An IOT-Based Architecture for Crime Management in Nigeria

Falade Adesola, Sanjay Misra, Nicholas Omoregbe, Robertas Damasevicius and Rytis Maskeliunas

1 Introduction

A crime is an act of wrongdoing that merit community condemnation and punishment usually by way of payment of fine or imprisonment [1]. There are numerous examples of crime, but this study is confined to rape, armed robbery, murder, kidnapping, and ritual killings, which are more prevalent in Nigeria [2]. Rate of crime is inversely proportional to the rate of economic development of any nation [3, 4]. This implies that no nation can experience any meaningful development with a high rate of crime. Hence, it is imperative for the government of any nation to curtail or eradicate this monster from society.

The activities and the dastard effect of this menace on the socioeconomic development of any nation are worrisome [5]. With Nigeria being the case study, the criminal activities have been on the increase in recent times as a result of economic downturn and recession in the country. This has had negative effects on the socioeconomic development of the country. Billions of dollars have been lost by Nigeria as a result of this ugly trend [6]. The report on Nigeria watch [7] showed the most crime fatalities tending to occur in major cities of the country such as Lagos and Rivers.

F. Adesola · S. Misra (✉) · N. Omoregbe
Center of ICT/ICE Research, CUCRID Building, Covenant University, Ota, Nigeria
e-mail: sanjay.misra@covenantuniversity.edu.ng

F. Adesola
e-mail: adesola.falade@covenantuniversity.edu.ng

N. Omoregbe
e-mail: nicholas.omoregbe@covenantuniversity.edu.ng

R. Damasevicius · R. Maskeliunas
Kaunas University of Technology, Kaunas, Lithuania
e-mail: robertas.damasevicius@ktu.lt

R. Maskeliunas
e-mail: rytis.maskeliunas@ktu.lt

R. K. Shukla et al. (eds.), *Data, Engineering and Applications*,
https://doi.org/10.1007/978-981-13-6351-1_19

In addition, a graph showing the various incidence of armed robbery dwindled over the years, and the report concluded that the fatalities have remained high since then. To this end, our research question is "What are the steps to be taken to eradicate or reduce to barest minimum the growing rate of crime in Nigeria?" Application of Internet of Things and Big Data ICT technologies have shown great potentials from recent studies [8–12] and so we believe it can give us an optimal solution to this problem where criminals and criminal activities can be monitored, tracked, and detected real-time online [4]. This will go a long way to assist security agents to do their job efficiently and productively. Therefore, the aim of this work is to harness the current state of technology in the Internet of Things and Big Data technologies and develop a model that can be used to track and monitor crime real-time online.

2 Related Works

According to IEEE IoT community, Internet of Things (IoT) can be described as a collective network of sensors and smart objects that are self-configuring and adaptive for the purpose of identification, communication, sensing, and data collection as well as interaction with humans [13]. The use of IoT in crime detection and monitoring will bring comfort to security agents because of its various applications such as real-time monitoring, crime prevention, crime information management system, and implementation of smart cities [14].

Manual-based approach to crime recording and documentation has been the norm and practices by the local police in Nigeria. When a crime is reported or brought to the police station, the usual practice is that an incident sheet is given and the person involved is asked to write a statement in the incident sheet. After this, the police officer in charge is required to keep the recorded statement in the incident case file [15].

In 2011, a Crime Tracker was developed and deployed in Enugu state in Nigeria, where it was test run and adopted by the police command in that state for managing criminal records [15]. It has really helped the police authority in that command to be more efficient in managing criminals and criminalities in the state. The software is popular among the police in Enugu state, Nigeria. However, Crime Tracker has the following shortcomings: First, the backend was built on a relational database model, this is a limitation if we have to extend the functionalities to Big Data. This is because crime data is huge and in different forms (videos, audio, text, emails, images, etc.). Second, Crime Tracker is not web-based; it is not accessible by tablets and mobile devices.

The study in [16] proposed the use of surveillance CCTV cameras and smartphones equipped with GPS technology to track and monitor mobile phone user. The surveillance mobile app installed on the smartphone can be launched at will to start video streaming and sending this to the centralized monitoring server, which in turn sends to the police authority for action. The limitation of their work is that it does not work on all mobile phone platforms.

