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Framework for the Design and Implementation of Mimetic Device with Embedded Machine-Learning Model for Internet of Things Deployment to Mitigate Security Challenges in Nigeria

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ABSTRACT

The challenge of insecurity in Nigeria is approaching its second decade of active war-like situation, and it is on the rise and becoming a new normal owing to the inability of the nation's security agent to overcome it. Having tried the military option, the intelligent option, the community option, social options, and collaboration with neighbouring countries, and have all failed, an intense technological home-grown approach is proposed in this paper. The approach involves the combination of multiple state-of-the-art technologies like artificial intelligence, internet-of-things, and mimetic-based surveillance system to monitor, predict, and relay information in real-time to appropriate authorities for immediate action. With this, the rising challenges of insecurity will be seriously degraded.

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INTRODUCTION

The need to finding a lasting solution to insecurity in Nigeria after about two decades of active and continuous disruptive activities cannot be overemphasized. Insecurity in Nigeria is multifaceted, the phenomena (terrorism, banditry, and kidnapping), which were initial restricted to regions have all spread to almost all parts of the country with near daily occurrence of one form of security breach in one or more regions in Nigeria with sharp increase in incidence, abduction, and death compared with previous years (The Nextier Group, 2026). These phenomena have defied the conventional response from the Nigerian security architecture, as the attacks have become more sophisticated, indiscriminate, and lethal; The growing instability and violence in Nigeria has continued unabated despite the joint-security response, involvement of civilian in the form of Civilian Joint Tax Force (CJTF) and Vigilante groups, collaboration with neighbouring countries, and the government continued re-assurance that tackling the scourge of banditry and insurgency remains a priority. Unfortunately, the situation has taken a toll on the trajectories of development in the country.

Starting from the work of (Fanglei W., Jianbo G., Yuting L., 2024) which traces the location and time of insurgence activities in Nigeria, it is observed that there are many different players within each of the groups causing violent insecurity challenges in Nigeria, and they most often applied divergent type of actions to carry out their nefarious activities. While terrorist activities are mostly controlled in the Northeast of Nigeria by "Jamāʿat Ahl al-Sunnah li-l-Daʿawah wa al-Jihād" but known popularly as "Boko Haram", the Islamic State in West Africa (ISWA) Province (ISWAP) together with another terror group called "Lakurawa" complete for domination of terror scenes in the Northwest. More so, the Indigenous People of Biafra (IPOB) is the leading terror group in the Southeast. The three regions have taken over and advanced the act of terror by groups from South-south Nigeria that started the terror in the 1990s targeting Petroleum installations and foreign oil industry workers.

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Banditry, which started from cattle rustling in North-central is still dominant in North-central and completing for top place with terrorism in Northwest. Kidnapping started in the South-south by local armed groups clamouring for resource control as a form of terrorist activities to scare oil expatriates, but has now spread to other regions and equally mutate into other forms like kidnapping for ritual, kidnapping for ransom, political kidnapping, and kidnapping for wholesome sales as shown in figure 1. Kidnapping for ritual is mostly found in the Southwest Nigeria, kidnapping for ransom in the Northwest, part of North-central, and also Southwest, and kidnapping of children for unlawful adoption in North-central, and kidnapping of children from North for sales into Southeast (HumAngle, 2026).

Except for kidnapping for rituals, the identity of the hostages and those claiming responsibility can shed light on the motive of the kidnappers who normally negotiates ransom for financial or political gains, or both. According to available records, all these categories are found across Nigeria which speaks to the fact that an average Nigerian, irrespective of status, is at-risk of either being kidnapped, or caught up in terror or bandit net, and evidently, everything done by the government to reverse the ugly trend has proven inadequate.

