FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 10 No. 2, January, 2026, pp 390 – 399
DOI: https://doi.org/10.33003/fjs-2026-1002-4386

HYBRID TECHNOLOGIES FOR COMBATING KIDNAPPING

***[1]Emekumeh Okpala Sanctus, [1]Abel E. Edje and [2]Opuh Jude Iwedike**
[1]Department of Computer Science, Southern Delta University, Ozoro, Nigeria.
[2]Department of Computer Science, Delta State University, Abraka, Nigeria.

*Corresponding authors' email: emekumehs@dsust.edu.ng

ABSTRACT
Kidnapping is a growing concern globally with devastating impacts on individuals, families and communities. Traditional law enforcement methods often struggle to effectively prevent and respond to kidnapping cases. This article shows exponential increase in how utilizing IoT and its technologies to combat human kidnapping. IoT design, geo-fencing, API integration, and GPS signal formed the backbone of the proposed model. While the GSM base stations provide signals for the model, the frontends are the mobile phone devices, application interface, and the GPS. The location signal is transmitted to the server when the case enters or exits the geofence for movement and direction tracing. The IoT paradigm hosts the web application, MySQL and GMS are used to provide backend solutions, and the GPS guarantees communication and placement of the case on the search map. The implementation involved suitable platforms and engines and followed up with case study of kidnapping scenarios involving 40 randomly selected cases showing path tracking 77%, GPS accuracy 85%, internet data conservation as 76% and concealability as 68% from conducted surveys. This research developed the practical function of the model and its good performances in areas of availability, concealment, security, location accuracy, seamless data transmission, among others. Comparative analysis with related works also developed the relative strength of the new method.

Keywords: Kidnapping, GPS transmission, IoT paradigm, Digital Image Processing, Noise, Over Segmentation, Under Segmentation

INTRODUCTION

Human kidnapping meshes the conscription, transportation, transferring, harbouring or receiving an individual using force, coercion or other related means for numerous reasons including exploitation and extortion (Clawson *et al.*., 2006). During kidnapping incidences, deprivation of liberty, safety, security, lack of access to health care or medical services, sanitary conditions, education or contact with family members and other heinous crimes are often committed against the victims (Uzorma and NwanegboBen, 2014). It is germane to note that the origin of kidnapping is traced to 1682 in England where humans were kidnapping and sold to colonial masters as slaves or agricultural workers (Turner, 1998; Mohammed, 2008). Present day kidnapping incidences are fuelled by poverty, inadequate education and opportunity, ethnic discrimination or social injustice and inequality between gender, tribes, race and states as well as quest for inexpensive labour or sex (Struckman-Johnson and Struckman-Johnson, 2016). In several parts of the present world, kidnapping has become an uncontrollable menace with statistics revealing that Mexico suffered an estimated 105,682 and 1695 kidnapping cases in 2012 and 2013 respectively (US Department, 2014; Partlow, 2014). Roughly 800,000 humans are reported missing each year in the United State (Uzochukwu, 2016). In Nigeria, there are over 1,000 kidnapping incidents on a yearly basis in recent times with several unreported cases. Among the victims are hundreds of foreign nationals who got kidnapped in the Niger Delta region since January 2007 (Catlin Group, 2012; Fage and Alabi, 2017). The wave of kidnapping in Nigeria began with the abduction of expatriate oil workers in 2005 as a way of drawing global attention to the many years of neglect, injustice, exploitation, marginalization, and underdevelopment of the oil producing areas by government and oil explorers. However, the social problem of kidnapping has spread like wild-fire to other parts of the country with individuals of different calibres and classes as targets (Nnamani, 2015; Inyang and Abraham, 2013). In other crime prone regions of the world, kidnapping has progressed steadily into a very lucrative business in forms of hostage-taking and hijacking while its growing pervasiveness and brutality has made it an issue of concern to the international communities. One of the problems militating against halting this heinous crime by the various law enforcement agencies within Nigeria and other state bodies is the lack of reliable information on its scale and modus operandi as well as the most effective means of preventing it (Akinyokun et al, 2020). The act of monitoring, alert and tracing incidences of kidnapping based on live, accurate and timely data collection, analysis and interpretation also remain key challenges (Struckman-Johnson and Struckman-Johnson, 2016; IOM, 2002; Davis, 2006). Attempts at combating these challenges include development of various automated human monitoring and activity reporting models, including geo-fencing. A Geo-fence is a virtual border technique for a real-world geographic area based on a pre-defined set of values. The application of the technique requires a virtual barrier that gives room for the setting up of triggers, text message or email alert when the preset boundaries are entered or exited. The technique has been useful in the monitoring of vehicles, persons and containers in transit. It is also useful for drone management, fleet management, human resource management, compliance management, marketing, asset management, law enforcement and home automation (Abhiruchi and Anurag, 2018; Abbas et al.., 2009; Akshada et al.., 2013; Karthikeyan et al.., 2016; Vyavahare et al.., 2016; Bhavale et al.., 2016; Harshitha et al.., 2016; Keykur et al.., 2016; Jain et al., 2017). Geo-fence-based monitoring requires that the location coordinates of the concerned objects are routinely and repeatedly obtained and transmitted to an administrator via mobile networks. Presently, geo-fencing applications integrate with Google Earth for defining boundaries for the satellite view of specific geographical areas while the boundaries are defined using longitude and latitude or any local or online map (Almomani et al., 2011; Singh et al., 2016). This research shown geo-fence and its other associated technologies to establish an antikidnapping model. The main aim here is to provide an interactive, fully concealed and cost-effective means of preventing human kidnapping. Investigations on the practical function and applicability of the proposed model show very remarkable results as well as its comparative merits over some existing works. Next is the organisation of the paper.

