Integration of Internet of Things (IoTs) With Wireless Sensor Networks (WSNs) For A Transformative Secure Community Mindset Applied Deep Learning Models and Natural Language Processing Techniques

Pascal Muam MAH,
AGH University of Science and Technology, Krakow, Poland
mahpascal01@gmail.com or mah@agh.edu.pl

Iwona SKALNA,
AGH University of Science and Technology, Krakow, Poland
skalna@agh.edu.pl

Tomasz PEŁECH-PILICHOWSKI,
AGH University of Science and Technology, Krakow, Poland
tomek@agh.edu.pl

Gilly Njoh AMUZANG,
Silesian University of Technology Gliwice, Poland
tahgilly151@gmail.com

Micheal Blake Somaah ITOE
Silesian University of Technology Gliwice, Poland
michaelblake4u@gmail.com

Ning Frida TAH
Silesian University of Technology Gliwice, Poland
fridatah@gmail.com

Abstract

The amalgamation bond between human-to-machine communications (H2M) with the Internet of Things (IoTs) technology has played a major role in easing the burden on conventional living methods in most developed communities. Wireless sensor networks (WSNs) integrated with the Internet of Things (IoTs) are paving the way to society 5.0 of a shared community sphere with the people, environment and economic growth. The study propose a neural language processing-deep learning model (scoring model) for data security and information encoding as part of the fight to ensure security for communications and data sharing. Recently, machine-machine (M2M) has dominated human-machine (H2M) coexistence. The global economy has survived and flourished in Industry 4.0 without compromising on our community standards, environment, and economic growth. The little share approach in Industry 4.0 is now manifesting in global climate change impacts. The study uses a community mindset transformation appraisal (CMTA) concept and applied deep learning knowledge and natural language processing data. Wireless sensor networks (WSNs) nodes are used as edges of redistributed data and sensor nodes. A formulated data flow is applied to deep learning model summation of data flow (DLMSDF) concept. Formulated data is applied to the input, hidden layers, and output layers to demonstrate a possible method to monitor data flow. Based on information on deep learning models summation of data flow (DLMSDF), a grade of 30 bits were recorded as input data equal to output and a score of 4.58 and 4.0909 for Class B and Class A respectively. This is as per the behavioral influence of the Internet of things and wireless sensor networks on data security for community mindset. We concluded that the Integration of IoTs with WSNs can secure a perfect transformative community mindset free of security threats, corruption, racism, poverty, dominant attitudes, and lack of information.

Keywords: wireless sensor networks, internet of things, deep learning, natural language processing, transformative secure community mindset

Introduction

Wireless sensor networks have achieved a considerable boost in community development due to their flexibility in solving problems in different domains [3-5]. Reliable data collection techniques, whose aim is to ensure that sensed data are received successfully by a sink [1]]. Wireless sensor networks have the potential to change our lives in many different ways. In recent years WSNs have been successfully applied in various application domains which uphold transformative community mindset awareness to most things we do unknowingly that affect and retard growth. WSNs are network systems developed for sensing and monitoring vital signs

of the environment and area by using distributed and connected sensor nodes [2]. The changes within communities require a boost in the network of devices that can gather information and then communicate it through any wireless systems to the community leaders. Wireless sensor networks have surveillance and Monitoring capacity to secure and detect threats in areas like environmental temperature, humidity, air pressure, and noise level of the surrounding. In modern communities, typical wireless sensor network technologies are network protocols, network topology control, data fusion, data management, QoS assurance, time synchronization, and location information.

Literature Review

Thanks to the Internet of Things (IoTs) that improve time-to-school via an e-learning platform, time-to-market via e-shopping, time-to-hospitals via e-healthcare services, and many others. The Internet of Things allows connectivity with everything desirable for human consumption giving sensors small gateways the ability to dynamically and remotely change run-time behavior without codes [6-8]. The tremendous change in technology has engaged in a wide variety of ways in transforming mindsets for better communication within communities. The integration of the Internet of Things with wireless sensor networks can enhance a cyber security-free community [9-11]. The security landscape continues to evolve which increases cyber security challenges. The Internet of Things security is the technology segment that focuses on safeguarding connected devices and networks. When integrated with wireless sensor networks, it will securely capture information and send it to central administration for proper attention. Deep learning is a branch of artificial intelligence that contains input layers, hidden layers, and output that is trained using machine learning algorithms to understand humans and function like the human brain in the form of neurons. Deep learning has many models of supervised, unsupervised, and reinforcement learning that allows human-related data acquisition for decision-making [12-13].

Wireless Sensor Networks (WSNs) have a wide range of applications and scenarios in computer vision that range from simple detection to robotic visualization [14-15]. Open-source training platforms like Pytorch, SpaCy, Tensor Flow, Bert, Python, Jupyter Notebooks, anaconda, and Numpy train deep learning models to build models faster, validate, and accurately. Deep learning models are trained using machine learning algorithms helps to increase security in wireless networks, and reduce congestion problems

Wireless sensor networks can be classified into

- Static and Mobile WSN.
- Deterministic and Nondeterministic WSN.
- Single Base Station and Multi Base Station WSN.
- Static Base Station and Mobile Base Station WSN

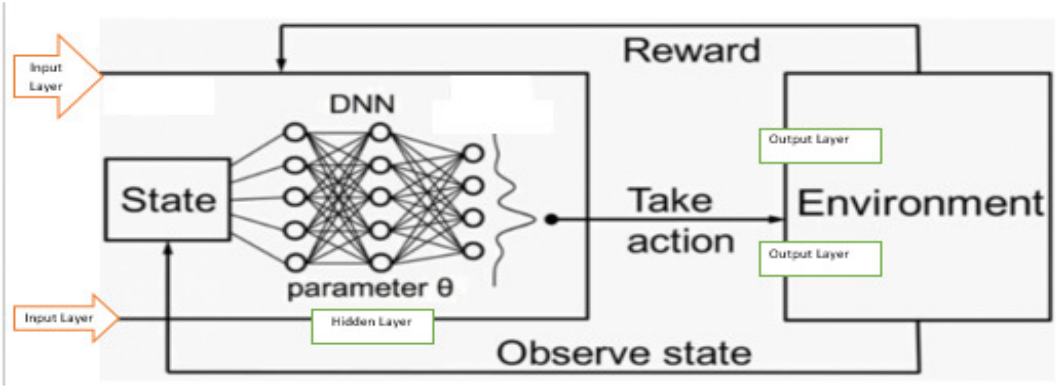

Figure 1: external input to the internal output

Figure 1 represents data circulation within system software for the internet of things and wireless sensor networks. From input to the state of standards of an application or community standards to deep neural networks into a pre-examination of observed state. Action can be taken to limit or expand the network within system administrators before sending to the external environment or community.

