

Enhancement of Environmental Security by the Application of Wireless Sensor Network in Nigeria

Ahmadu Girgiri, Lawan Gana Ali, Mamman M. Baba

Abstract—Environmental security clearly articulates the perfections and developments of various communities around the world irrespective of the region, culture, religion or social inclination. Although, the present state of insecurity has become serious issue devastating the peace, unity, stability and progress of man and his physical environment particularly in developing countries. Recently, measure of security and its management in Nigeria has been a bottleneck to the effectiveness and advancement of various sectors that include; business, education, social relations, politics and above all an economy. Several measures have been considered on mitigating environment insecurity such as surveillance, demarcation, security personnel empowerment and the likes, but still the issue remains disturbing. In this paper, we present the application of new technology that contributes to the improvement of security surveillance known as “Wireless Sensor Network (WSN)”. The system is new, smart and emerging technology that provides monitoring, detection and aggregation of information using sensor nodes and wireless network. WSN detects, monitors and stores information or activities in the deployed area such as schools, environment, business centers, public squares, industries, and outskirts and transmit to end users. This will reduce the cost of security funding and eases security surveillance depending on the nature and the requirement of the deployment.

Keywords—Wireless sensor network, node, application, monitoring, insecurity, environment.

I. INTRODUCTION

IT is very clear that measurement of security in an environment determines the unity, peace and progress of that particular environment. Security has been marked as the fundamental factor that contributes to the development of any society. Nowadays, a weakness in the determination of security has almost affected every aspect of human planning and the development. In Nigeria, the level of in-security has been playing a negative impact irrespective of religion, tradition, ethnic group or region.

Recently, Nigerians have been experiencing some sort of setback on the performance and effectiveness of various activities that include; communication, business transactions, marketing, politics and socio-economic activities particularly in low income communities, where people are living in an

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unsecured environment. Several studies and strategies have been put in place aimed at providing sustainable and improved techniques of security management that satisfy security requirement. Moreover, most of the traditional method of environmental security encounters some setbacks due to the nature of their application. Recently, many lives were lost, thousands of people fled out of their community as a result of insecurity in across the world. In addition, several classes of illegal activities that includes, burglary, rape, drug abuse, robbery and likes were reported almost every hour particularly in developing countries compared to developed nations. However, current state of environmental security can be improved by introducing a modern technology known as wireless sensor network (WSN). This paper reflects the importance of applying WSN for improving environmental security. Wireless sensor network (WSN) is smart system of wireless networking that comprises complex mechanisms aimed at providing large number of services in various types of applications. They are modern technology that offers considerable means of communication through wireless networks. WSNs plays some significant role in the tier of networks, ICT and the communications that involve system design, information management, networking, security and other social issues [1]. The study of [2] and [3] described that WSNs are modern systems of wireless networking that provide smart technology for communication by employing sensor nodes that facilitate data transfer from the deployment areas to the end-users.

In this paper, we discuss the impact of insecurity on the environment in Section II, the next section analyses the application of WSN. Section IV analyses the significant of using WSN in mitigating the level of environmental insecurity and in Section V, the comparison of using sensor and conventional method of security improvement were discussed.

A. Statement of Problems

The effective measure of security in any society determines the level of development and productivity in that particular environment. It is also an awareness of every individual that proliferation of insecurity would leads to the increase in social vices that eventually transform to the failure of man and his living environment. Most of these problems arise due to lack of modern technologies that helps in improvement of monitoring and detection of criminal activities. To satisfy the requirement of security improvement in our environment, we do consider the performance and the application of wireless sensor network to assess the level of security intensity by providing monitoring, detection, storing and dissemination of information/data from the deployed areas (such as,

communities, schools, markets, farmland, hospitals etc.) to base station (collection centre) for further action.