Section 2 shows the review of work done with emphasis on strengths and weaknesses while Section 3 focuses on the design of the proposed model for combating human kidnapping. Sections 4 depict the implementation's hardware and software requirements as well as the strategies. Section 5 presents the results and the discussion. The conclusion drawn is depicted in Section 6

MATERIALS AND METHODS

An IoT model for smart cities is presented in Zanella et al., (2014). The model incorporates a large number of heterogeneous-end platforms to provide open access to selected subsets of data for the development of a plethora of digital services that ease the livelihood of the citizenry. The model is also leveraged on web services, link layer technologies and other relevant components. However, the implementation is limited to Padora city and its practicality is strictly on Internet availability. In Mukhtar et al, (2015),a geo-fence-based attendance management application is presented. The application was developed on an android platform with GPS and Wifi-3G technologies to allow personnel on pre-defined valid locations to remotely clock in or out the attendance record. The model provides ease of management for the administrators to view and track the staff attendance performance but limited by the high energy demand of the android platform. A scholar bus monitoring model is presented in Zambada et al., (2015). The model implements localization and speed sensors using the IoT architecture in which localization, GPS module, cloud-based central broker and a transport tracking model are the major components. The localization and speed sensors rely on the GPS/GPRS/GSM V3.0 module for component-component communication. The application builds a response based on the information received on location and speed from the sensors and transmits same to the parents and other stakeholders view link. Although case study of some simulated scenarios showed some encouraging results, the model gives no consideration to big data analytic. In Sujithra and Venkatesan (2016,), a Radio Frequency Identification (RFID) and Global Model for Mobile Communication (GSM) technology for combating of child kidnap is presented. The model monitors the position of a child and sends a message or alarm when the child exits the preset or predetermined domain. The key components of the technology are hand tag sensor-based location tracking model and an alarm blower. An ARM 7 Processor LPC2148 microcontroller and Radio Frequency (RF) communication is incorporated for data transmission to remote location while the tracking model hinges on mode selection switches-controlled GPS. The technology demonstrated the possibility of defining logical safe zones for combating of child kidnapping but requires that the case is not dispossessed of the tracker. In Shaik and Bogaraju, (2017), an IOT enabled model for woman and child protection is presented. The model comprises of wearable smart-band that is inter-connected to a mobile phone with a pre-installed programmable application and data on anger, anxiety, nervousness, fear or any other unpleasant situation. When the case is perceived to be in any of the unpleasant situations, emergency signals are generated and transmitted to the nearest security agents and the GPS is consequently engaged for location tracking. Though there is high prospect for the model, the possibility of dispossessing the carrier of the smart-band is its major setback. The authors in Huang et al., (2018) developed a location-based model for providing information and services relevant to the location, context, characteristics and needs of a mobile user. The model used web location-mapping architecture that consists of mobile components (application, devices and maps) as well as communication networks and GPS. Although the model is capable of auto-pushing relevant information about the location and activities of individuals, it lacks positioning accuracy alongside breach of user privacy. With a view to preferring solution to the worsening state of insecurity in some places, the authors in Akinyokun et al., (2018) designed a model for combating human trafficking and kidnapping using smart objects and Internet-of-thing (IOT). Sensor Processing Station (SPS), Media Server Station (MSS), Smart Engine Server (SES) and Digital Situation Room (DSR) were the key components of the model while events around the case are to be monitored in real-time and ondemand modes based on Internet Protocol version 6 (IPv6)-enabled communications. Although, the proposed model is designed for cost effectiveness and time saving combat of human trafficking and kidnapping, the experimental study is missing. An IOT based alert and assist model for crime investigation is presented in Punnaivanam et al., (2018). The model involved save our souls (SOS) key press and GSM/GPS module as well as voice and video recognition. The model has a high prospect of curtailing domestic crimes but its key challenge is the extreme reliance on Internet connectivity. In Sangeetha et al., (2018), a school bus tracking and security model is presented. The model uses an IoT backbone to provide real time information to parents on their wards entry and exit the school as well as location when commuting through the school bus. However, the implementation of the model is limited in its applications and lacks consideration to global application In Abbas et al., (2019), GPS-based vehicle location monitoring model with geofencing capabilities is presented. The model uses satellite communication components to communicate the location of the vehicle to a remote user while geo-fencing is used to accomplish remote surveillance of the geographic areas surrounded by a virtual fence as well as detection of entry and exit times. The components of the model include ESP8266 NodeMCU GPS module, a WiFi receiver and IoT cloud. The model developed a practical way to solve location tracking problem but is suceptible to interference and its practical application is limited to Internet availability. A smart geofencing for inventive mobile marketing strategy is presented in Paulose et al., (2019). The strategy is directed at solving the problems arising from non consideration of user's interests in targeted products by introducing a novel end-to-end model for automated design of affinity based smart geo-fences. The strategy delivers relevant notifications and suggestions using smart digital devices but underperforms during network instability. The authors in Keefe et al., (2019) present an overview of positioning models for moving resources in fire management, forest and other natural resources as well as a hierarchical model for data collection and sharing. The model reflects tradeoffs in range and bandwidth when recording, processing and communicating large quantities of data in time and space to support resource management, science and public safety in remote areas. A hierarchical approach through wearable devices and other sensors which typically transmit data at short distances using Bluetooth, Bluetooth Low Energy (BLE), or ANT wireless was adopted. Smartphone and tablets serve as intermediate data collection and processing hubs for information that can be subsequently transmitted using radio networking models or satellite communication. Though the implementation of the model show some positivity, it lacks recognition capacity for common forestry and fire-fighting activities as well as basic and applied statistical and analytical methods for the movement and interaction of resources. The authors in Reflesia and Lestarini, (2020) present a geo-fencing and gravity sensor-based child abuse combating technique. The technique uses geo-fencing module for virtual fence monitoring of the humans while the sensing module is used to trigger the model's notification to parents and the server. The technique is suitable for facilitating parents and government monitoring of humans and combating of abuse. However, its performance is greatly influenced by Internet connection and GPS accuracy. Analysis on runtime monitoring as a strategy to contain the unmanned aircraft model (UAS) in its operational volume is presented in Torens et al., (2020). A formal methodology was used for assuring predefined properties in flight and guaranteeing of operational safety. The geo-fencing concept of safe operation monitoring was linked with the upcoming regulations regarding the specific category and operation risk assessment. The functional and safety requirements for geo-fencing regarding their impact on the underlying specific operation risk assessment were also presented. The authors in Ilya and Ahmad, (2020) proposed a smart solution for livestock tracking and geo-fencing using IoT and GPRS. A geographical safe zone for remote monitoring and control of livestock as well as collection of data on the location and well-being of the livestock was created using these technologies. The model is suitable for use as a geographical paddock to monitor spatio-temporal behaviours of livestock but requires energy and bandwidth optimization for significant utilization.