The hidden layers that self-multiply or allocated to data during training is a set of roles provided to secure information. The same manner in providing a set of rules to govern data for miners is possible to set the same roles to monitor this data from being stolen. The only challenge with machine learning is that training a system to handle data for the sake of preparation or analysis is time-consuming, costly, and difficult. Figure 1 is an example of how to predetermine the inflow of data or network and how to manage it till final users and keep track of it.

Wireless Sensor Networks and the Internet of Things with Radio Frequency Identifiers

To achieve a higher level of security, the study proposes an integrated system that allows the Internet of Things to monitor and secure weak nodes of wireless sensor networks. RFID can help to detect location by collecting information from the GPS. RFID can work with just short distance signals but can effectively share concise and precise information on time and cheaply. Wireless sensor networks and the Internet of Things can communicate faster with RFID and build stronger nodes for wireless sensor networks.

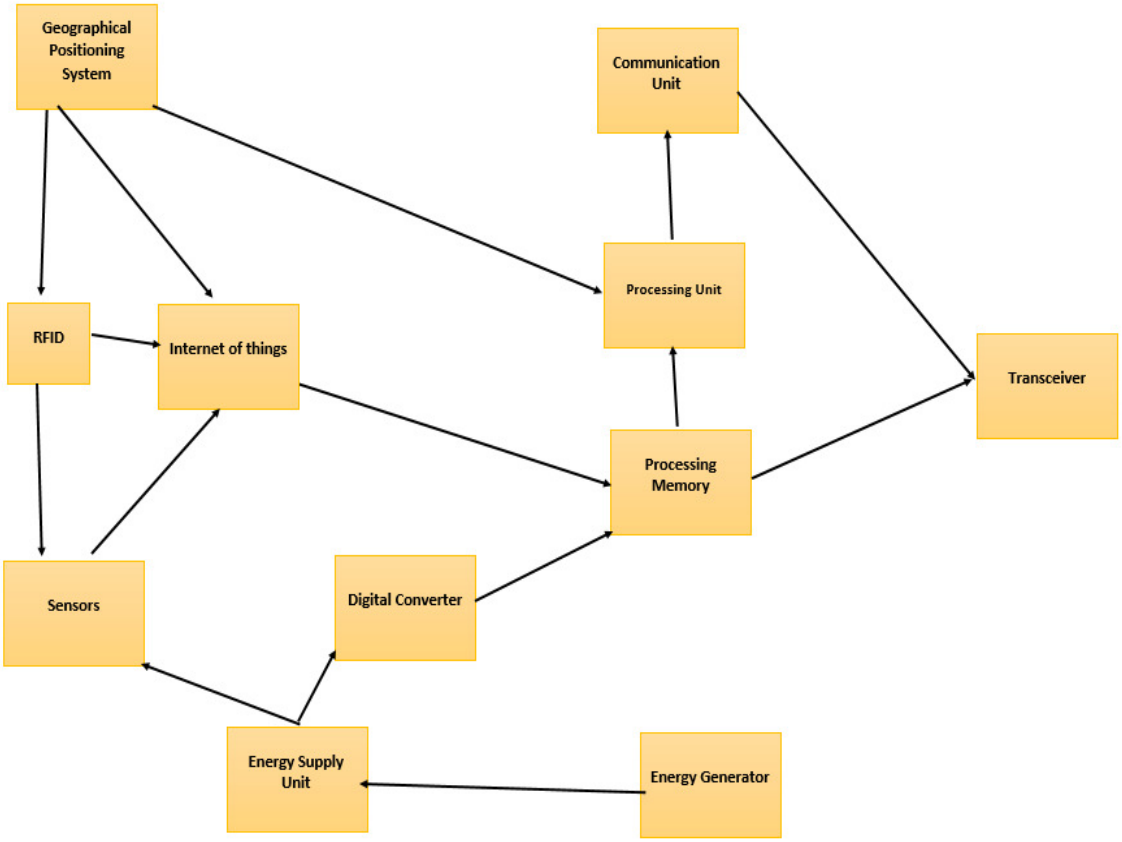

Figure 2: internal lower input to internal higher input.

Figure 2 briefly explains the flow of data between wireless sensor networks and the Internet of Things. There is an energy supply unit that receives energy from a generator. Sensors receive power from the energy supply unit and send it to the system servers to power connectivity with objects and devices (Internet of Things). The processing memory sends the data from the system to the processing unit and then to the communication unit. The final destination is the transceiver which distributes to community users with a keen attention and desire to enhance security of users through devices-objects connectivity with the help of Internet of Things. Sensors are network systems that are controlled by servers and other devices to achieve a desirable outcome. If integrated with the Internet of Things which can connect with almost everything, it is possibly easier to identify security breaches based on location tracking and device uses. Deep learning can work in a very smart system to document the number of output layers or data receivers or community users of the internet. Once the output number or users changes, there is an indication of the data breach if the changes are not equivalent to same responses from the input. GPS is a satellite signal that helps navigate and can perfectly work well with a 5G network to provide more access to our daily connectivity's with either items or

related user's objects and also provide more capacity for the Internet of Things to connect with other devices. NB: The bases of this approach lays with faster connectivity as it concerns humans whom are very difficult to manage. When there is fast internet there is fast connectivity over short and long distances. As it stand at the moment only satellite internet (5G) can provide this fast internet connectivity. The approach assume that internet of things is just a technology that enable connectivity with devices and object with the use of internet. When involved with 5G network, the level of connectivity improves.
For instance, communication amongst students in a student community are frequently based on academic disciplines. It is easier to identified non-academic communication using visual audio and text automated systems. There are systems such as ChatGPT that can detect and segment information. With the artificial intelligence systems like ChatGPT, it is possible to track down intruders in any community especial in student zone who are not students or academicians based on their communication content.