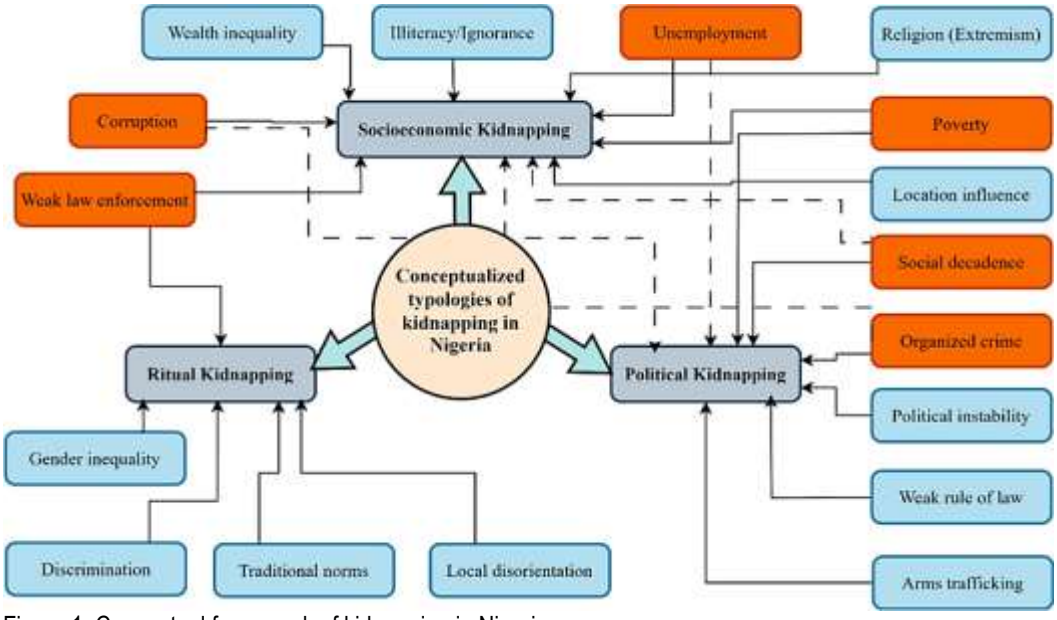


Figure 1: Conceptual framework of kidnapping in Nigeria

VIOLENT INSURGENCE IN NIGERIA: CAUSES-EFFECT-RESPONSE

In Ojewale, O., (2024), all forms of violence in Nigeria were discussed, and in an attempt to finding a lasting solution to the menace of terrorism, banditry, and kidnapping in Nigeria, a cause-effect- response paradigm was established and the findings are as shown in the following sections

CAUSES

Amadi L. and Ugwu C., (2025), identified grievance either in form of social injustice or political injustice, or competition for scares resources are the root cause of violent behaviours in Nigeria. This was earlier suggested in the work of (Charlene Charmwakat Makai et al, 2024) who called it socioeconomic grievances, including governance deficits, and regional dynamics. Elaborating further, scarce climate

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resources was blamed for the violence by (Akaninyene O. Unaam, 2025, Oluwole Ojewale; Tosin Osasona; Yekeen Shamsudeen, 2024). Olejeme, B.C. et al, 2025 find the hands of international players in acts of terrorism in Nigeria, while political instability in neighbouring countries like Libya and Chad was identified as contributing factor by (Monday, T. U et al, 2026).

Babagida B.K. Haruna, A. M., & Mohammed, A. B. (2025), and Al Chukwuma O., Folahanmi A., (2024), see drug consumption and drug abuse as both a cause and effect of violence in Nigeria. Poor police handling of kidnapping cases, worsening economic conditions, community safety concerns, ethnic marginalization, ineffective police force and low ethnic trust were pointed at by (Christopher Amrobo Enemuwe; Janet Okailey Okine; Stella Akua Gyau, 2026), and (Onyedikachi Madueke, 2025) as having huge contribution to all forms of evil bedevilling Nigeria. Corrupt politics, and leadership abdication, and politicisation of the Civilian Joint Task Force (CJTF) are seen as both remote causes and reason for failure in tackling the scourge by (Abbass I. M., 2025), governance deficits, (Charlene Charmwakat Makai et al, 2024), and (Mark P. Jatau; Michael I. Ugwueze, 2026) and these are said to be products of state failure.