The study in [17] presents a ubiquitous crime prevention system that leverages on Internet access and a mobile app. The mobile app provides information based on the factors that could cause crime occurrence within an area. The mobile app is connected to a big data analytic engine that could analyze public big data such as credit card usage, pedestrian flows, smartphone usage, etc. The resulting big data is then analyzed using spatial statistical analysis to produce factors affecting crime occurrence and then provide crime information to the general public through the Internet or a mobile app.

The study in [18] developed a model for smart crime detection using IoT that is able to detect crimes in real time by analyzing the human emotions. It serves as a tool for both police agencies to determine crime as well as for citizens to be on the safe side of the places they live in. The limitation, however, is that the use of only wearable sensing devices was proposed and this could be subjected to removal during striping when attacked by kidnappers.

As for the study in [14], a smart community using wireless communication and ubiquitous sensing technologies to connect smart homes in a local community is proposed. It provides useful functions for the local residence—neighborhood watch and pervasive healthcare with a limitation of no capability to detect and track criminals.

The study in [19] proposed a system that identifies deception in communication through emails about criminal activities. In the study, decision tree classification data mining technique was applied to detect deception in suspicious emails. Deception is usually characterized by reduced frequency of first-person pronouns and exclusive words, elevated words as well as the use of action verbs. They applied this model of deception to a large email dataset and then applied decision tree classification techniques. The decision tree that was generated was then used to classify the email as fraudulent or not. However, the gap cited in their work is that it does not take care of real-time monitoring of criminals and only using emails to detect crimes is not enough.

As a result of a variety of gaps cited in [15–18], we are motivated to fill these gaps using current technologies in crime recording and tracking in Nigeria whose trends have been on the increase recently. By using big data technologies and IoT, it becomes very easy to derive and mine security intelligence from the vast volume of crime data [13].

3 Conceptual View of the Proposed Model

In this section, the conceptual model of the architecture is depicted in Fig. 1.

From Fig. 1, the following components can be observed: (i) the emotion state-sensing module that has the ability to sense the emotions of the user through a body-centric RFID enabled smart sensor, which is worn by the user (ii) there is also the emotion state recording module that records and stores the type of crime detected (iii) there is a crime detection module, which is responsible for sending alerts to the stakeholder concerned, for instance, the police authority or relative of the user (iv)