II. IMPACTS OF INSECURITY ON THE ENVIRONMENT

Nigeria has been facing numerous security challenges such as the waves of insurgency in the north-east, prevalent kidnappings in the south, and ethno-religious conflicts in mid-central States like Plateau, Nassarawa, Kogi and Taraba States. All of these had seriously affect socio-economic development that leads to the loss of hundreds of thousand lives and large numbers of people have been displaced across the country as well as properties worth billions of naira damaged have been lost. The term insecurity has various meanings such as prevalence of danger, hazard, uncertainty, and deficit of protection, absence of peace as well as lack of safety. Insecurity is a state of anxiety or fear as a result of lack of protection or safety [4]. Studies have shown that there are strong connections between development and security after the end of cool war as no development can be recorded in a nation where crises, conflicts and war remain persistent [4], [5]. In addition, scholarly consensus has been identified that security and development are two indivisible and different concepts that virtually affect one another and subjects of debate on development-security nexus [5].

A. Socio-Economic Impacts of Insecurity

For years, Nigeria has been confronting grave security contests prior to 2007. Therefore, challenges ravaging Nigerian since the take up of democracy in 1999 are more of internal security and have received mixed reactions both from inside and outside the country's political environment. Moreover, security situation in Nigeria between 2007 and 2011 has taken a different dimension. In this period, the government has witnessed a constant pressure from militia groups such as pipe line bunkering, burning oil well by the Movement for the Emancipation of the Niger Delta (MEND), Movement for the Sovereign State of Biafra (MOSSOB), increasing surfs of kidnapping in the South-East, frequent bombings in the north by Boko Haram insurgents, ethno-religious crises in Jos, Plateau State as well as politically encouraged killings among others [4]. Conceivably, for the details of Nigerian security challenges look at Table I which aids in the quick understanding of security challenges in Nigeria from 2007-2011. Therefore, the incapability of the Nigerian security to deal with the nation's security challenges during the above period come up with yet another question on the readiness of the nation to achieve its desired socio-economic and political heights in the year 2020 as well as this poses grave threat to the corporate existence and unity of Nigeria as an independent state [4]. The Human Rights Watch has reported that about 2800 lives have been lost as a result of terror inclined violence between 2009 and 2012. In third-quarter of 2012, 275 attacks launched by the Boko Haram terrorist group leads to the killing of 815 people. This figure is more than the total number of lives lost in 2010 and 2011 [6]. Human Rights Watch further states that 275 police officers have been killed while over 60 police stations have been

attacked and burnt in at least 10 northern and central States by the terrorist Boko Haram groups, with the exception of police headquarter that have been bombed in the federal capital territory, Abuja [6].

TABLE I
FORMS OF SECURITY CHALLENGES IN NIGERIA FROM 2007-2011 [4]

Security challenges	Years	Geo-Political Zones
Niger_delta militia activities	1999-2007	South-South
Jos crises	1999-Date	North- Central
Kidnappings, ritual killing and armed robbery	2007-2010	South-East
Boko haram insurgency	2009-Date	North-East, North-West and North-Central

B. Implications of Insecurity on Nigerian Economy

The increasing rate of insecurity in Nigeria since 2007 has drastically impacted the nation's economy. Prior the federal government's Amnesty Programme intended for Niger Delta militants, the production of oil and the numbers of daily barrels produced have significantly declined. This was largely as a result of kidnapping and hostage of oil workers in the area. This was the only problem negatively decreased the government revenue from oil and implementation of government programmes and policies during this time frame [4]. Moreover, most capital projects budgeted for the year 2007 and 2008 were not implemented largely due to shortage of finance triggered by MEND in the oil producing region of Niger Delta inclusive is the rehabilitation and construction of federal road linkages in six geo-political regions, the urgent kick off of rummaging of River Niger, construction of dams in the North-West and North-Central zone as well as construction of additional power plants in the all of the six zones of the country [4]. Furthermore, the continuing activities of kidnapping in some parts of Nigeria have finally led to significant economic setbacks. The frequent kidnapping cases in commercially buoyant cities of Aba, Onitsha and Port Harcourt have clearly forced businessmen, investors and manufacturing companies relocating other cities in the peaceful parts of the country. For example, in Aba, companies like the SEVEN UP, UNILEVER PLC, NBL and PZ PLC have relocated to Enugu chiefly due to unceasing kidnapping of expatriates [18], [20]. Security problems in Nigeria have been damaging costs that signal the other nations that the nation is not secure, safe and not suitable for economic activities and investment. Surprisingly, foreign international investors are leaving Nigeria for other countries across the Africa with relative peace which place grave economic setback to the nation. Accordingly, this has the possibility of criticising the so-called transformation agenda drawn by the government and making the anticipated incomes from Foreign Direct Investment (FDI) an illusion [6]. Reference [6] opined that the rates of kidnapping, insurgent bombings, armed robbery assaults on banks and other violent criminal activities in recent months have caused huge loss of the country's human resources. This hideous development poses a challenge to the future of the country's agricultural production, petroleum sector growth rate, private sector investment volume, manpower as well as overall economic development.

