Corresponding Satellite Coordinates

HR_ID	Department	Location	Satellite Coordinates
aauaict017	Software	Faculty of Agriculture	7.480986N, 5.739356E
aauaict009	Network	AAUA CBT Centre	7.480986N, 5.739356E
aauaict010	Network	AAUA CBT Centre	7.480986N, 5.739356E
aauaict002	Administration	ICTAC	7.482184N, 5.741238E
aauaict003	Administration	ICTAC	7.482184N, 5.741238E
aauaict013	Network	ICTAC	7.482184N, 5.741238E
aauaict015	Network	Access Bank	7.479479N, 5.742752E
aauaict012	Network	Library	7.483575N, 5.752748E
aauaict008	General Services	Faculty of Agriculture	7.483773N, 5.750815E
aauaict001	Administration	Senate	7.480462N, 5.756469E
aauaict025	Software	Senate	7.480462N, 5.756469E

**5.3 Movement Route**

Tracing the route taken by any HR is obtained by clicking on the button ‘Profile’. This opens a new page where the list of all HRs is displayed, by clicking on the HR whose route is to be monitored, the route for the day for that HR is depicted on the Google Map as shown in Figure 13. The information obtained is helpful in cases of abduction and missing HRs.



**Figure 13.** Movement route for HR

**5.4 HR Facial Recognition**

The system obtains the facial images of HRs through the use of IP camera. The cameras were installed at the entrance of



each building in such a way that it will be easy to capture the faces of HRs entering the building as shown in Figure 14. The camera detects the facial images of HRs entering the building and the captured images are compared with the stored images in the database as shown in Figure 15. This is necessary for the verification of the identity of the HR bearing the IoT wearable device. This feature addresses the problem of identity theft and impersonation.



**Figure 14.** Camera Images for Person Entering a Building



**Figure 15.** Comparison of Database Image and Camera Image

### 6. COMPARATIVE ANALYSIS WITH EXISTING SYSTEMS

The functionality and versatility of the system was tested based on the major requirements of localization system. The results obtained were compared with other existing systems. The comparisons were based on the environment where they were deployed, that is, either indoor or outdoor and the metrics considered were technologies used, algorithm, accuracy, complexity, scalability, robustness and cost. Table 6 and Table 7 show the comparison of the system with other existing systems by taking into cognizance the environment used.

**Table 6.** Comparative Analysis of Systems in Indoor Environment

System	Technologies	Positioning Algorithm	Accuracy	Complexity	Scalability	Robustness	Cost
Ref <sup>[19]</sup>	WLAN RSS	Probabilistic method	2m	Moderate	Good 2D	Good	Low
Ref <sup>[20]</sup>	Active RFID	kNN	2m	Medium	Nodes placed densely	Poor	Medium
Ref <sup>[21]</sup>	WLAN	TDOA	2.4m	Moderate	2D	Good	Low
Ref <sup>[22]</sup>	Passive RFID	ToA, RSS, ANN	1m - 2m	Moderate	2D	Good	Low
Current research	Passive RFID	TOA, RSSI, Trilateration, Kalman Filter	<1m	Moderate	Good, 3D	Good	Low

**Table 7.** Comparative Analysis of Systems in Outdoor Environment

System	Technologies	Positioning Algorithm	Accuracy	Complexity	Scalability	Robustness	Cost
Ref <sup>[25]</sup>	GPS, GSM	Kalman Filter	13.7m – 21m	Moderate	Global	Good	Medium
Ref <sup>[18]</sup>	GPS, WSN	Cell of Origin (CoO)	12.5m - 18m	High	Global	Good	High
Ref <sup>[23]</sup>	GPS, GPRS	TOA	10m - 12.5m	Moderate	Global	Good	Medium
Ref <sup>[24]</sup>	RFID	RSSI Fingerprinting, LSM	6m - 10m	High	Limited by the RFID coverage	Poor	High
Current research	GPS, Camera, Sensors	TOA, RSSI, Trilateration, Kalman Filter	<5m	Moderate	Global	Good	Low

The results obtained show that the developed system has significant improvement in accuracy, cost coverage, robustness and scalability when compared with existing systems.

## 7. CONCLUSION

This paper presents the development of a multi-sensors positioning system for the tracking, monitoring and localization of activities of human resources in a workplace using Internet of Things. Real-time information about the location of any HR at any instant is very essential considering the rising spate of kidnapping, terrorism and insurgency in the world.

Having established the importance of HR in the actualization of organizational goals and objectives, adequate measures should be taken to ensure their preservation and security at all times. Further works that will include monitoring of health status, environmental condition and other workplace parameters is recommended.

## CONFLICTS OF INTEREST DISCLOSURE

The authors declare that there is no conflict of interests and permissions were obtained from the persons whose images appeared in the paper.

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