EFFECT

This situation has affected Nigeria and Nigerians in a number of ways both immediate and remote, and short and long terms. Among the immediate effect are adoption of people (BBC News, 2025), killings and kidnapping (Mubarak G., 2026), school kidnapping (Save the Children, 2026), ransom taking (Guardian Nigeria, 2025) Internal displacement (Oluwole Ojewale, 2025), breakdown of law and order in form of drug abuse (Al Chukwuma Okoli; Folahanmi Aina, 2024), and abuse of women and girls (Ojewale, O., Balogun, O., & Sadiq, M. M. (2024)) from affected areas, and disruption of academic activities (Bature E. A., 2024) According to (Monday, T. U et al, 2026) food insecurity in a major effect of violent attacks on rural communities where most of the foods are grown. Furthermore, (Njemanze P., 2024) posited "Security threats of biological terrorism" that these violence are sponsored by international organizations in order to cause food insecurity for the promotion of Genetic Modified Organism (GMO) seedlings thereby shifting African nations food dependence to Western manipulators for among other things, total control and population reduction.

RESPONSE

Usamotu B. O., Agara T. (2024) appraised the capacity of the national Counter Terrorism strategy to prevent and combat terrorism in Nigeria, including researchers like A. U. Kinafa; A. U. et al (2024) who Stochastically modeled Boko-Haram insurgence with counter terrorism operation in North East Nigeria. Apart from works of research aimed at proffering solution to terrorism, banditry, and kidnapping, It is a known fact that the Nigerian government has always been responding to these challenges of insecurity (Obi M. 2026). Government security apparatus and community owned security networks have tried with some success (Obi M. 2026, BBC Pidgin, 2026) and failure, (Egobiambu, E., 2021, April 30th), BBC News, 2025; Save the Children International, 2025; Guardian Nigeria, 2025; and Mubarak G. 2026, The Punch, 2026), but communities are continuously at risk due to the sophistication of insecurity activities in Nigeria which made Gbenga Salau (2026) to call on security expert to seek people-centered strategy to end terrorism, and the establishment of Anti-terrorism court (Umar A. S. et al, 2024) for quick dispensation of justice.

Moreso, what is obvious is the lack of abeyance in the last three years which makes it difficult to seek total elimination of the violent acts. According to researchers, part of the reasons government inability to put a stop to these are ineffective police force (Madueke O., 2025) to nip it in the bud, politicization of the Civilian Joint Task Force (CJTF) in northeast Nigeria (Jatau M. P., Ugwueze M., 2026), lack of adequate supply of weapons (TheCable, 2026 & Premium Times Nigeria, 2026), and probable corruption within the security network, some security agents cooperation/collaboration with criminals, and

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discouragement from families of Nigerian security personnel because of difficulties in accessing death benefits should any member of the nation's security member die in active service.

However, there is no reported attempt at combining multiple technology at the scale proposed here at solving the problem of terrorism, banditry, and kidnapping either collectively as planned in this article or as individual challenges facing the nation. Therefore, It is imperative that we locally proffer solution as advocated by (Ike T. J., Antonopoulos, G. A., & Singh, D., 2025) that will be robust, comprehensive, technological, and as a low cost alternatives solution to available on-the-shelf devices for perpetual mitigation of insecurity in Nigeria. This will take the form of machine learning model built into mimetic-based state-of-the-art devices, and deployed in the form of Internet-of-things (IoT) to technologically strengthen the Nigerian security institutions by secretly monitoring their activities, detecting their locations, predicting their moves/actions, disrupting their plan through false alarm, and alerting security agents by transmitting information from remote locations (MDPDA). And this represents a new strategies and tactics of curbing the menace of terrorism, banditry, and kidnapping as depicted in figures 2 and 3. Hence, this will ultimately lead to the attainment of the United Nation (UN) sustainable development goals (SDGs) 1, 2, and 16.