In the northern parts of Nigeria, economically busy cities of Maiduguri, Kano, Bauchi, Yobe, Yola and some parts of Gombe State experienced economic standstill due to the frequent attacks by boko haram terrorists. Numerous markets and other some business points remained closed for months due to ban imposed by Nigerian soldiers with a view to bringing continuous attacks by terrorists under control. Up till now, several sets of curfews have been imposed in those terrorist stricken states of Borno, Yobe and some town in Adamawa states.

C. Causes of Insecurity in Nigeria

Several studies have been conducted that the primary causes of insecurity are poverty and its derivatives. In the study of [6] the causes of insecurity in Nigeria derived from the following factors: poor governance, corruption, unemployment, drug-abuse and the proliferation of small weapons. The writer disclosed that poor governance is the key function of insecurity in Nigeria in such that in 2011 UNDP, HDI reports rank Nigeria as 156th out of 187 countries that suffers infant mortality of 74.36 per 1000 live births; 840 maternal mortality in every 100,000 births and 51 years life expectancy. In 2010 perception index of corruption by TI rated Nigeria 134th out of 178 at point 2.4 on scale of 1-10 [6]. According to NBS findings in 2011, unemployment in Nigeria reached 29.3% particularly in the states of Yobe and Kano at 60.7% and 67% that not corresponds to the economy growth at 7%. In addition, the proliferation of small weapons and drug-abuse leads to the foundation of illegal and breach of law. In Nigeria various sects, political thugs and gangs with different names prevail some of which include; Militants of Niger Delta, Area Boys of Lagos, Egbesu of Rivers, Bakassi Boys of Abia, Yankalere of Bauchi; Ecomog of Maiduguri, all these acts are the derivatives of poverty that causes insecurity across the nation.

III. HOW WIRELESS SENSOR NETWORK IMPROVES SECURITY

WSN is an emerging technology for the large range of applications that provides monitoring mechanism and in-networks operation such as detection, actuation, aggregation and data compilation at different levels of deployment [7], [8]. WSN is a multi-hop infrastructure based on wireless networks and it is a well-known technology that constitutes various layers of services. It is concerned with effective performance in hardware/software, system design, programming, data management, security, social activities and environmental networks [1]. The Architecture of WSN is illustrated in Fig. 1.

Wireless network is unreliable in nature and it is subject to the security threats at various layers on the network. The common attacks on the sensor network are: denial of service, a malicious injection, traffic analysis and the masquerade. These attacks are resulting to spoofing, phishing and the sniffing of information packet on the networks [9]. References [3], [10], [24] state that the primary aims of WSNs are to collect an aggregated data from the spatially distributed sensor nodes across the application areas and present it to the user through

wireless networks. They are designed to facilitate wireless communication by monitoring and in-network services such as detection, data computation and aggregations at various levels of applications. WSN constitute thousands of sensor nodes spatially disseminated across a deployment area and communicate the collected data to the base stations for computation [2], [29].