Deep Learning Innovative Expectations on Community Security

The role of digital technologies has been as a main solution to carter and manage the challenges that come with an economic and community shift to cloud systems. Deep learning is an added option and powerful adoption [16]. Data security is the heart of human dignity and a priority for business growth [17]. Machine learning has addressed a lot of issues beginning with data classification, prediction, forecasting, decision-making, and the fight against climate change. Presently, security is one of the major concerns for the business world, administrators, and even computer wizards. The following steps are set by this study as forceps areas needed for machine learning. The study called this area of concern as the objective of effectively managing the challenges the world faces with security issues.

The first objective is the need for a blended behavioral mindset change toward technological innovation. The management and collection of valuable physiological needs and data is a great way to change our thinking, feeling, and respect for each other privacy. This has to start with new laws governing the usage and sharing of data. The new shift in digitalization is like a surprise to the world and new education is needed to enable us to understand and monitor our surroundings with iMotions. There is a need for a holistic technology that cohabitates with humans and the existing digital space. Machine learning is one of the technologies that have this approach to cohabitating digital space but little training has been provided to the general public. Even with open access, remote areas still fall below requirement due to a lack of internet access to benefit from open libraries like Jupiter, anaconda, tensor flow, and many others. The World-leading behavioral analysis software for human behavior research should emphasize the need for all to know, have access and talk with a specialist.

The second object is the need for modernized socio-technical drivers that will accelerate a balance transition. One of the effective ways to mitigate the impact of data and Security breaches is to enable a far-reaching transformation of electricity, internet, open access, and limited privatization of network systems and autonomous systems. The amalgamation towards a sustainable system that is fully free or with fewer bridges is that which people don't go underground to have access to their needs. A sustainable socio-technological mindset is possible to achieve by focusing efforts to change our attitude towards security issues by examining the reactions of the past. The government should be fully engaged in the fight against security and community mindset. Security issues should not be limited by industrial policies, cultural norms, and political motivations.

The last objective is the need for digital technologies that provide access to information, challenges, and impact on the globe. The world needs to respond better and faster to divided systems, data scarcity, and breaches to achieve global health, and market-free systems with intelligent automation. Optimizing relationship management with intelligent servers, services, systems, and applications is what the world needs to timely respond to the growing security shift. Digital factory solutions should engage together with consultancy and local users. The reason is that digital solutions and community consultancy are both ICT tools that are collaborating to better share human needs and their impact on humans. Access to information and communication technology differ considerably across the globe with heavy impact. Many efforts made to close this digital divide and if successful, a better harmonize approach to fight security breaches can be achieve

Results

In this section, we provide details on how text or speech content can be classified into different parts of the speech based on data obtained via NLP means that help in decision-making. Data clustering here helps health practitioners to make proper decisions. This section represents the stages of documenting the inflow of data and outflow to determine if there is a breach or not. This section provides brief statistics that can be the program to allow algorithms to perfectly monitor network flow and strange communication.

Solution on Language Structure

Determination of Behavior oriented drive and influential function of IoTs-WSNs on content extraction

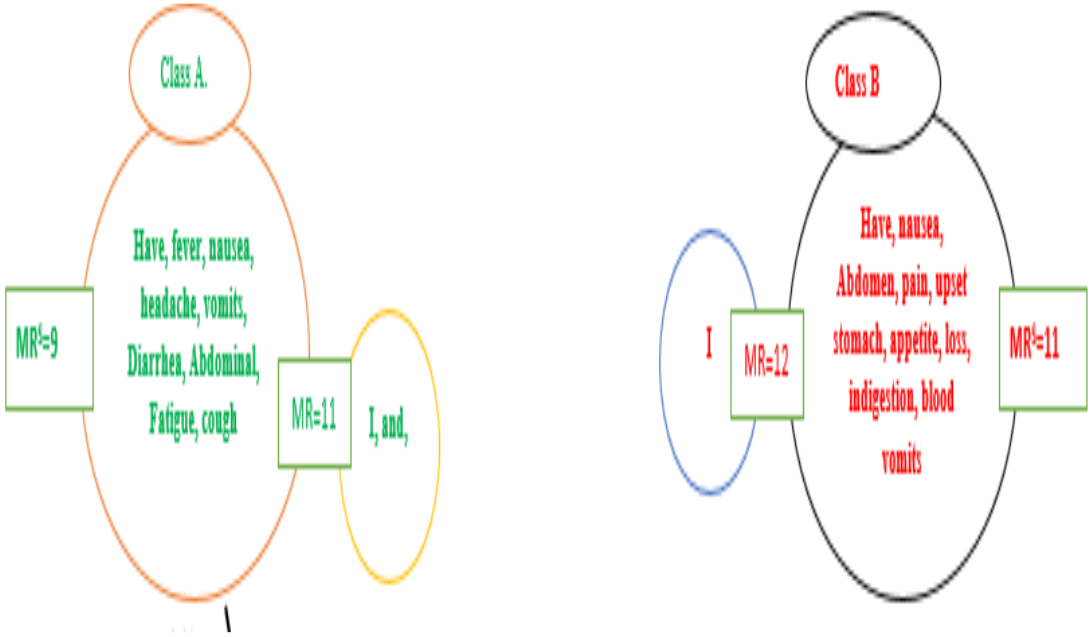

Figure 3: metrics range substitute and metrics range

Figure 3 as per (fig 7 & 8), provide data classified into different groups Class A and Class B. The group mark with red are made up of metric range substitute and metrics range for a single individual called Class B and that with green is called Class A which constitute of metrics range substitute and metrics range. To obtain influence rate, metric range substitute is divided by sum of metric range then multiple by behavior score. *Class A MR =11 and* MR^S=9 while *Class B :::)) MR =12 and* MR^S=11

SOLUTION CLASS A

BIF=Behavior oriented drive and influential function of internet of thoughts on *content extraction*
Class A MR =11 and MR^S=9
F=push factors of
D=Dependent parameters
MR=Metrics Range
MR^S*= Metrics Range Substitute*
BS=Behavior Score (Also human five sense organs)
KBS=key benefits score
$Eq=\int(D)\ {}^{MR^S}_{\sum MR} \times BS$

====)))) $\int(D) = {}^{9\cdot}_{11} \times 5$
====))) $\underline{\int(D) = 4.0909}$

SOLUTION CLASS B

BIF=Behavior oriented drive and influential function of internet of thoughts on *content extraction*
Class B MR =12 and MR^S=11
F=push factors of
D=Dependent parameters
MR=Metrics Range
MR^S*= Metrics Range Substitute*
BS=Behavior Score (Also human five sense organs)
KBS=key benefits score
$Eq=\int(D)\ {}^{MR^S}_{\sum MR} \times BS$

====)))) $\int(D) = {}^{11\cdot}_{12} \times 5$
====))) $\underline{\int(D) = 4.58}$

The statistics above detailed how the level of situation for both class of data. The class with higher amount require attention than class with lower score value. From the statistics we can say that the influence score is grade " Very Good" as per classification is achieve by both class but Class B is better than Class A with behavior score of 4.58 and 4.0909 respectively.