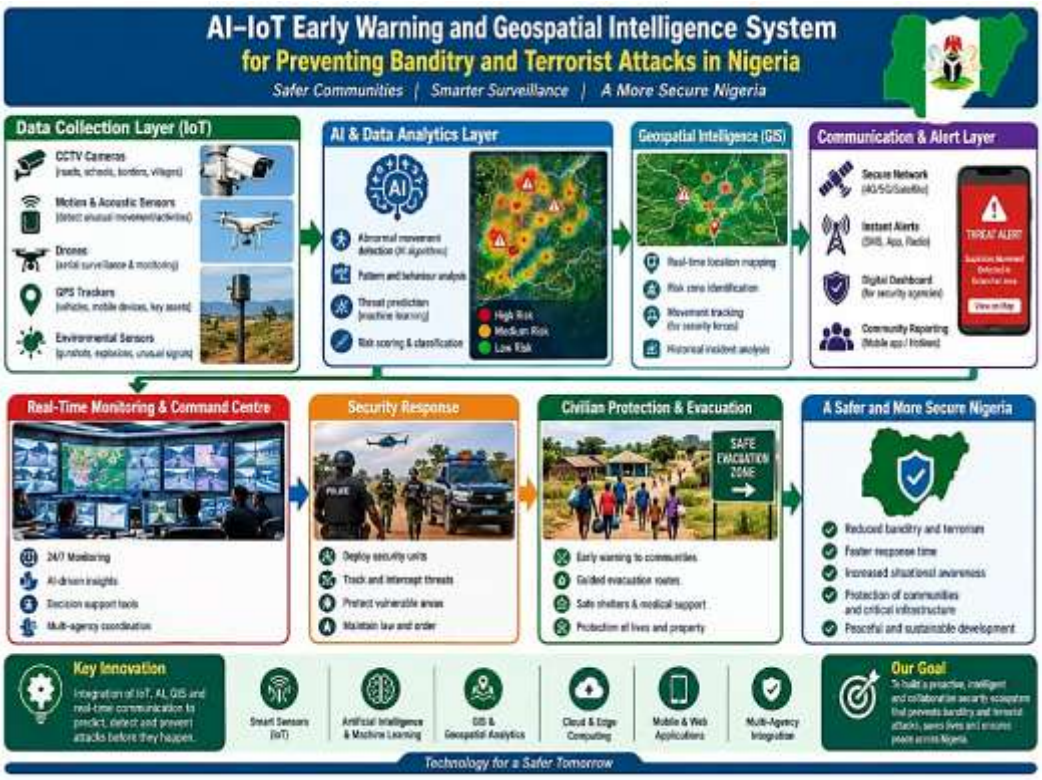


Fig. 2: AI-IoT Early Warning and Geospatial Intelligence System

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Fig. 3: IoT-Based for Locating Kidnappers and Kidnapped Persons

METHODOLOGY/TOOLS

The methodology will start with data collection using all forms of data ranging from Questionnaire, Interview, and Interaction and data collection from affected local communities and counterterrorism experts within Nigerian security system. Literature review, online data bases for synthetic data. The data will also include images of scenes and actors, videos, audios, et cetera. This will be followed by traditional data analysis, and then computer-based data analysis starting with data pre-processing, and then data processing. Selection of suitable machine learning algorithm follows with appropriate software and libraries.

The combination of previous stages gives rise to machine-learning model which will be tested and evaluated. The development of surveillance and mimetic systems follows, and these are trailed by acquisition of apposite Internet-of-things (IoT) devices, and development of smart antenna system. These are then packaged as a single unit for deployment while the development of a real-time network communication protocol and signal reception capabilities comes next. The whole system is integrated and simulated and evaluated and if satisfactory, field testing and evaluation will be done.

Data Collection

Five different types of data collection modalities will be used namely: questionnaire, interview, interaction, literature review, and synthetic data. And data will be collected across the three major types of violent security threat, that is, terrorism, banditry, and kidnapping. Also, for good coverage, collection of data will be spread out within the country to cover the six geopolitical zones and their peculiar security challenges.