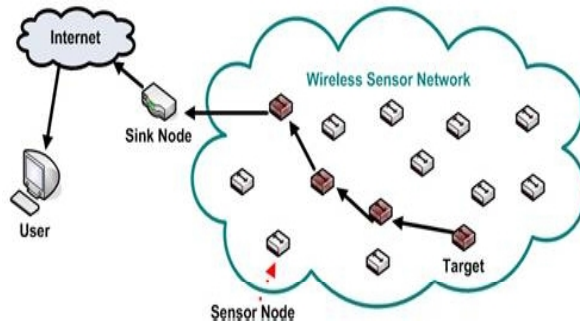


Fig. 1 Architecture of WSN [8]

A. Fundamental of WSN on Security Measures

Following the modern techniques for security improvement, application of wireless sensor network satisfies the requirement of users at various level of deployment. However, monitoring, tracking and detection of information remain special features that make WSN to be smart and modern network for collecting and forwarding of information to the user. Some typical uses of WSN are: environmental monitoring, water-way monitoring, industrial safety control, wildfire detection, cattle range monitoring, and the like [8], [10], [11]. Therefore, it is very much significant that the duty of every member of community, society or an organisation is to be supportive and conscious of security in order to maintain peace, progress and sustainable development of the environment. To disclose the important of the application of WSN in our environment such as schools, markets, and farmland and the likes. Let compare the difference between the use of WSN and the traditional method of environmental security. Basically, sensors play important roles in manifestation of environmental related monitoring that satisfy the security measure in Nigeria. Fig. 2 shows target application of WSN on security.

Any Ad-hoc wireless networks other than WSNs like (Mobile Ad-hoc Networks) are the wireless networks that are basically design to perform specific function or purpose such as data transmission, providing communication facilities and from transmitting source to the receiving end through wireless medium. The MANETs are typically operated based on self-configuration and do not require manual or physical set up to initialise [12].