Proposed Model

The proposed kidnapping combating model adopted a full-stack IoT design, Application Programming Interface (API) integration and GPS signal to function as shown in Figure 1. It also hosts a web location-mapping model that comprises of mobile application, mobile devices, mobile maps, communication networks, GPS and service and content provider. The model is configured to possess information on the location of the Case based on geo-fencing and apply the same for safety monitoring. The Case is the individual whose location is being monitored and he or she is expected to possess a functional and preloaded Android phone. The Trackers constitute a group of people that monitor the location of the Case as well as render and initiate the monitoring and search operation alongside the security agents. The GSM base station of the telecommunication companies provide wireless signals to mobile phones as well as the GPRS/3G/4G Internet connectivity.

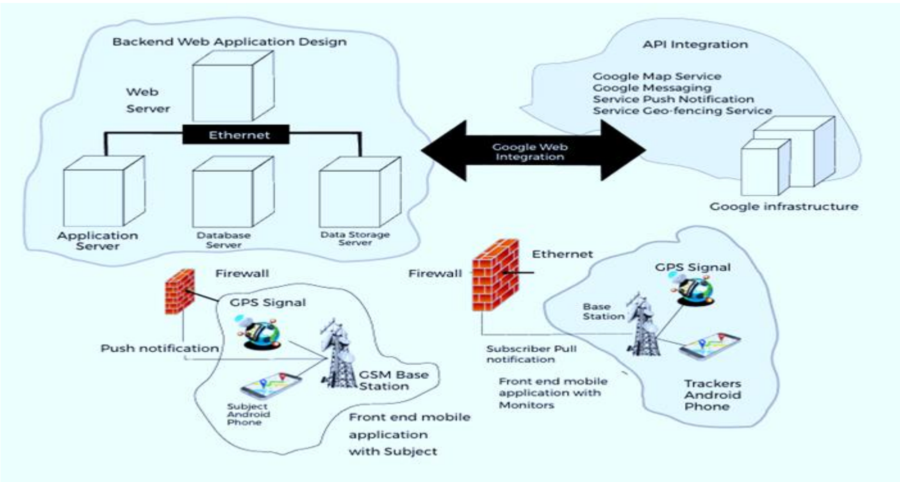

Figure 1: Application Programming Interface (API) Integration with the GPS Signal

The frontend components consist of the Case and Tracker mobile phone devices, application, the interface and the GPS. Based on the pre-installed application, the mobile phone device in the possession of the Case will transmit the location signals to the Trackers while alert and localization will be affected by manipulating radio signals across all the cell towers in the network and phone. The transmission of the location signals happens when the Case steps in or out of the virtual fence that is pre-created for his or her device as shown in Figure 2. The location signals which comprise the longitude and latitude coordinates will be transmitted to the web server application at a predefined sequence of time for movement or direction tracing. The Case's phone is simply a concealable mobile device with an embedded application which sends the notifications to the Trackers phone without leaving any trace. Tracker's mobile phone also requires preloading an application which behaves differently from the one on the Case side phone and it is majorly concerned with pulling of data on the case's location information from the server. The receipt of an exit signal from the Case-side application will trigger the generation and transmission of a confirmation and safety verification message by the Tracker-side application. A suspected case of kidnap will be developed if no response is obtained from the Case within the regulated time. Consequently, the Tracker-side application pulls the location notifications from the web application leaving no trace on the Case's application and movement or direction tracing. The IoT component of the model is used to provide a backend solution to the Case and the Tracker via the telecommunication service providers. As shown in Figure 3, it also provides identification, sensing, communication, computation and other related services towards achieving functional efficiency. A standard GPS receiver is used to place the Case on the search map at any particular location as well as trace its path across the map. With an active GPS receiver, constant communication is maintained with the GPS

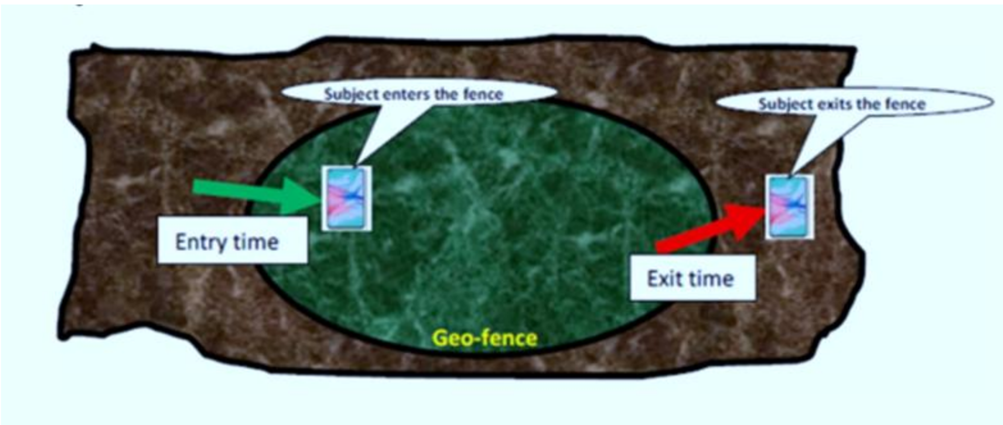

Figure 2: The Transmission Of The Location Signals

satellites and any change in the Case's location can be monitored. The GPS receiver determines the best time for location finding i.e it indicates when the users are to start searching for the kidnapped using the information provided by the GPS and uses its findings to calculate the current latitude and longitude of the Case as well as the speed at which he or she progresses beyond the geo-fence. As shown in Figure 3, the model backend comprises of an administrative web application, MySQL and Google Messaging Services (GMS). The administrative web application sits on the cloud to coordinate notifications, repository, report logs and trigger parameters as well as overseeing the Case and Tracker activities. The MySQL section of the backend handles entry, exit and other notifications while the GMS engine is used to implement the triggers and manage the model ' s alerts, message passing and routing of responses based on Internet connectivity. The GMS engine is also used to generate escalated notifications from the web application to the Trackers prior to commencement of a search operation. Each escalated notification requires a "READ" confirmation by the receiver within a pre-set time, failure of which the escalation is repeated until the server is able to establish that someone has been informed and a monitoring or tracing operation has been initiated. The Reactive Programming Design (RPD) concept adopted an eventbased asynchronous programming to consistently stream the GPS generated coordinate (x,y) of the Case' s location to the Tracker. The coordinates (x, y) is obtained in equation 1