Solution on Deep learning distribution of data

HLP=Hidden layer pattern Value
HL=Hidden Layers
IL^S*= Input Layers*
OL=Output Layer
$Eq=\int(OL)\ {}^{IL^S}_{HL} \times HLPV$

====)))) $\int(OL) = {}^{30\cdot}_{6} \times 5$
====))) $\underline{\int(OL) = 30}$

From the solution, we can see that input equal to output. With the above system, it is possible to achieve a stable data flow with the integration of the internet of things and wireless sensor networks.

NB: To calculate hidden layer pattern value, you must know the required output determine to supply. Once you know the exact output required to supply a given data set, you calculate the hidden layer pattern value by dividing the total number of an input layer by the total output. This is to allow the possibility to monitor data usage amongst users in a community.

Applied Method

This section represents a step taken to explain the approach author used to develop the study. The following are subtitles: community transformative secure mindset, deep learning neural network for transformative community secure mindset, internet of things and wireless sensor networks integration architecture, stages to secure transformative community mindset communications using deep learning and natural language processing, and Communication secure transformative community with deep learning and natural language processing.

Community Setup and Deep Learning Layers

The way system administrations are being arranged in the physical environment is similar to system software setups. All algorithms are built to manage data generated by humans and the same way we produce this data is the same way computer administrators use to build and develop programs to manage the data
.

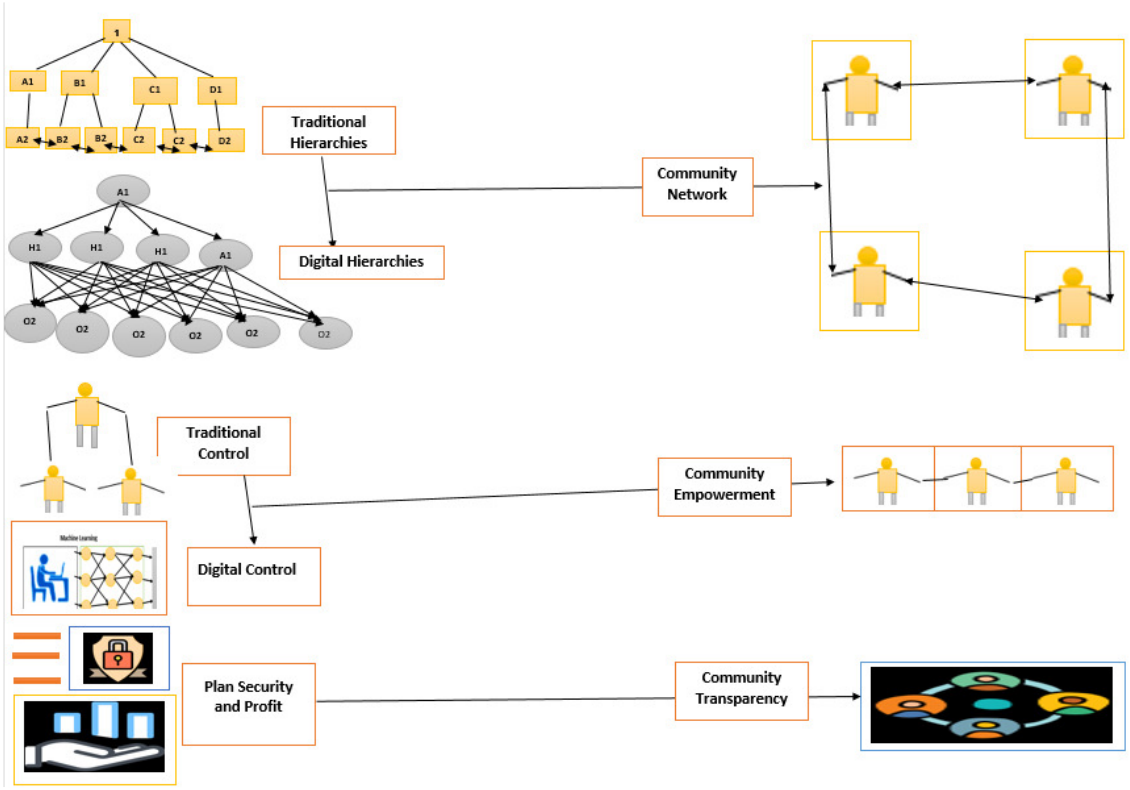

Figure 4 : community transformative secure mindset

Figure 4 represents the community's transformative secure mindset. Figure 4 represents three (3) stages which are traditional hierarchies to digital hierarchies, traditional control to digital control, and plan security and profit. These three (3) stages represent a move from a difficult system to a liberal system where there are networks of people, systems, information, transparency, freedom, and community empowerment.

How a community system administration is built determines the pattern of relationship between community dwellers. Security challenges in every community start with system management. A good community is built on a network system that allows and cohabitates togetherness, sharing, care for oneness, and collaboration. A community free from political divides, cultural divides, religious divides, marketing divides, and other social divides is a community free from a security breach. Figure 4 represents a system network that will build a community mindset free from security breaches. From system setup with similar deep learning algorithms to collaborative networking, and community empowerment to community transparency full of business opportunities.

Network Security Distribution and Deep Learning Standards

In a secure community, network distribution can take a similar format that will hinder hackers from taking advantage, These deep learning approach is an example of a standard distribution of network that will allow easy access to monitor unauthorized users. The system allows the software to document the amount of input and output.