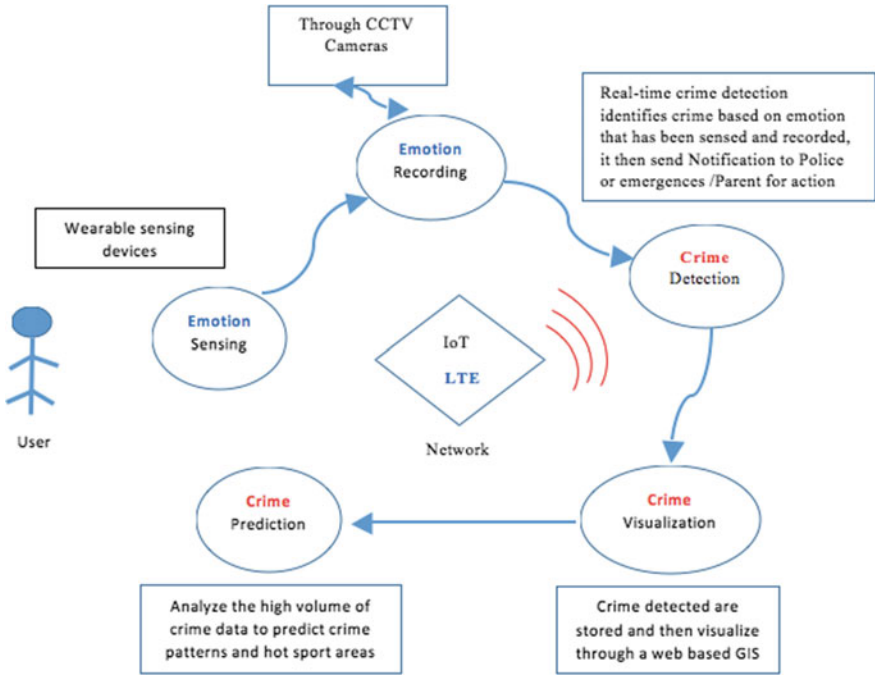

Fig. 1 The proposed crime prediction and monitoring model

furthermore, there is the crime visualization module, which stores the detected crime in a repository and then visualizes it through a web-based Geographical Information System (GIS) (v) finally, the fifth component is the crime prediction module for making crime predictions through the analysis of high volume of crime data. From Fig. 1, every person being tracked is equipped with a wearable or implantable device. The sensor here is a body-centric RFID enabled smart sensor that is capable of sensing the emotions of the user. This will be interconnected with and monitored through programmable CCTV cameras that have the capability of recording 36 emotional states of humans. If the person is attacked or in a dangerous situation, his/her emotion changes and this is sensed and recorded through the CCTV cameras and the emotion recording component module to get the actual crime being committed. In order to improve the accuracy of the type of crimes detected, the user emotions are recorded through emotions programmable CCTV cameras [18]. The crime detection component identifies crimes that are based on the emotions that were sensed and recorded. Alerts and notifications are then sent to the Police authority patrol vehicle for urgent action to be taken after the crime is reported. The crime visualization component stores the detected crimes in a database and then visualizes it through a web-based Geographical Information System (GIS). Crime prediction works by

analyzing a big volume of crime data, prediction can then be made for future crimes and area of crime hot spots can be avoided, and also help police to focus on the most problematic regions.

4 Implementation

In this section, the proposed model is implemented as a proof of concept. The system operates as follows.

A startup and welcome screen are first displayed as depicted in Figs. 2 and 3. In Fig. 3, the user is expected to enter a valid user name and password in order to proceed into the system. On successful login, the Administrator/user is provided with a menu option to choose from as depicted in Fig. 4. The options include criminals in a locality; crime Type; criminals record search, and criminal's search by description. If a user selects criminals in a locality, he would also have to specify the locality so as to retrieve relevant records. The user can then go on to select a crime type (e.g., rape, arm robbery, kidnapping, etc.) and click OK as depicted in Fig. 5. If there are records based on the search, the record is displayed as given in Fig. 6.

It is important to note that in the implementation of the web-based GIS in the above model, Microsoft Windows 8 was the operating system, on which the machine was running. MySQL and NoSQL were used as backend database for storing criminal records and PHP, HTML, NodeJS platform was used for the implementation of the proposed model. These development tools were chosen because of their simplicity