$$x = \frac{r_1^2 - r_2^2 + \left(u_2 - u_1\right)^2}{2\left(u_2 - u_1\right)} \quad (1)$$

$$y = \frac{r_1^2 - r_3^2 + \left(v_3 - v_1\right)^2}{2\left(v_3 - v_1\right)} \quad (2)$$

$$r_1^2 = x^2 + y^2 \quad (3)$$

$$r_2^2 = \left(x - u_2\right)^2 + y^2 \quad (4)$$

$$r_3^2 = \left(x - u_3\right)^2 + \left(y - v_3\right)^2 \quad (5)$$

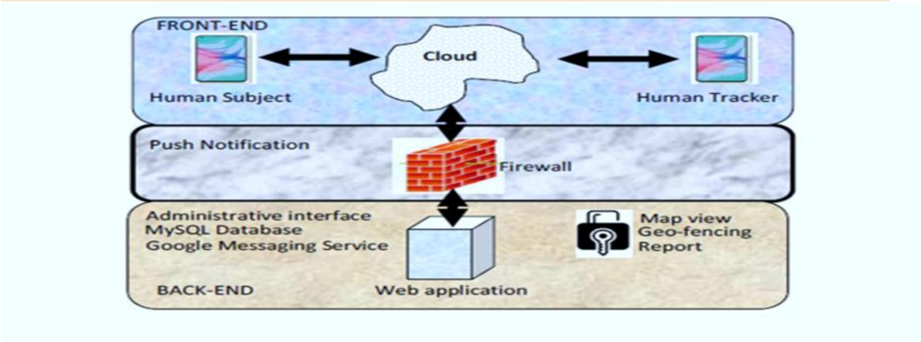

Figure 3: The Interface of the Model's Backend

r1, r2 and r3 are the distances of the Case from preset reference positions and the initial and final velocity A(u1 , v1), B(u2 , v2) and C(u3 , v3) respectively. The streamed information is consequently used to create a pattern that is compared with the geo-fence boundary to determine if trigger action and tracker notifications are necessary. The mobile applications run seamlessly at the background without blocking the main threads and do not interfere with the normal operation of the phone. The process flowchart, algorithm and the code are shown in Figure 4.