Data Bases

In order to carry out good literature review and get lots of synthetic data, online resources and data bases will be consulted. Data bases like ACLED (Armed Conflict Location and

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Event Data Project)[Event-level data on battles, violence against civilians (explicitly includes kidnapping and disappearances), riots, fatalities; Nigeria data from 1997 to present, updated weekly]; Global Terrorism Database (GTD) [Incident-level terrorist attack records (date, location, group, weapon, attack type, casualties)]; UCDP GED and UCDP PRIO-Grid [Organized-violence event data and gridded covariates (population, terrain, geography) joinable to violence events]; Nigeria Security Tracker (NST, Council on Foreign Relations) [Nigeria-specific incident tracker covering Boko Haram attacks, banditry and kidnapping].

Nigeria Watch [Lethal-violence, conflict and human-security database compiled from ten national daily newspapers plus NGO/security reports; downloadable PDF tables]; SBM Intelligence [Kidnapping-for-ransom tallies by state and period (e.g. 2,938 kidnapped in the North-West between July 2024 and June 2025)]; ACLED-Clingendael North-West Nigeria dataset [Granular extremist-group monitoring (Mahmuda, Sadiku, JNIM, ISSP, Lakurawa) in the North-West and border areas, integrated into ACLED]; Web news archives and verified media reports [Incident reports on banditry and kidnap-for-ransom where official data are scarce]; Nigeria Police Force records [Official crime counts including murder, armed robbery, kidnapping by LGA and year]; Social media platforms (X/Twitter) [Real-time chatter usable for early-warning features].

Traditional Data Analysis

Upon data collection, traditional data analysis will be carried out determined the measure of central tendency (mean, mode, and median), measure of dispersion (standard deviation, and variance), measure of distribution shape (symmetry, flatness, lean, skewness, and kurtosis).

Data Processing

Owing to the intended use of the data collected, which is to develop machine-learning model, there is need for computer-based data processing which will culminate into the intended Machine Learning Model. Picking from data acquisition in stage one, the process of data pre-processing begins with piecing the data together called data integration. This is followed by data profiling and distributions and identifying correlated features. Data cleaning follows which involves handling missing values, handling outliers, and removing duplicates and irrelevant entries. Data transformation and formatting is carried out, and this involves categorical encoding, feature scaling and parsing restructured data. A process called Feature engineering and reduction follows comprising feature engineering, and dimensionality reduction. And finally, data splitting and validation which means dividing the data into training dataset, testing dataset, and evaluation dataset.

Software and Libraries

In order to arrive at machine-learning (ML) model, the use of machine-learning (ML) algorithm is sacrosanct, and consequently, software and libraries are paramount to run the ML algorithm adopted. And there are software like Python, R, MATLAB. IBM Watson Machine Learning Studio, Power BI, and QGIS / ArcGIS. And the fitting libraries are: Python (Python, R, MATLAB. IBM Watson Machine Learning Studio, Power BI, and QGIS / ArcGIS.), R (randomForest, forecast (ARIMA/ARFIMA), xgboost, keras/torch for R, sf and terra for spatial data; the crimedatasets package ships a ready Nigeria terrorism data frame sourced from GTD and UCDP PRIO-Grid), MATLAB (Neural Network Pattern Recognition toolkit; used to train the ANN terrorist-pattern recognition model), IBM Watson Machine Learning Studio (Cloud training platform used to train and deploy the violent-crime deep transfer learning model), Power BI (Exploratory data analysis and visualization of GTD/ACLED terrorism data), and QGIS / ArcGIS (Hotspot mapping and geospatial layer preparation for ConvLSTM and risk-surface models). This will be chosen based on the kind of ML algorithm one intends to use.