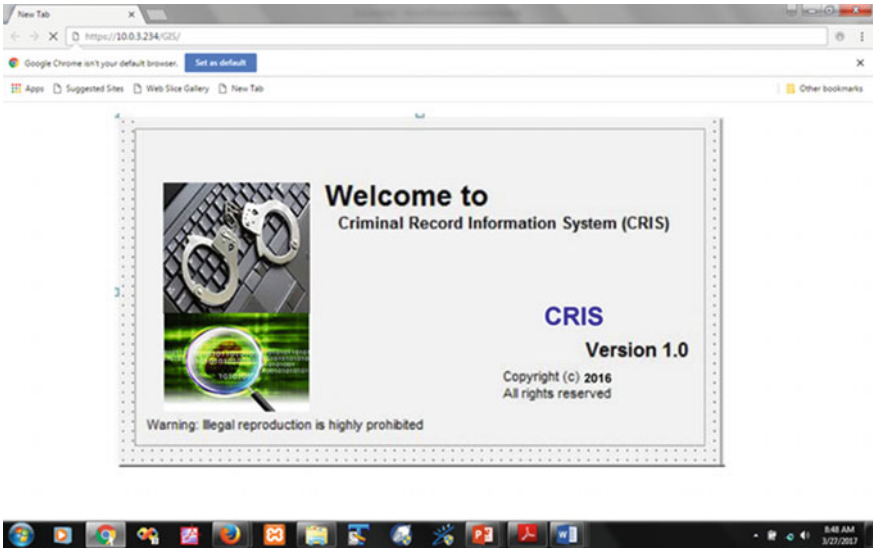

Fig. 2 Welcome screen

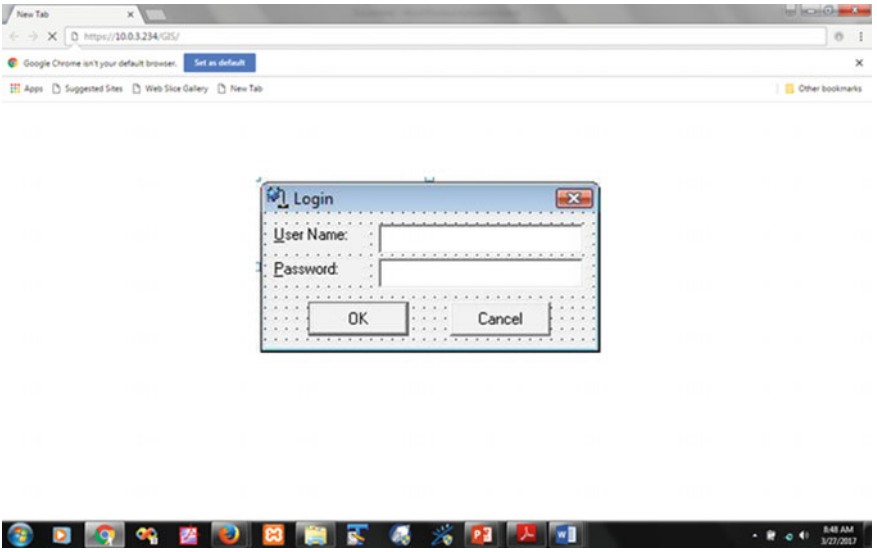

Fig. 3 Login screen

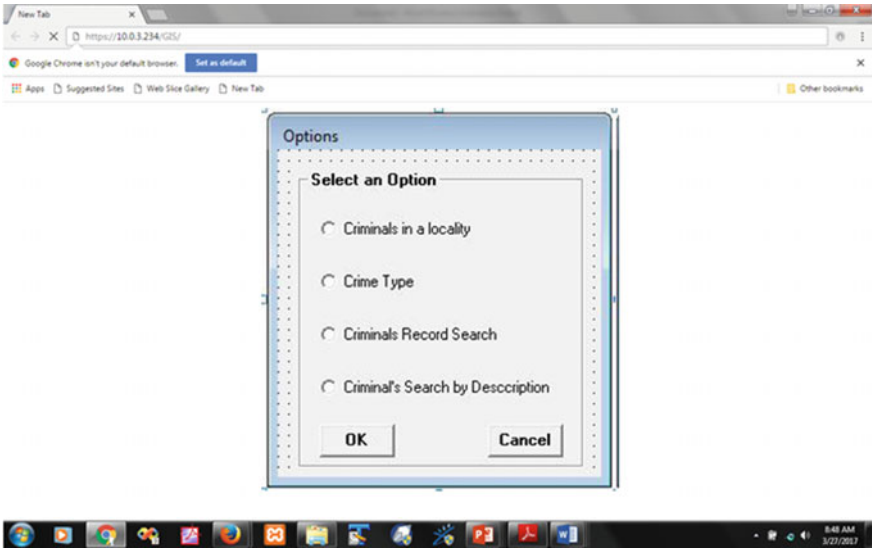

Fig. 4 Options Dialog

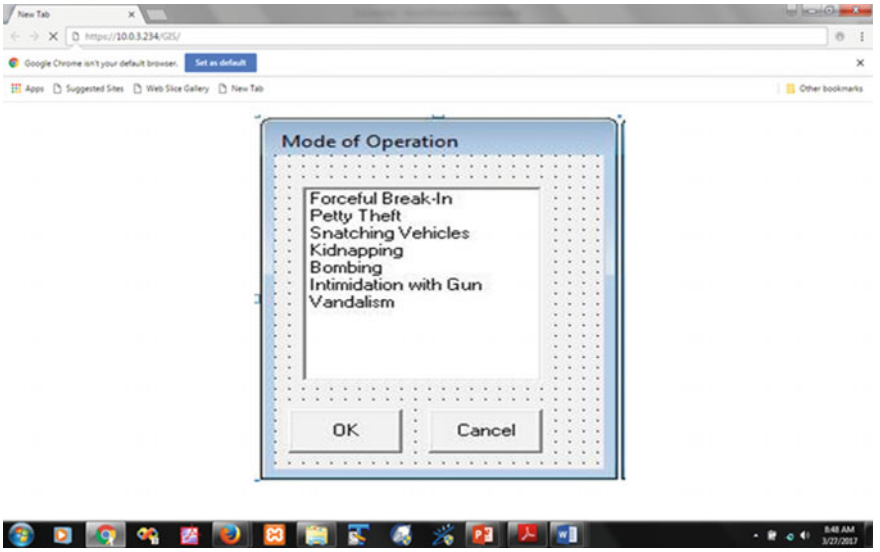

Fig. 5 Criminal Mode of operation

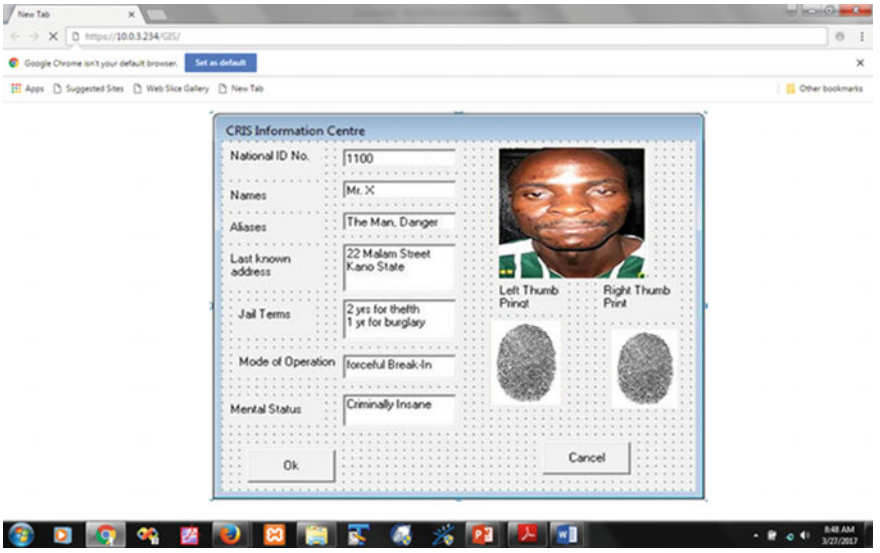

Fig. 6 Information form about criminal

Table 1 Comparison of our proposed application with an existing system

Functionalities	Crime tracker	Proposed application (CRIS)
GPS required	No	Yes
Costing	Expensive	Cheap
Ease of tracking criminals	Yes	Yes
Web-based GIS	No	Yes
Interoperability	No	Yes
Support NoSQL	No	Yes

and flexibility in coding, easy integration, and deployment. This will serve as a tool for the police authority and go a long way in assisting security agents in keeping track and saving criminal records in the database, and also is able to speedily retrieve necessary information about criminals and any other offenders when needed.

The designed system was implemented, tested, evaluated, and interpreted as discussed in this section. The system captured the following information on criminals:

- The names and the aliases used
- Crime type carried out
- Operation mode
- The Jailed term issued
- Committed last crime date
- State of mental status
- Criminal sex, etc.

The welcome screen, login page, and the rest of the interactive screens in the application provide the step-by-step process for tracking, record keeping, and searching and criminal records management. The following table (Table 1) shows the comparative analysis of our proposed system with an existing one.

From Table 1, it can be observed that the comparison was done based on functionality (i.e., GPS required, Costing, Ease of Tracking Criminals, web-based GIS, Interoperability, and Support for NoSQL). As depicted in Table 1, our application requires GPS functionality; it is web-based GIS (implying a wider audience coverage), and also is able to work with other softwares such as fingerprint reader (interoperability). Our software also supports the NoSQL, which is requisite to handling big data records.

5 Result and Discussion

The results obtained showed that the model and the application developed can be used to track and manage crime in Nigeria and the benefits of the proposed system that actually makes it different from the existing one are summarized as follows:

1. The application we are proposing here is comparatively cheaper to develop and use comparing with the existing systems, this is because it was developed using an open source platform, which is free to use. The existing one was developed using a proprietary platform, visual studio.net that is a paid license platform of development. Also in terms of simplicity and flexibility in usage, this is a system to be reckoned with [15].
2. The proposed application is simply convenient in easily tracking and locating criminals. This was confirmed during the testing stage where it was deployed [9].
3. This automated system will help in facilitating the record keeping of criminals for future references and if finally adopted, will make it difficult for criminals to escape authority. This is because the fingerprint and other biometric data of criminals are already stored in the system as shown in Fig. 6.