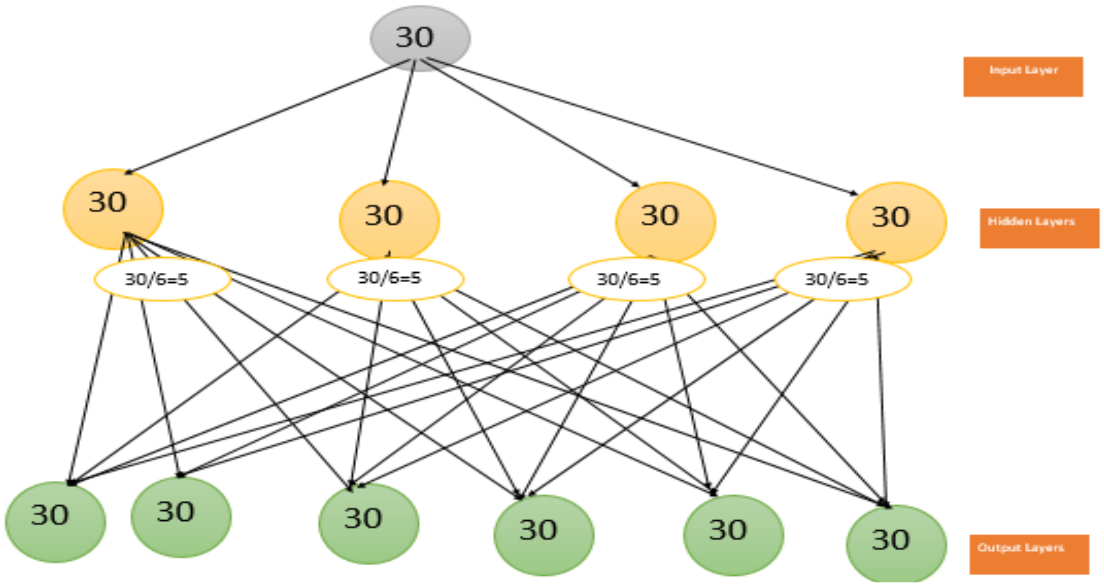

Figure 5: deep learning neural network for transformative community secure mindset.

Figure 5 represents a deep neural network that can be integrated to achieve a community transformative secure mindset. In the deep learning self-explain Figure 5, a single input with standard value is distributed amongst hidden layers. The aim is to achieve a fixed input and output and a possible faster approach to detect a break in the flow of data. In Figure 5, one (1) input distribute data to four (4) hidden layer and this data end up in six (6) output layers.

Figure 5 explains a system where output is predetermined by understanding the number of expected users. This allows the deep learning algorithm to monitor the flow of data effectively and securely. With a single input and a known output center, it is possible to monitor breaches as the hidden layers enable the system administrator to monitor shortage and excess direction.

Integration architecture internet of things and wireless sensor networks

This section shows how the Internet of things can be distributed alongside wireless sensor networks to monitor and identify devices, systems, areas, and locations where security challenges are predominant or occur and how often. It is possible to build a device with the modern application and install it with all devices to track down hackers, or simply install an optimizer of the internet of Things to identify and track down people who exceed community norms.

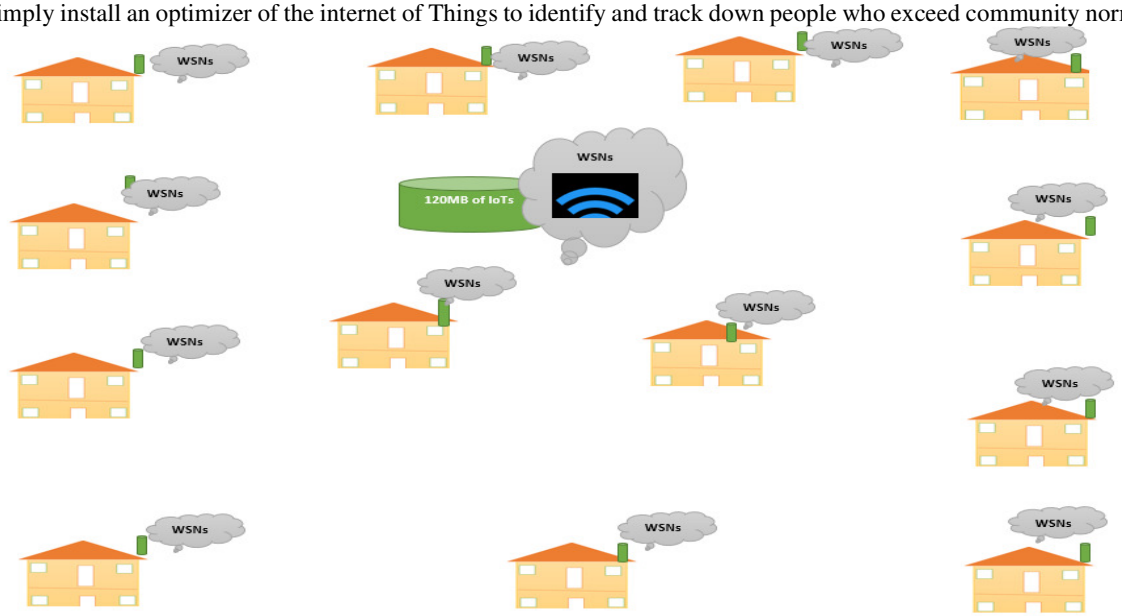

Figure 6: internet of things and wireless sensor networks integration architecture

Figure 6 represents the integrated architecture of the Internet of Things and wireless sensor networks. Figure 6 shows a community of 13 houses with a well-developed sensor of the Internet of Things installed on each home. This Internet of Things sensor help identified the quality and quantity of the network and supply data to wireless sensor networks. Internet of Things overseas if the level of internet supply from the main control unit is stable or stolen or broken or not. The 13 homes in this imaginable community are registered in the main supplier center. Any additional user is identified by the Internet of Things and information is sent to the control unit for follow-up or tracking down.

Figure 6 represents a community with an Internet of thing software server that automatically switches off the Internet and sends signals to a wireless sensor network about a system breach. This is a system that can work for a community with similar laws, and respect for each other, has a community networking system, community empowerment system, and community transparency desire mindset.

For instance, communication amongst students in a student community are frequently based on academic discipline. It is easier to identified non-academic communication using visual audio and text automated systems. There are systems such as ChatGPT that can detect and segment information. With the artificial intelligence systems like ChatGPT, it is possible to track down intruders in any community especial in student zone who are not students or academicians based on their communication content.