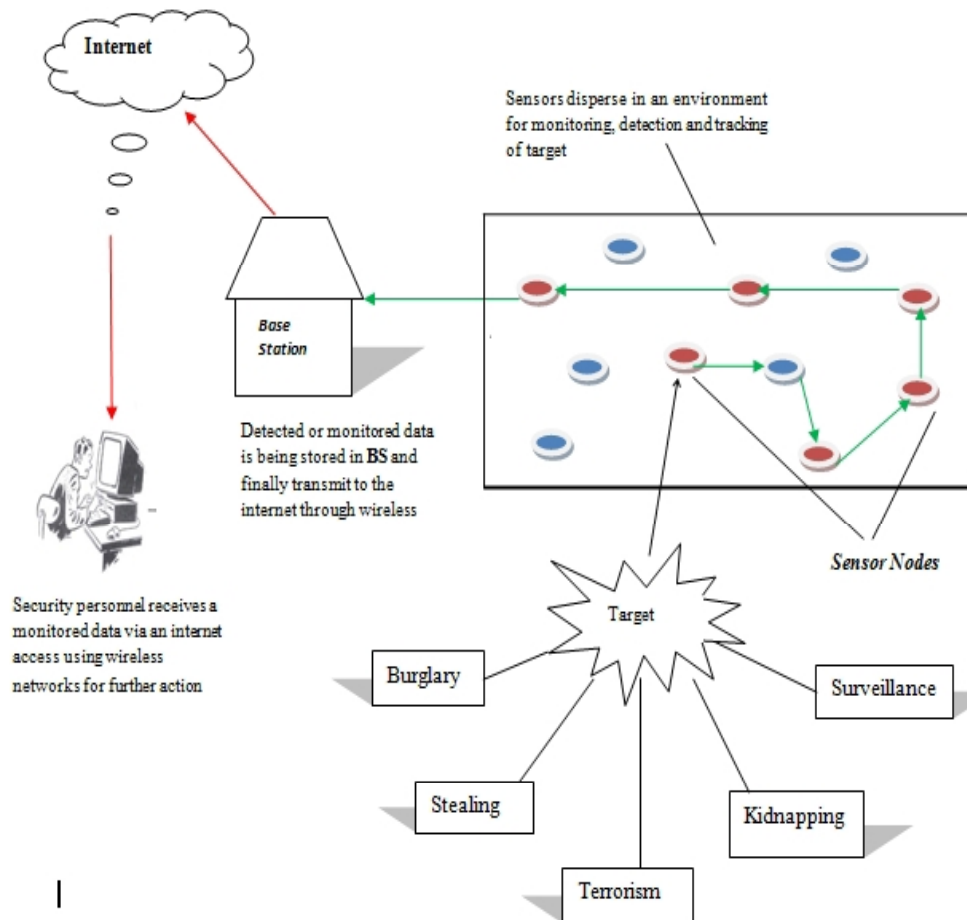


Fig. 2 Targets application of WSN on security

WSNs are wireless communication networks that facilitate a transfer of data from a source to the destination by means of a system called *node*, in such a way that nodes are static at particular location unlike in other wireless networks which are mostly dynamic. Nodes are devices that used to monitor, detect, and record and transfer of information from a field to the end-user [26]. In WSN, nodes are located at positions or distributed across an area depending on the nature of environment and type of application. For examples: environmental pollution is being monitored by a sensor designed to monitor the environmental [13]-[15]. In this study, sensor systems that featured to detect, monitor, record and establish a transfer of information in form of sound, picture or video to the user at the base station or monitoring centre are primary facilities. WSN has different practice and features compared to other wireless networks, in term of system facilities, applications, environmental services, and availability of services, quality of service, mobility, power consumption and data centric [12], [16], [27]. Furthermore, WSN comprises of hundreds of nodes integrated with sensing system, receivers, processors, transmitters and spatially distributed across application areas. It operates with unlimited number nodes and low power consumption. On the other hand, other wireless networks pose limited number of resource, with

high power consumption but required minimum number of nodes and usually operate on dynamic protocols.

B. Applications of Wireless Sensor Network

There are different types of sensor system depending on the mode of application. Some were specially designed and manufactured to facilitate a specific action, but others were constructed to be work in single system [17], [25]. WSNs are smart system of communication that serves for various applications at different levels of requirement. They have unlimited resources ready to provide an exchange of data from deployment area to the base station. The applications of WSNs include: wildlife monitoring, pollution detection, marine applications, security applications, military, application, wildfire detection, medical sensing, marine, industrial detection system, hazard monitoring, alarm detection and the like [1], [18], [19]. WSN is a new technology that lasts for long-duration and large-scale applications that aimed to provide in-networks operation that involves *detection*, *actuation*, *computation* and *aggregation* of data, and monitoring activities within the network. Another application of WSN includes: cattle range monitoring, micro-climate, virtual fencing, environmental monitoring and current in field of biodiversity monitoring [8], [28]. In [20]-[22], WSN covers

wide range of applications which include: marine navigation, military control monitoring, safety detection, industrial hazard detection, and temperature detection, energy fault detection, pollution detection and wildlife monitoring. The writer's added that applications of WSN have become a threshold of

modern means of data communication under low energy consumption, robustness, reliability and good performance due to constituted facilities of the system. Fig. 3 illustrates an application of WSN.

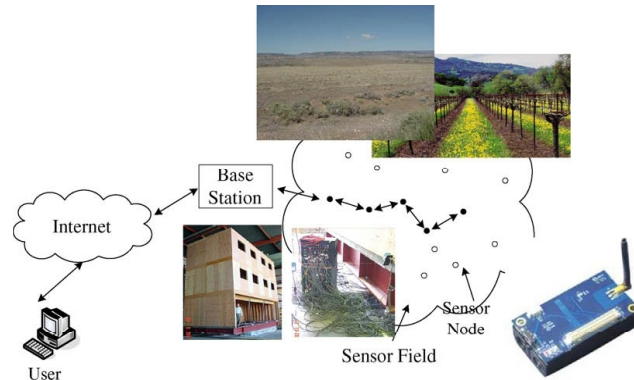


Fig. 3 Application of WSN [23]