6 Conclusion and Future Work

This study has afforded us the opportunity to make contributions toward a crime free society by using IoT and Big Data technologies in curbing the growing crime rates in the country. The proposed crime detection and monitoring model and the software application evolved, if adopted by the government will go a long way in assisting our security agents to be more efficient and proactive in detecting crimes and hot spots areas in the country. Future work should, however, be focused on the maintainability of the software developed since this is a work in process and often comes with heavy cost. Software maintainability usually prolongs the lifespan of any software. However, future research work tends to show a detailed maintainability and security model. Stringent security measures should be put in place to prevent third party and cybercriminals from hacking the system.

Acknowledgements We acknowledge the support and sponsorship provided by Covenant University through the Centre for Research, Innovation and Discovery (CUCRID).

References

1. Ellis, A.: Theories of punishment. In: Encyclopedia of Criminology and Criminal Justice, pp. 5184–5192. Springer, New York (2014): Morris, S.V.: Crime and Punishment in Africa. The Encyclopedia of Crime and Punishment (2016)
2. Renold, A.P., Rani, R.J.: An internet based RFID library management system. In: IEEE Conference on Information & Communication Technologies (ICT), pp. 932–936 (2013)
3. Osabiya, B.J.: Ethnic militancy and internal terrorism on Nigeria's national security. Int. J. Dev. Confl. **5**, 59–75 (2015)
4. Li, X., Chen, J., Lin, X.: Smart community: an internet of things application. Commun. Mag. **49**, 68–75 (2011)

5. Abioro, T., Adefeso, H.A.: The menace of poverty and the challenges of public policy making in Nigeria. J. Sustain. Dev. **9**, 177 (2016)
6. Dlodlo, N., Mbecke, P., Mofolo, M., Mhlanga, M.: The internet of things in community safety and crime prevention for South Africa. In: Innovations and Advances in Computing, Informatics, Systems Sciences, Networking and Engineering, pp. 531–537. Springer International Publishing (2015)
7. NSRP: Nigeria Watch Project: Fifth Report on Violence (2015). http://www.nigeriawatch.org/media/html/NGA-Watch-Report15Final.pdf. Accessed 15 Mar 2017
8. Xiao, L., Wang, Z.X.: Internet of things: a new application for intelligent traffic monitoring. Syst. **6**, 887–894 (2011)
9. Lopes, N.V., Santos, H., Azevedo, A.I.: Detection of dangerous situations using a smart internet of things system. In: New Contributions in Information Systems and Technologies. Springer International Publishing, pp. 387–396 (2015)
10. Jalali, R., El-Khatib, K., McGregor, C.: Smart city architecture for community level services through the internet of things. In: 18th International Conference on Intelligence in Next Generation Networks (ICIN), pp. 108–113 (2015)
11. Suh, D.H., Song, J.H.: Establishing crime prevention systems based on internet of things and associated spatial urban factors (2016)
12. Kim, G.H., Trimi, S., Chung, J.H.: Big-data applications in the government sector. Commun. ACM **57**, 78–85 (2014)
13. Botta, A., De Donato, W., Persico, V., Pescapé, A.: Integration of cloud computing and internet of things: a survey. Futur. Gener. Comput. Syst. **56**, 684–700 (2016)
14. Swapnali, R., Rohini, B., Kaustubh, B., Mahendra, S.: Crime monitoring and controlling system by mobile device. Int. J. Recent. Innov. Trends Comput. Commun. **3**, 123–126 (2014)
15. Tae-Heon, M., Sun-Young, H., Sang-Ho, L.: Ubiquitous crime prevention system (UCPS) for a safer city. In: 12th International Conference on Design and Decision Support Systems in Architecture and Urban Planning (2014)
16. Byun, J.Y., Nasridinov, A., Park, Y.H.: Internet of things for smart crime detection. Contemp. Eng. Sci. **7**, 749–754 (2014)
17. Pulim, P.R., Rajesh, D.: Data analytics applied for crime identification over IOT. Int. J. Sci. Res. **5** (2016)
18. Cai, H., Xu, L.D., Xu, B., Xie, C., Qin, S., Jiang, L.: IoT-based configurable information service platform for product lifecycle management. IEEE Trans. Industr. Inf. **10**, 1558–1567 (2014)
19. Jara, J., Zamora-Izquierdo, M.A., Skarmeta, A.F.: Interconnection framework for mHealth and remote monitoring based on the internet of things. IEEE J. Sel. Areas Commun./Suppl. **31**, 47–65 (2013)