Internet of things technology can be used to automatically switch off internet connection once a non-academic text or audio content is detected in each community especially in a purely academic setting. Since internet of things connect with devices and objects. The sensors network system will be able to act in similar way like alert systems that sends signal to the internet of things technology to respond with an adequate action. Some countries already uses systems of this nature especial at airports to detect fetching text or facial view of suspected persons.

Natural language processing and deep learning for a community security mindset

The language of a people is an ideal identity that cannot be cheated or easily broken without being fully integrated into it. One of the ways to track outsiders is a constant request for digital translation. The following paragraphs explain how natural language can be determined using a parts of speech to extract content

.

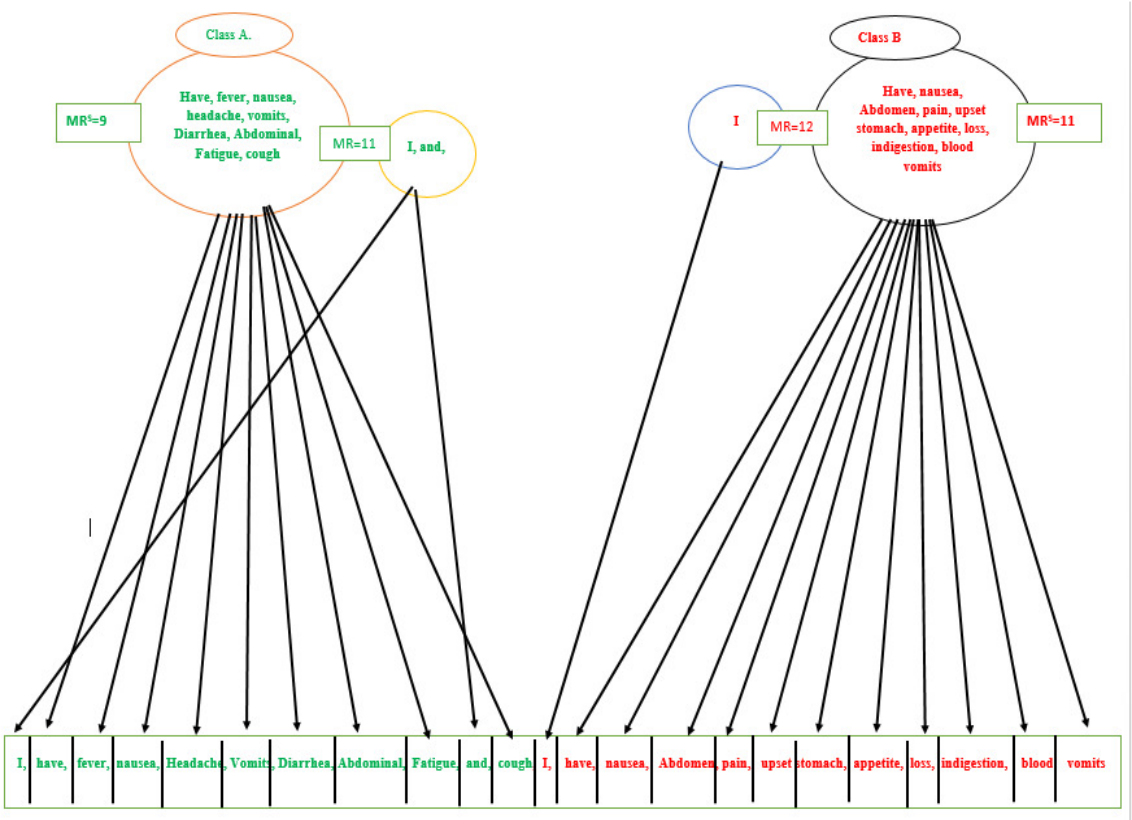

Figure 7: stages to secure transformative community mindset communications using deep learning and natural language processing

Figure 7 represents the stages required to secure transformative community mindset communications using deep learning and natural language processing. In a community with every device and user identified, it is possible to track unidentified habitats. The study uses parts of speech as what identifies a community and certain culture to suggest a deep learning model that follows standard parts of speech.

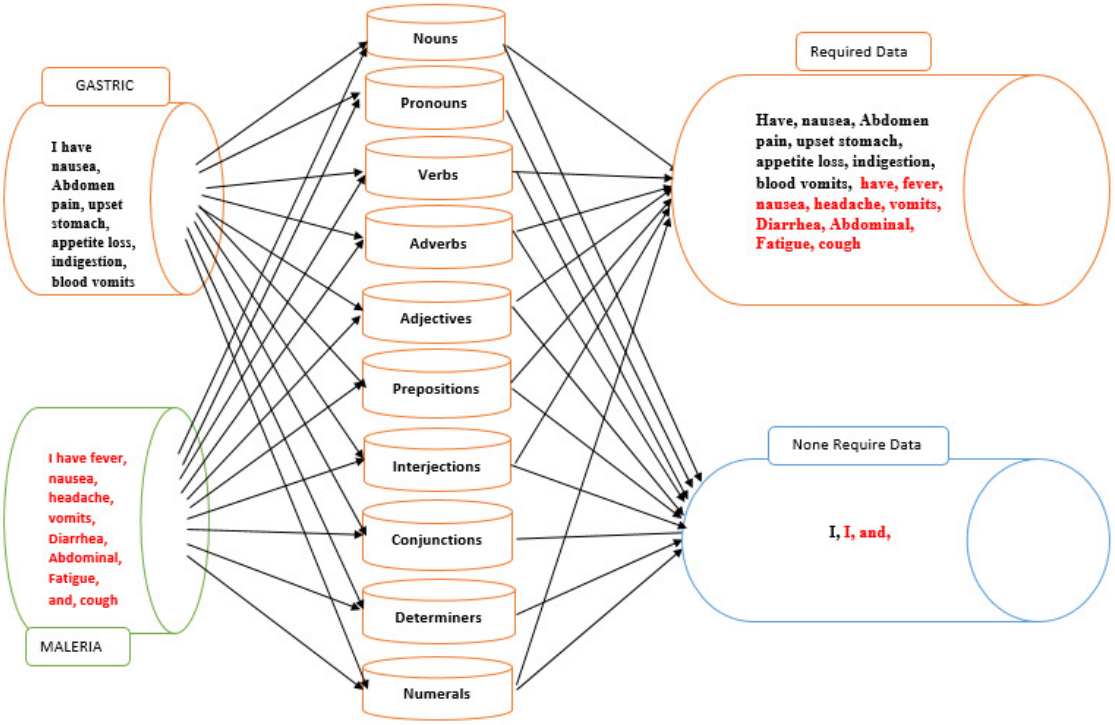

Figure 8 : communication secure transformative community with deep learning and natural language processing

Figure 8 represents laydowns and how parts of speech can be structured into a deep learning model to achieve content awareness. This system can help community leaders track down known dwellers based on their communication and uses of the community language. It is possible to identify unknown native speakers based on their communication tone, ascends, and proper grammar structure of words. This study uses this to suggest a deep learning system based on parts of speech.