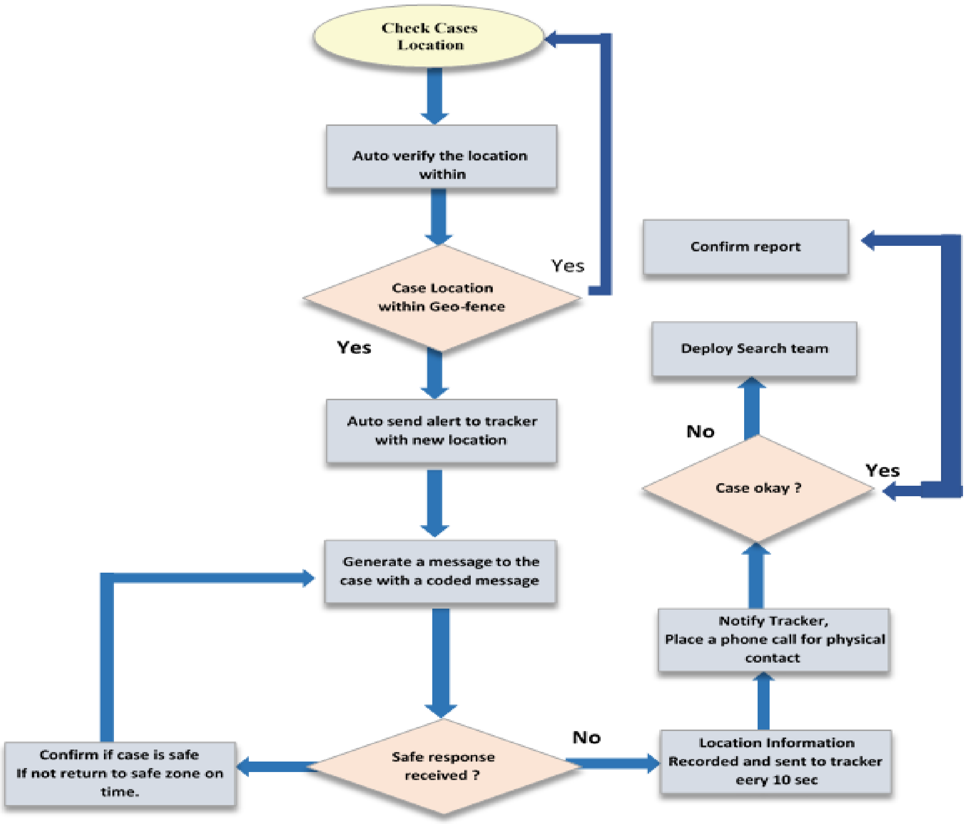

Figure 4: The Flowchart of the Process

Model Implementation

Windows 10 pro Operating Model served as the implementation environment for the proposed model and the software tools include Microsoft Visual Studio, Net Model, C Programming Language, C# Programming Language, Xamarin Mobile Development Kit and MySQL Server. Microsoft Visual Studio creative launching pad was used to build, edit and debug the code as well as publish the application. C# was used to complement .NET model for the actualization of encapsulation, inheritance and polymorphism programming concepts and creation of console, GUI and web applications. Xamarin Mobile Development Kit was used to extend the .NET platform with tools and libraries that support seamless development of applications for Android environment. It also offered abstraction layer that manages the communication of shared code with underlying platform code and runs a managed environment that promotes simple memory allocation and garbage collection. The MySQL Server was used for building the basic and scalable function of storage and retrieval of data by the interacting applications. The Net Model's virtual machine was used for developing form and web-based applications as well as Windows and phone-based services. It was also used for the compilation and execution of programs written in C, C# and VB.Net. The implementation was done using a computer model with iCore 7 Processor, 8GB of RAM, 900GB Hard Disk size. The Case and the Tracker Smartphones run Android 8.0 with 4GB of RAM, 16GB Scandisk size, GPS and GSM/GPRS modules with Internet connectivity. The operational Web was hosted using Linux box and MySQL backend with 8GB RAM and 250GB HDD. The implementation also adopted Google Maps and Geo-fencing Application Programming Integration (API). The key objective of the implementation phase is to convert the design into source code while each component is implemented as a program module. There are modules for user login and quick link to the entire functionality of the model. There is also a geo-location setup interface that is also useful for the display of the list of geo-locations in the model. There is a module that handles the registration and tagging of the Cases whose movements are to be monitored relative to the geo-fence. The registration requires relevant personal information and security credentials while tagging is used to link the Case to a minimum of one of the geo-tagged addresses. There is a Notification Dashboard (ND) that shows all exit and entry notifications which comprise the Case pre-registered details and the location coordinates. Relative to the position of the Case, the active geo-fencing (boundary) is defined by the preconfigured radius. As soon as the mobile application senses that the Case steps out of the geo-fence, its new location is picked and reported to the Tracker. The Tracker is required to click on the new location coordinate to link the Google Map and the path to the Case's new location is plotted using the distance and estimated time to the location as shown. Case study of kidnapping scenarios involving fifty (50) randomly selected individuals was carried out. The selected individuals comprise of twenty-five each from urban and remote settlements. The case study required installation and configuration of the geo-fence applications on the selected individuals' Android phones. The administrative side of the application was also installed on the Tracker's phone and a Safety Code assigned. With the pre-installed application, location-based information on the selected individuals were subsequently collected and sent to the Tracker for real time monitoring without drawing the attention of the individuals. Upon the receipt of the geo-fence exit notification, the trackers' side application initiates a request for Safety Code as shown in Figure 7. If the mutually agreed code is received from the Case, the Tracker side Application enters a "mute" state and continue to receive the location data from the Case side application. Forced exit and suspected case of kidnapping was taken where false or no safety code was received. within speculated time. In practical scenarios, the application adopts a self-activation mode knowing there is a great risk to the life of the kidnap Victim if he or she takes any action that can arouse the suspicion of the Kidnapper.

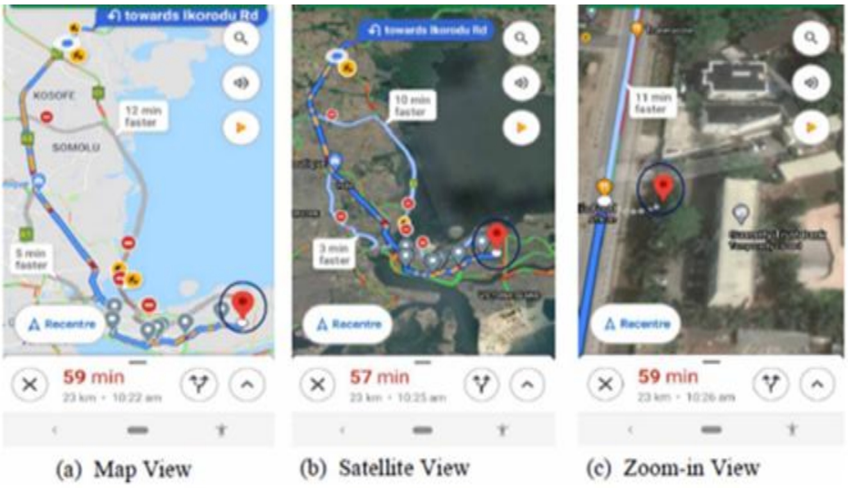

Figure 5:The Geo-fence Exit Notification

RESULTS AND DISCUSSION

A survey on the views on the performance of the proposed model by fifty (50) randomly selected individuals comprising twenty-five each from urban and remote areas is presented in Table1. In Nigeria, a settlement is classified as urban if its population figure exceeds 20,000 otherwise it is a remote settlement (Bloch et al., 2015). It is revealed from Table 1 that 94% of the selected individuals from the urban and remote locations 'Agree' or 'Strongly Agree' that the application promoted data economy while 92% 'Agreed' or 'Strongly Agreed' that the application achieved accurate notification on exit-transition, performed trace-free activities and monitoring as well as promote confidence and safety. It is also revealed that 90% of the individuals from the urban and remote settlements "Agreed' or 'Strongly Agreed' that the application is suitable for use by the security agencies. It is worthy of note that 86% of the selected individuals 'Agreed' or 'Strongly Agree' that the model is simple and autonomous just as 48% of the selected individuals 'Disagree' that the application is

Table 1: Users' Evaluation of the Proposed Research

Performance Parameters Used	Disagree		Agree		Fairly Agree		Strongly Agree	
	Urban	Remote	Urban	Remote	Urban	Remote	Urban	Remote
The model detected location accurately	0	0	2	4	3	2	20	19
The application performed location data transmission without any issue	0	1	3	4	3	3	19	17
The model notified the Tracker of exit-transition from the geo-fence on timely basis	0	0	6	4	1	3	18	18
The solution is safe to use and provided active monitoring	0	0	4	5	4	2	17	18
My Phone performed trace-free activities and monitoring	0	0	8	7	3	1	14	17
The model is simple and autonomous	0	0	6	2	5	2	14	21
The application is energy efficient	12	12	2	1	2	4	9	8
The application is data economy	0	0	9	8	3	0	13	17
The application is efficient for early reporting and tracking	0	0	5	5	2	2	18	18
The path information provided for tracking is accurate	0	0	4	7	4	5	16	13
The application promotes confidence and safety	0	0	5	8	2	2	18	15
The application is suitable for use by the security agencies	0	0	3	10	3	2	19	13

energy efficient while only 34% "Strongly Agree". In summary, the ratings developed the acceptability of the model for tracking, monitoring, and reporting suspected kidnap cases through real-time and discrete data and information transfer in urban and remote places. The Cases who participated in the case study have expressed through the survey that the application exhibited accurate detection of locations, timely notifications, concealed and autonomous operations, low energy and data requirements and error-free path tracing. The practical function of the geo-fence application is therefore developed and its suitability for safe monitoring and combating of cases of kidnapping is recognized. The analysis of the responses has also developed the superiority of the new application over those presented in