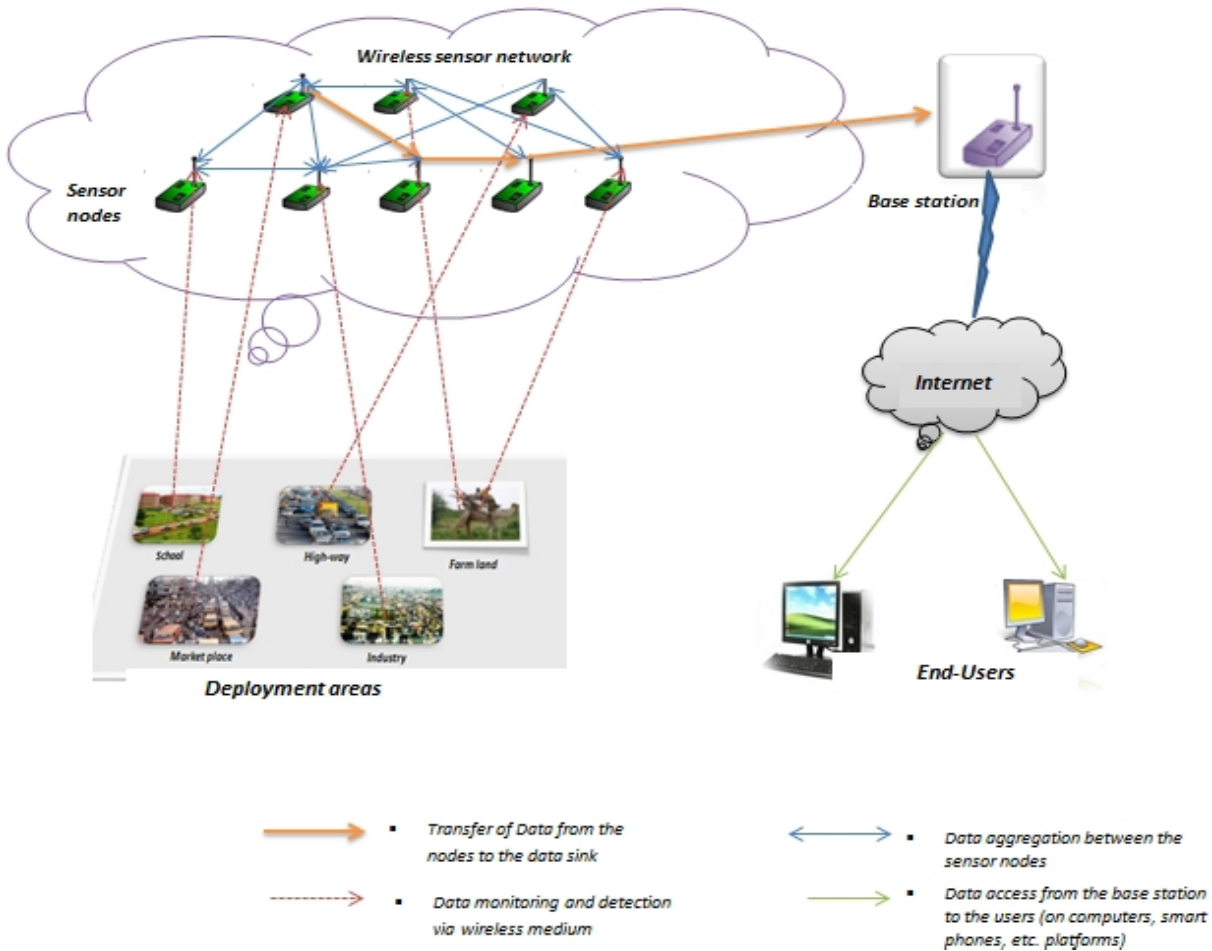


Fig. 4 Deployment of WSN on Targets

IV. DEPLOYMENT OF WSN ON IMPROVEMENT OF ENVIRONMENTAL SECURITY

The deployments of WSN depend on the requirement, nature and task given to the system to comprehend. Due to the smartness of the system, sensor nodes do compromises with their neighbour nodes to remain determinant, sensitive and responsible in monitoring, detecting and tracking for information at the deployment site and consequently disseminate the data to the end-users through wireless network [30]. Fig. 4 illustrates the deployment of sensor system to monitor, track and detect aggregated information from a target. Sensor network can be used or deploy to various area on different requirement despite the geographical location of the site, meaning, various types of sensor were designed to hold different mode of applications.