For instance, communication amongst students in a student community are frequently based on academic discipline. It is easier to identified non-academic communication using visual audio and text automated systems. There are systems such as ChatGPT that can detect and segment information. With the artificial intelligence systems like ChatGPT, it is possible to track down intruders in any community especial in student zone who are not students or academicians based on their communication content.

To achieve a communication-secure transformative community with deep learning and natural language processing parts of speech can be grouped into two levels as per table 1.

Metrics Range	*Nouns*	*Adjectives*	*Adverbs*	*Verbs*	*Prepositions*	*Pronouns*	*Conjunctions*	*Interjections*	*Determiners*	*Numerals*
Metrics Range Substitute	*Nouns*	*Adjectives*	*Adverbs*	*Verbs*	*Prepositions*	*Interjections*	*Numerals*			

Table 1 above represents elements of the part of speech that the study uses to evaluate the influence of technology application with a deep learning model using natural language processing that can help a secure community. The classification is following the English language standard.

Discussion of Application of Community Secure Mindset

This section discussed possible areas of securing information, method, and how business enterprises use the internet of Things, wireless sensor networks, RFID, deep learning, and natural language processing to manage and circulate goods and services.

Community Secure Mindset for Logistic Services

A community secure mindset is a system that allows working together, empowering for global success and advancing maximum transparency. This system of community mindset can also be achieved within a logistics enterprise. Logistics inventory tracking systems are one of the most important information distribution between suppliers and customers. In recent years, Confidence was built and trust was restored between customers and suppliers when timeliness existed within short notice. With the coming of modern technology, confidence has shifted from Just being timely updates but transparency throughout the supply chain. With the Inventory tracking systems, logistics managers have been seriously assisted throughout delivery services with the help of RFID, wireless sensor networks, and the Internet of Things. The Internet of Things connects customers' devices, and home and wireless sensor network nodes with RFID to maintain maximum security. Logistics managers nowadays use the Internet of Things, RFID, and wireless sensor networks to plan for the following

- Stock distribution
- Re-stocking of warehouse
- Predictive analytics systems.
- Location management tools.
- Drone-based delivery.
- Automated vehicles.

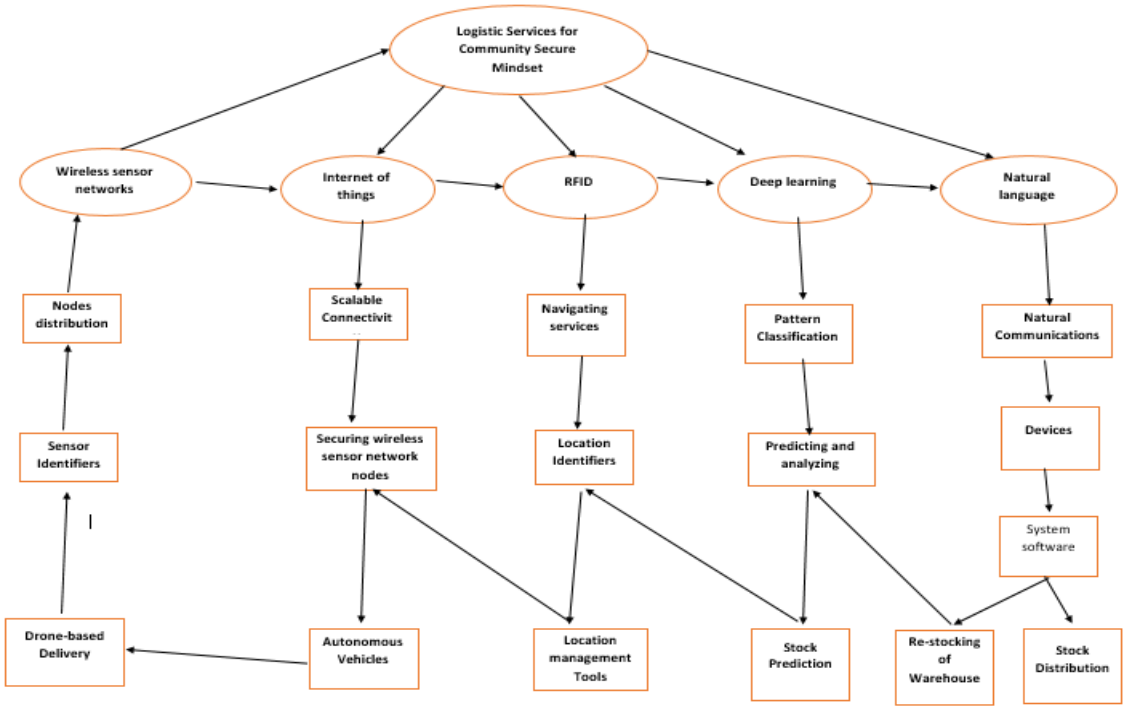

Figure 9: Community Secure Mindset for Logistic Services

Figure 9 represents some of the aspects of logistic systems and services manage properly and secured using wireless sensor networks, the Internet of Things, RFID, deep learning, and the Internet of Things. The following paragraphs provide details on the services.

Stock distribution. Thanks to the advancement in technology that distribution can take place at any time be it manpower-wise or autonomous systems. Wireless sensor networks have been able to navigate through communities, capture locations and share with system administrators. Knowing the area before embarking on delivery has been one of the most important aspects of wireless sensor networks for logistics managers. The Internet of Things has tremendously boosted security within logistics services. The Internet of Things is capable of identifying security

threats and pretexting wireless network nodes [18]. The RFID helps navigate throughout the process by locating and directing the movement of the distribution from supplies to consumers.

Re-stocking. RFID is several logistics devices that help register stocks in advanced systems incorporated with the Internet of Things to track the warehouse and the shop supply chain. The wireless sensor networks collect information from warehouses and send them to management units.