Mukhta, (2015): Paulose et al., (2019); Keefe et al., (2019); Ilya and Ahmad, (2019) which are susceptible to high data and energy requirements. The high confidence expressed by the Respondents equally justified the usefulness of the geo-fence technology in the combating of kidnap-related crimes

Table 2 also presents the comparison of the findings from the proposed research with those from some existing and related works. The authors in Abbas etal.(2019)

Table 2: Analysis of the Proposed Research with Existing Researches

Index	**Research works**				
	Abass *et al.* (2019)	**Sangeetha *et al.* (2018)**	**Torens *et al.*, (2020)**	**Ilyas *et al*(2020)**	**Proposed Research**
Concept	Location monitoring	School bus tracking	Onboard safety monitoring	Livestock tracking	Auto tracking ofkidnap incidences
Approach/Technique	Geo-fencing and GPS	SMS, localization, speed sensors	Geo-fencing	Geofencing, IoT,GPRS	Trilateration, geo-fencing, Google map
GPS Accuracy	Low	High	Low	High	High
Concealability	Low	Very low	Low	Low	Very high
Battery Usage Efficiency	Low	High	High	Very high	Average
Internet Data Conservation	Low	High	High	Very high	High
Instantaneous Availability	Low	High	High	High	High
Path Tracking	Not available	Not available	High	High	Highly Available
Travel time calculation	Not available	Not available	Not available	Not available	Highly Available
Distance calculation	Not available	Not available	Not available	Not available	Highly Available
Remote reporting	Highly Available	Not available	Highly available	Available	Highly Available
BoundaryExit Alert	Highly Available	Not Available	Highly available	Available	Highly Available

combined location monitoring model and geo-fencing to provide models that prevent vehicles from kidnapping based on a neo 6M GPS module with a baud rate of 9600bps and average performance in the neighbourhood of 40%. The model is only useful where speed is not critical, hence, the GPS module accuracy is lower compared to those found in present day smart phones. Localization and GPS-enabled smart phone is also combined in (Mukhtar, 2015) to provide an attendance application with geo-fencing functionality to clock-in and out. The embedded GPS has access to better satellite connections for real-time data. In (Sangeetha et al., 2018), Short Message Service (SMS), localization and speed sensors were used to provide a school bus tracking and security model with embedded smart phone GPS while a smart-watch was used for tracking of women's safety by combining SOS, shake2safety, localization, geo-fencing, and google map in (Vahini and Vijaykumar, 2017). The current research advanced the works of (Abbass et al., 2019; Mukhtar,2015) by combining smart phone embedded GPS, two-way GPS signal tacking, trilateration, geo-fencing, google-map, and reactive programming to achieve responsive and timely tracking and reporting of suspected cases of kidnapping. The model from (Abbas et al., 2018; Mukhtar.2015; Vahini and Vijaykumar, 2017; Torens et al., 2020; Ilyas and Ahmad, 2020) exhibit varying degree of portability but are not easily concealable; hence they can easily be identified by criminals. The proposed model also advanced these other works by providing embedded and Android-based application with a very high level of concealment. The solutions from (Abbas et al., 2018; Vahini and Vijaykumar,2017: Torens et al., 2020; Ilyas and Ahmad, 2020) exhibit low rate of availability due to the background validations often required for them to function while those from (Sangeetha et al., 2018, Mukhtar, 2015) and the current study demonstrated much improved rate of availability because they leveraged on smart phone enhanced integrated and telecommunication network GPS modules for dada retrieval.

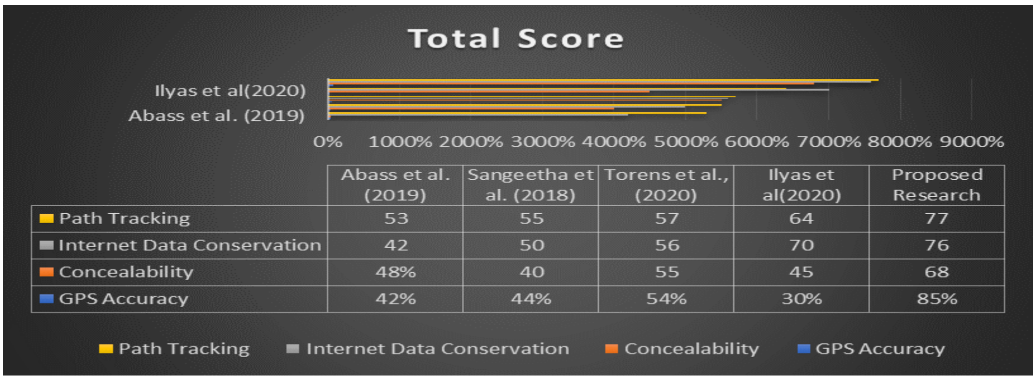

Figure 8: Comparison of Existing Researches and the Proposed Research

Figure 8 reveals the overall performance scale obtained for some previous and current works. The current work considered extended functionalities like path tracking via Google map, instantaneous alert of all geo-fence entries and exits and distance calculations. It also considered travel time and remote reporting which were significantly missing in the previous works. The adoption of these functionalities is largely responsible for the highest accuracy of 86% that is recorded