Looking at the in-depth applications of WSN in improvement of environmental security, it helps in effective and fast monitoring of illegal and criminal activities in the society thereby reducing the number of lives lost to insecurity, economic setbacks due to solid vices and so on. WSN also offers less costly and less risky monitoring and detection of crimes in the society compared to deployment of other facilities. In addition, deployment of sensor also revives the progress of security measures by assisting the military and other security personnel in speeding of information gathering derived from such activities.

V. CONCLUSION

WSN is an emerging technology that used sensor nodes fixed at strategic locations for monitoring and detection of criminal activities with less cost and risk compared to traditional methods of environmental security enhancement. The network promises surveillance, detection of activities at the deployed areas and reports the discovered information to end-user via wireless medium. The technology is deployed in vast areas of human endeavours which include schools, markets, banks, military, and industries and so on. With the deployment of WSN in Nigeria, the number of lives lost to social vices would be reduced, economic activities that suffered setback due to burglaries, terrorisms, kidnapping and other ethno-religious violence would pick-up. Therefore, it is highly suggested that Nigerian authorities should show concern on the significant of using modern technologies on improvement of recent state of security. This really decreases the total expenditures incurred compared to traditional methods as described in the content.

REFERENCES

- [1] D. Sushma, D. Nandal, and V. Nandal, "Security threats in sensor wireless networks", *International Journal of computer science and management studies*, vol.11, pp.59-63, 2011.
- [2] M. Hammoudeh, A. Kurz, E. Gaura, "MuMHR: Multi-path, Multi-hop Hierarchical Routing", *IEEE International Conference on Sensor Technologies and Application*, Valencia, Spain, October,2007.
- [3] C. I. Nwagboso, "Security Challenges and Economy of Nigerian State (2007-2011)". *American Journal of Contemporary Research* (online). Vol.2(6), pp. 244,2012.
- [4] O.O. Ewetan, and E. Urhie, "Insecurity and Socio-economic Development in Nigeria", *Journal of Sustainable Development Studies* (online). vol. 5(1), pp. 40-63, 2014.
- [5] A. Oladiran, "Security Challenge and Development in Nigeria: Leadership to the Rescue", *International Journal of Academic Research in Public Policy and Governance*, vol. 1(1), pp.49, 2014.
- [6] A. Danbazau, "Poverty Elevation, Security and Stability in Northern Nigeria", *The NMFUK, 22nd Annual Winter Conference*, Leicester, UK, December 2012.
- [7] P. Corke, T. Wark, R. Jurdak, W. Hu, P. Valencia, and D. Moore, (2010) "Environmental Wireless Sensor Networks", in *Proc. of the IEEE,2010, paper*, 98.11, pp1903-1917.
- [8] A.k. Darabkh, S.I. Shareen, A. Mohammad, F.J. Iyad, E. Alkhader, and F.A. Mamoun, "Performance evaluation of Selective and Adaptive Heads Clustering Algorithm over Wireless Networks", *Journal of Network and Computer Application*, vol. 35, pp. 2068-2080,2012.
- [9] P. Bakaraniya, and S. Mehta, "K-LEACH: An Improved LEACH Protocol for Lifetime Improvement in WSN," *International Journal of Engineering Trends and Technology*, vol. 4, pp.1521-1526, 2013.
- [10] G. Sharma, S. Bala, and A.K. Verma, "Security framework for Wireless Sensor Networks-Review" *2nd International Conference on Communication Computing and Security*, Thapar University, Patiala. India: ICCCS.