Machine Learning Algorithms

A machine learning algorithm is a method or procedure use for learning patterns and

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relationships from data. This section deals with selection of suitable machine learning algorithms, software, and Libraries. The major category of algorithm suitable for machine learning are: Tree ensembles, Sequential deep learning, Classical supervised classifiers, Neural pattern recognition, Transformer models, Time-series econometric hybrids, Probabilistic / kernel regression, Reinforcement learning. Reinforcement learning, and Geospatial and interpretable models.

Each of the algorithms named is a category covering several other algorithms, and those of them that are useable for crime and insecurity related issues are listed herewith. Under Tree ensembles, there are Random Forest, and XGBoost (gradient boosting). Sequential deep learning (LSTM, BiLSTM, ConvLSTM), Classical supervised classifiers (Decision Tree, SVM, Logistic Regression, KNN, Naïve Bayes), Neural pattern recognition (ANN (multilayer perceptron, scaled conjugate gradient backpropagation)), Transformer models (BERT (bidirectional encoder representations from transformers)), Time-series econometric hybrids (ARIMA, ARFIMA), Probabilistic/kernel regression (Gaussian Process Regression, Support Vector Regression), Reinforcement learning (RL-based adaptive control), and Geospatial and interpretable models (Geospatially tagged predictive models, learned decision trees, deep transfer learning).

Machine Learning Model

Machine learning model is the outcome of using machine learning algorithm to learn patters and relationships from data. It is a computer program that has learn patterns and relationship from data in order to predict, classify, recognize, and decide when it encounters new data. Machine learning model could be supervised learning model, unsupervised learning model, or reinforcement learning model. Depending on which of the three, algorithms used in building ML models are: Linear regression, Logistic regression, Decision tree, Random forest, support vector machine, K-means clustering, and Principal component analysis. Software tools usually used in developing ML models include Python, scikit-learn, TensorFlow, and PyTorch. However, an existing trained model may be adapted.

Testing and evaluation of ML model is carried out to determine that the developed model works accordingly. Testing and evaluation is done using the remaining part of initial data reserved for the purposes namely testing dataset and evaluation dataset. The ML model is considered satisfactory if the two stages are since to have worked perfectly.

Development of Surveillance System

A surveillance system is collection of electronic devices made of sensors, microphones, and cameras as inputs, microcontroller(s) for data processing, and an antenna for sending and receiving data either to a nearby device or the satellite. It could also send and receive information via a GSM module and the internet as an alternative/additional input/output to the microcontroller. The output power of the surveillance devices will depend on the deployment architecture adopted based on the location of use. A very important aspect is that the developed ML model is written onto the microcontroller, and the whole system could be powered using a battery or any of the renewable energy system depending on where it will be deployed. The surveillance system will be tested and evaluated until satisfied satisfactory.

Development of Mimetic System

A mimetic system is a device or an object made to have a camouflaged appearance. It could be static or dynamic. The mimetic device houses the surveillance system, and the type of object to mimic, energy type, and whether static or dynamic depend on the assignment and environment.

Acquisition of Suitable IoT Devices

The mimetic objects deployed to different locations of interest are made to be interconnected via the internet in such a way that one or few will act as the major node(s) for processing data, while others will be nodes sending and receiving data and commands from the major node(s). Key features of the IoT are:

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connectivity, data collection and sharing, real-time monitoring, automation and control, and scalability.

Develop A Smart Antenna System

In order for signal/information to be transmitted and received from devices, there is need for an antenna. A smart antenna is an intelligent antenna that combines multiple antenna elements with digital signal processing (DSP) in order to automatically locate the direction of signal (highest lobe), transmit and receives only when required thereby minimizing energy usage and interference. It features are: Direction of Arrival Estimation, Beam Forming, Interference Nulling, and Adaptive tracking. For this purpose, the shape of the antenna will be determined by the type of mimetic device, and it will enhance maximization of the surveillance system power output.

Study Deployment Strategy

Since Nigeria is in an active war-like situation, security agents, and counter terrorism experts will provide best locations for deployment of the surveillance devices, the back-end location where monitoring of surveillance and AI analysis are carried out, and real-time counter measures are initiated.