CONCLUSION

A number of techniques have been adopted for addressing the menace of kidnapping which has been a major crime against humanity across the world. Some of the techniques involve the integration of devices from cameras to transducers and Hitech media processing centre which all require huge financial backing for prototyping and nationwide rollout. In this research, conceal-ability, ease of deployment and financial implications were topmost in the design priorities such that the resultant application is deployable for family members and personnel protection against act of kidnapping. The design adopted geo-fencing technology for instantaneous and real-time reporting of suspected cases of kidnapping when forceful removal of humans from a virtually defined zone is noticed. It also leveraged on the concept of the IoT to efficiently track and locate individuals by combining GPS-enabled smart phones and mobile Internet while the tracked human locations are published relative to the tracker's location on Google map. Upon the receipt of a report, the subsequent lines of action range from monitoring to reporting and confirming the Case's safety using a safe code or placing a call. The model was tested with fifty randomly selected individuals from the urban and remote locations. Their ratings on concealment. early reporting and monitoring within the virtual fence. ease of use among others shows their acknowledgement of the good performance of the model and acceptability for adoption. Responses from the surveyed individuals expressed that the application demonstrated reliable and fool-proof detection of locations, speedy notifications, intelligent and attention-free operations,energy and data efficiency as well as accurate path tracing. The practical application of the new model is developed alongside its usefulness for concealable and result-oriented monitoring of individuals. The superiority of the new application over some of the existing works in the research domain in areas of availability,portability and durability is also developed.
The applicability of the model is however limited to mobile phone environments which case it to human, Internet and energy efficiency factors. The quality and strength of the Internet and Telecommunication networks also play major role on model efficiency and availability. Similarly, the 'liveness' of the smart phones that host the application modules are required for as much as necessary since any downtime of the battery will cause a setback to the monitoring and combating tasks. Future research will consider a periodic activation of the GPS receiver instead of continuous tracking, use of built in accelerometer in smart phones to detect user movements such that the GPS receiver will only be operational when the user begins to move as well as application of cell-identification positioning per default.

REFERENCES

Abbas, A. H., Habelalmateen, M. I., Audah, S. L., & Alduais, N. A. M. (2019).GPS Based Location Monitoring Model With Geo-Fencing Capabilities. AIP *Conference Proceedings,* 2173(1), 1-8. Available: https://aip.scitation.org/doi/abs/10.1063/1.5133929

Abhiruchi, R., & Anurag, D. (2018). Energy Efficient Clustering in Wireless Sensor Network Using *ANFIS.International Journal of Engineering and Techniques,* 4(3).138-141.

Akinyokun, O. C., Akintola, K. G., Iwasokun, G. B., Angaye, C. O., & Arekete, S. A.(2018). Design of a Model for Combating Human Trafficking and Kidnapping Using Smart Objects and *Internet-of-Things.Artificial Intelligence Research Journal,*7(1),45-52.doi: https://doi.org/10.5430/air.v7nlp45

Akshada,D.,Harshalata,W., Leena, Z., Neha, D., & Preetee, K. (2013). Webcam Based Intelligent Surveillance Model. *International Journal of Engineering and* Science,2(8),38-42.

Almomani.I.M.,Alkhalil. N. Y.. Ahmad, E. M., & Jodeh, R. M. (2011). Ubiquitous GPS Vehicle Tracking and Management Model. *Proceedings* of *IEEE Jordun.Conference on Applied Electrical Engineering and Computing Technologies,* 1-6.doi: https://doi.org/10.1109/AEECT.2011:6(13)2526

Bhavale. D.M. Priyanka, S. B. & Atul. S. (2016). IOT Based Unified Approach Ior Women and Humans Security Using Wireless and *GPS.International Jourmul of Advanced Research in Computer Engineering and Technology.* 5(8).2325-2328

Bloch. R. Monroy, I, Fox. S., & Adegbola, O. (2015). *Urhanisation and Urhan Expansion In Nigerir.* Urbanization Research Nigeria Research Report, London ICF International Creatire Commons Attribution-NonCoinmereial-ShareAlike CC BY NC-SA Available https://core.acisk/downbbad/pd0/96701289-pdfScience,2(8),38-

Almomani, L M., Alkhalil, N. Y., Ahmad, E. M., & Jodeh, R. M. (2011). Ubiquitous GPS Vehicle Tracking and Management Model. *Proceedings of IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies,1-6.*doi: https://doi.org/10.1109/AEECT.2011.6(13)2526

Bhavale, D.M.,Priyanka, S. B., & Atul, S. (2016). IOT Based Unified Approach for Women and Humans Security Using Wireless and GPS. *International Journal of Advanced Research in Computer Engineering and Technology,* 5(8),2325-2328.

Bloch. R., Monroy, J., Fox, S., & Adegbola, O. (2015). *Urbanisation and Urban Expansion In Nigeria.* Urbanization Research Nigeria Research Report, London: ICF International,Creative Commons Attribution-NonCommercial-ShareAlike CC BY-NC-SA. Available: https://core.ac.uk/download/pdf/96701289.pdf

Catlin Group.(2012). *Kidnap and ransom today.* Report by Catlin Group Limited.Available: http://files.investis.com/cgl/reports/annual-report-2010.pdf

Clawson. K. Dutch. H., & Cummings. M. (2006). Trauma, *Violence and Abuse National Criminal Justice Reference Service,10(1).3-30.*

Davis, D. (2006). *Inhuman bondage: The Rise and Fall of Slavery in the New World* Ouiford University Press.

Fage K.S & Alabi. D. *O.(2017)Nigerian Government and polifcs* Busfu Glohal Concent Limited. Available: https://www.ajoLinfo/indexphp/afrrov/urticle/VI2b/163979/153468Science,2(8),38-42

Harshitha, N., Aishwarya, S., Jayalakshmi, K. V., & Pravalika, R. (2016). Smart *Security Solution for Women Using* IoT. Rajarajeswari College of Engineering.Available http://ijariie.com/AdminUploadPdf/Smart_Security_Solution_For_Women Using_IOT_1560.pdf

Huang, H., Gartner, G., Krisp, J. M., Raubal, M., & Weghe, N. V. (2018). Location Based Services: Ongoing Evolution and Research Agenda. *Journal* of *Location Based* Services.Available: https://lbs.icaci.org/wp-content/uploads/2018/09/Location-based-services-ongoing-evolution-and-research-agenda.pdf

Ilyas, Q. M., & Ahmad, M. (2020). Smart Farming: An Enhanced Pursuit of Sustainable Remote Livestock Tracking and Geofencing Using IoT and GPRS. Wireless *Communications and Mobile Computing,2020,1-12.doi*: https://doi.org/10.1155/2020/6660733

International Organization for Migration (IOM). (2002). *Shattered Dreams:* Report on *Trafficking of Persons* in *Azerbaijan.* Available: https://publications.iom.int/model/files/pdf/shattered_dreams.pdf