- [11] H. Karl, and A. Willing, *Protocols and Architectures for Wireless Sensor Networks*", England: John Wiley & Sons, Ltd., 2007.
- [12] J. Amiri, M. Sabaei, and B. Soltaninasab, "A New Energy Efficient Data Aggregation Approach in Wireless Sensor Networks," *Communication and Networks*. vol. 4, pp.61-72, 2012.
- [13] K. Pawar, V. Pawar, and T. Sharma, "Enhancement of LEACH protocol Using Energy Heterogeneity Concept", *Internal Journal of Emerging Trends and Technology in Computer Science*, vol. 2(1), pp.49-56.
- [14] S. Harmandeep, and G. Malik, "Approaches to Wireless Sensor: Security protocols", *World of Computer Science and Information Technology Journal*, vol.1 (7), pp.301-306, 2011.
- [15] S. Singh, and V.H. Kumar, "Security for Wireless Sensor Network", *International Journal of Computer Science and Engineering*, vol.3, pp.2393-2399. Jun.2011.
- [16] J.A. Stankovic. (2008). *Wireless Sensor Networks. IEEE Computer Society*, vol.41 (10), pp.92-95,2008.
- [17] POSTECH (2013) Research Area on WSN and Ad-hoc Networks. *Monet Lab* (online).
- [18] A. Nayebe, and H. Sarbazi-Azad, "Performance Modelling of the LEACH for Mobile wireless sensor Networks", *Journal of Parallel and Distribution Computing*, vol.71, pp.812-821, 2011.
- [19] J. Lee, K. Kapitanova, and S.B. Son, "The price of security in wireless sensor networks", *Computer Networks*, vol. 54(1), pp.2967-2979, 2010.
- [20] L. Doherty, J. Simon, and T. Watteyne, "Wireless sensor Network Challenges and Solutions", *Microwave Journal*, Vol.5, pp. 22-34,2012.
- [21] K. Sohraby, D. Minoli, and T. Znati, "*Wireless sensor Networks: Technology, Protocol, and Applications*" New Jersey: John Wiley & Son, Ltd.,2007.
- [22] B. Sun, Y. Xian, C. Chung, H. Chen, and T.A. Yang, (2008) "Security Co-existence of Wireless Sensor Networks and RFID for Pervasive Computing", *Computer Communication*, vol.31(1), pp.4294-4303, 2008.
- [23] M. Bloznelis, J. Jaworski, and K. Rybarczyk, (2008) "Component Evaluation in a Secure Wireless Sensor networks" *An International Journal of Networks*, vol.53(1), pp.19-26, 2008.
- [24] S. Waware, N.D. Sarwade, P. Gangurde, "A Review of Power Efficient Hierarchical Routing Protocols in Wireless Sensor Networks" *International Journal of Engineering*,2012
- [25] V.M. Potdar, and A.J.D. Rathnayaka, "Wireless sensor network transport protocols: review, *Journal of computer networks and application*. vol.36(1), pp.134-146, 2013.
- [26] Fu, Z. Jian, E. Weiw, and A. Wei, "An Energy-balanced Algorithm of LEACH protocol in WSN. *Internal Journal of Computer Science* (online). 10(1), pp.354-359,2013.
- [27] M. El-Sadaawy, and E. Shaaban, "Enhancing S-LEACH Security for Wireless Sensor Network", *International Conference on Electro/Information Technology*, Indianapolis, IEEE computer society, May, 2012.
- [28] X. Ma, and X. Yu, "Improvement on LEACH protocol of Wireless Sensor Network" in *Proc. 2nd International Symposium on Computer, Communication, Control and Automation*, Paris, France, ISCCCA 2013.
- [29] M. Hammoudeh, R. Newman, and S. Mount, "An Approaches to Data Extraction and Visualisation for Wireless Sensor Networks", *8th IEEE*

International Conference on Networks, Gosier, Guadeloupe, March, 2009.

- [30] S. Tyagi, and N. Kumar, "A systematic review and clustering routine techniques based upon LEACH Protocol for wireless sensor networks", *Journal of networks and Computer and Application*, 2012.