Testing/Simulating And Evaluation

From the completion of the system design, the whole system is simulated, and upon satisfactory performance, the system is built and deployed. Thereupon, testing and evaluation is conducted until acceptable results are given.

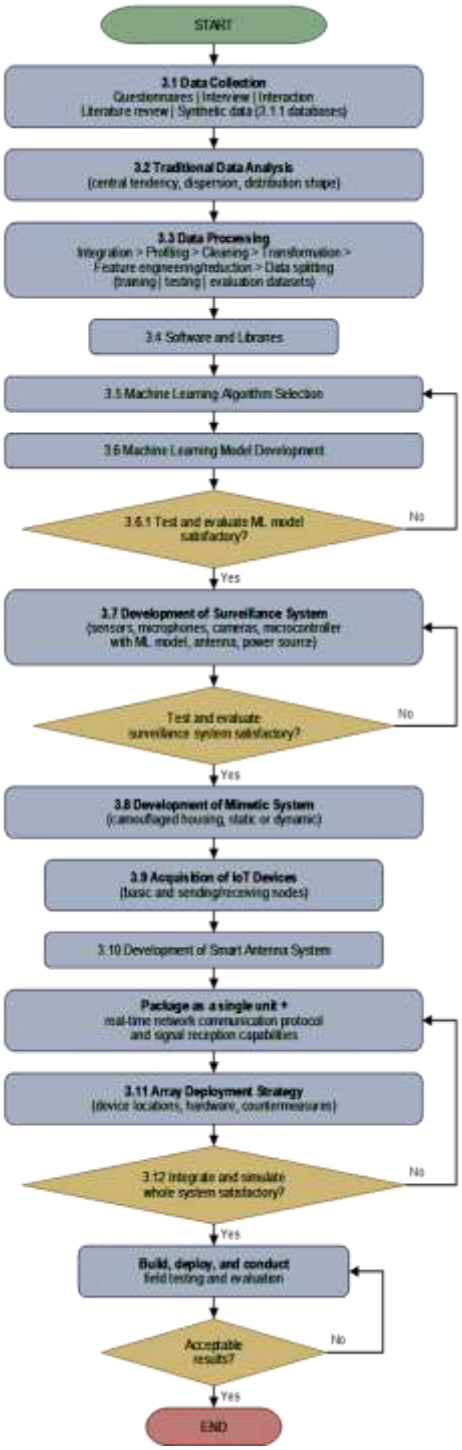


Fig. 4: Methodological Workflow

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Summary

A framework for a multilayer technology-driven solution to the challenges of insecurity in Nigeria. The framework enlisted the use of data collection to drive ML algorithms to produce ML model that will be embedded onto the microcontrollers at the heart of the surveillance devices to process field data. The surveillance devices are camouflaged mimicking objects from the deployed environment. The surveillance devices are connected mostly via internet to create an internet of things (IoT) topology. The processed field data from the IoT topology is sent to the front-end in real-time combat decision and deployment of forces.

CONCLUSION

The framework is a collection of different technologies fused together to create a formidable system that challenges the stalemate in the fight between state and non-state actors, and secure victory for the state actors.

RECOMMENDATIONS

A plan for a three-layer technological approach to insecurity challenges in Nigeria is presented. Moving from the planning to implementation consist of multiple sequential steps presented below:

1. Re-evaluation of the framework
2. Data collection of various forms
3. Traditional Data Analysis
4. Data Pre-processing
5. Data Processing for Machine Learning
6. Selection of Appropriate Software and Libraries
7. Selection of workable Machine Learning Algorithm
8. Development of Machine Learning Model
9. Development of Surveillance Device with ML Model Embedded
10. Development of a Mimetic Device
11. Acquisition of suitable IoT Device
12. Development of Smart Antenna
13. Development of Back-end system
14. Integrate the system
15. Study of the Deployment Strategy
16. Deploy the Integrate system
17. Testing/Simulation of the Integrate system
18. Evaluation of Results obtained.

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