Inyang, D.J., & Abraham, U. E. (2013). The Social Problem Of Kidnapping and Its Implications on the Socio-Economic Development of Nigeria. *Mediterranean Journal of Social* Sciences,4(6),531-544.doi: https://doi.org/10.5901/mjss.2013.v4n6p531

Jain, A.. Patil, A., More, P. S., & Totewar, S. (2017). Women's Safety Using IOT *International Research Journal of Engineering and Technology,4(5),4883-4885.*

Karthikeyan, B., Asthapuri, R. M., & Anurag, M.(2016). Internet of Things (IOT)Based Attendance and Intrusion Detection Model. *International Journal* of *Inovative Research in Computer and Communication,4(3).*

Keefe.R.F., Wempe, A. M., Becker, R. M., Zimbelman, E. G., Nagler. E, S., Gilbert,S.L.. & Caudill, C. C. (2019). Positioning Methods and the Use of Location and Activity Data in Forests.Forests,/0(5),1-46.doi: https://doi.org/10.3390/f1005045

Keefe, R.F., Wempe, A. M., Becker, R. M., Zimbelman, E. G., Nagler, E. S.,Gilbert,S.L.,& Caudill, C. C. (2019). Positioning Methods and the Use of Location and Activity Data in Forests. *Forests*, 10(5), 1-46.doi: https://doi.org/10.3390/f10050458

Keyur,K.P., & Patel,S.(2016).IOT Based Data Logger for Monitoring and Controlling Equipment Working Status and Environmental Conditions. *International Journal* of *Innovative Research in Computer and Communication Engineering*, 11(2),29-48.

Mohamed, M. K.N.(2008).Kidnap for Ransom in South-East Asia: The Case for a Regional Recording Standard.Asian Criminology,3(1),61-73.doi: https://doi.org/10.1007/s11417-007-9040-1

Mukhtar,M. (2015). GPS-Based Advance Vehicle Track and Vehicle Control-Models.*International Journal of Intelligent Models Application,* 7(3), 1-16. doi: https://doi.org/10.5815/ijisa.2015.03.01

Nnamani,L.C.(2015).Socio-Economic Effects of Kidnapping in South-East Nigeria.*World Journal of Management and Behavioral Studies, 3,36-43.*

Partlow. J.(2014). *Washington* Post. Available: https://www.washingtonpost.com/people/joshua-partlow/

Punnaivanam. A., Sumbli, S., Dwivedi, R. P., Peroumal. V.,& Rajashree, R.(20An IOT Based Alert and Assist Model for Harassment Investigations. *10Journal of Mechanical Engineering and Technology. 9(10).1542-1554.*

Raflesia, *S. P. &.* Lestarini, *F.D.(2020).An Integrated Child Safery asing Gee fench Information on Mobile Devices,Academic Press.*

Sangeetba,S., Krishnapriya,S..& Janani, M. S.(2018)School Bus Trackin and Security Model. *International Journal of Advance Research in Science ano Engineering,7(2),218-227.*

Shaik.K.& Bogaraju. *S.* (2017) *Implementation of Novel Application for* Woman and Child Protection *Using Iot Enabled Technigses. Intereotional Joureal of Advanced Research in Computer Science,8(3),414-419*

Singh,S., Panchal, *M. & Jain.R.(2016)Fuzzy Logi Baied Energy Efficiont Network* Lifetime Opuimization in *Wireless Sensor Netwnrl.Proecwings*dof t*vieraatenol Conference on Micro Electronics and Telecommanscan Engineerin* 件 g，．（ 4 ），491 项 9 售 doi: https://doi.org/10.1109/ICMETE.2016.78

Strackman-Johnson.C.. & Struckman-Johaso *61.Coapuriaon of Seaenl* Coercion Experieaces of Men an *interparusal* 答 *hokenen.*2/(12),1591-1615.doi:10.1177

Sujithra. T.,& Venkatesan. R.(2 *国 YE1()* *Gathering in wireless Sensnr No *答：最的制元不知管时有方作* Syatems.//(2).1-7.dob10.5120/

Torens.C.Nikodem.F.Da requitements for onbo01(3),767-779.doc10-020-00451

Torner. M. (1998) Kidnapping 郑药费 07 445-16011*1106/**

Turner, M. (1998). Kidnapping and Politics, *International Journal of the Sociology* of Law, 26(2),145-160.doi: https://doi.org/10.1006/ijsl.1998.0061

U.S. Department of State. (2014). *Boko Haram and United State Counter Terrorism Assistance* to *Nigeria.* Available: https://2009-2017.state.gov/r/pa/prs/ps/2014/05/226072.htm

Uzochukwu, M. (2016). *Kidnapping: Overview, Causes, Effects, and Solutions.*Available:

https://owlcation.com/social-sciences/Kidnapping-Overview-Causes-Effects-and-Solutions

Uzorma, P. N., & Nwanegbo-Ben, J. (2014). Challenges of Hostage-Taking and Kidnapping in the South-Eastern Nigeria, International Journal of Research in Humanities. Arts *and* Literamre,2(6),131-142.

Vahini,S..& Vjjaykumar,N.(2017).Efficient Tracking for Womien Safety And Security Using IOT. *International Journal of Advanced Research in Computer Science, 8(9)*.328-330.doi: https://doi.org/10.26483/ijarcs.v819.4915

Vyavahare. V. A. (2016). Live Audio and Video Transmission Model Using Raspberry *Pi International Journal of Innovative Research in Computer and Communication Engineering 4(6)*

Zambada, J.. Ouintero. R.,Jxijara, R. Galcana, R.. & Santillan, L. (20151 4a *1oF*

Vyavahare, V.A.(2016).Live Audio and Video Transmission Model Using Raspberry Pi. International Journal of Innovative Research in Computer and Communication Engineering,4(6).

Zambada, J., Quintero, R., Isijara, R., Galeana, R., & Santillan, L. (2015).An loT based Scholar Bus Monitoring Model.Computer Science Department Technological Institute of Culiacan.doi: https://doi.org/10.1109/ISC2.2015.7366202

Zanella, A., Bui. N. Castellani. A.. Vangelista. L., & Zorzi, M. (2014). Internet of Things for Smart Cities. IEEE Internet of Things Journal. /(1).22-32.doi: https://doi.org/10.1109/JIOT.2014.23