Predictive analytics systems. The level of predetermining of future sales, security threats, and increased supplies has relatively improved in the few past years. Thanks to the tracking systems. RFID, wireless sensor networks, and the Internet of Things are radicalizing the supply chain with advanced methods of monitoring and evaluation systems [19]. This has made it quite easier to track and predict outcomes in a very simple way.

Location management tools. Thanks to modern technology. Nowadays, RFID systems help navigate through the warehouse, sea, communities, and globally. Suppliers take it very easy to identify customers' locations.

Drone-based delivery. Most logistics managers use drones to monitor the warehouse and production systems. The challenges of underemployment and the need for hiring an expert to run some underground monitoring are over. Risky monitoring and distribution services are handled by drones.

Automated vehicles. Logistics services are handled by mostly automated vehicles, trains, and plains nowadays. With the emergence of self-driverless cars, it is possible to remotely access and deliver goods to customers [20]. Drones are already running most of these services.

Communication Security with Digitalized Method (Scoring Model)

This a neural language processing system of securing communication and information using a deep learning model approach. This is a systematic approach developed by the study to secure communication between the author and the intended receiver. This model can secure communication in several ways using code. With the proposed method as a model, a piece of information can be coded in two-layer method, three-layer method and many more base on communication between the producers and users

.

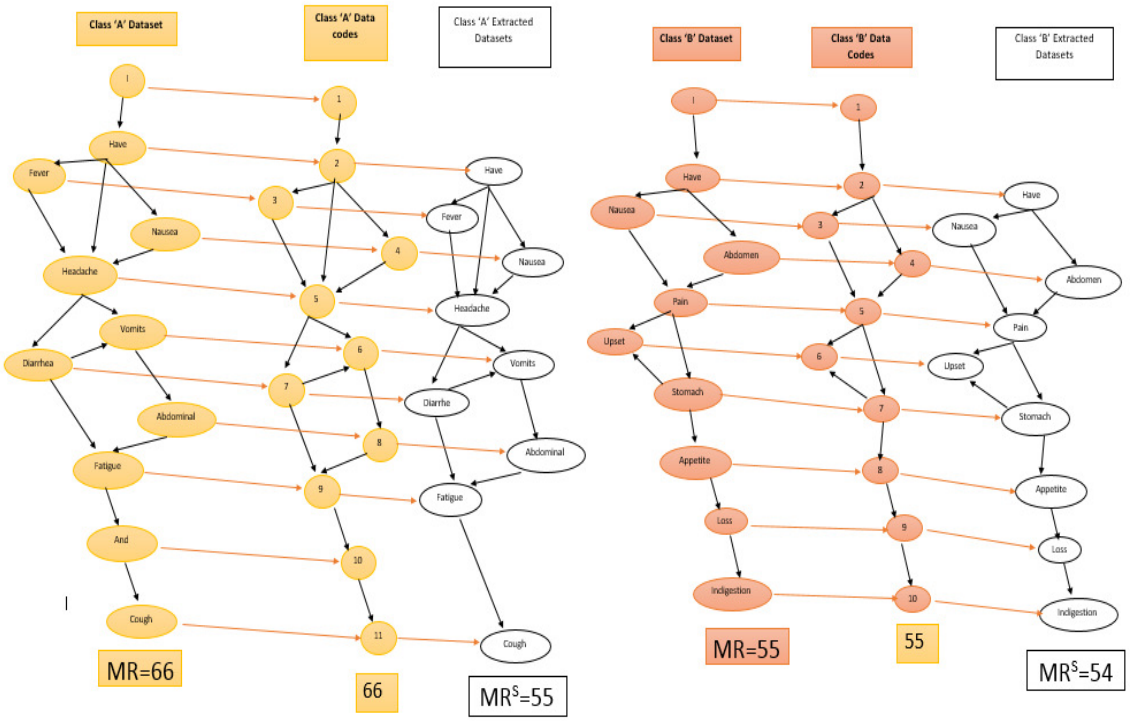

Figure 10: (Scoring model) for communication security.

Figure 10 represents a piece of data coded with the reference total of each stage. Any modification difference from that of intended producers will not be accepted by the end users. This model of information securing can code a language or communication and share only codes. Once the intended receiver has the software, he or she can interpret the data and even if the data is breached or modified, it cannot be interpreted because the real data remain between the producers and intended receiver and can be modified with prior notice between the two parties.

Conclusion

This study is concerned with the application of wireless sensor networks (WSNs) technology with the Internet of Things (IoTs) to large-scale environmental monitoring communicative transformation to shape people's minds on their wrongs through monitoring systems. Based on formulated information for deep learning models summation of data flow (DLMSDF), a grade of 30 bits was recorded as input data equal to output. We concluded that the Integration of IoTs with WSNs can secure a perfect transformative community mindset free of security threats, corruption, racism, poverty, dominant attitudes, and lack of information. We designed an integrated framework that takes into consideration both the operational, and application-specific needs of a well-defined community. We explain WSNs and IoTs using deep learning to secure communication, run language checks for non-nature speakers, and present a deep learning model approach to secure stable WSNs using IoTs for community use.

For instance, communication amongst students in a student community are frequently based on academic discipline. It is easier to identified non-academic communication using visual audio and text automated systems. There are AI systems such as ChatGPT that can detect and segment information based on content. With the artificial intelligence systems like ChatGPT, it is possible to track down intruders in any community especial in student zone whom are not students or academicians based on their communication content.

References

- Wei, X., Guo, H., Wang, X., Wang, X., & Qiu, M. (2021). Reliable data collection techniques in underwater wireless sensor networks: A survey. IEEE Communications Surveys & Tutorials, 24(1), 404-431.
- Khalaf, O. I., Romero, C. A. T., Hassan, S., & Iqbal, M. T. (2022). Mitigating hotspot issues in heterogeneous wireless sensor networks. Journal of Sensors, 2022.
- Rawat, P., Singh, K. D., Chaouchi, H., & Bonnin, J. M. (2014). Wireless sensor networks: a survey on recent developments and potential synergies. The Journal of supercomputing, 68(1), 1-48.
- Raza, M., Aslam, N., Le-Minh, H., Hussain, S., Cao, Y., & Khan, N. M. (2017). A critical analysis of research potential, challenges, and future directives in industrial wireless sensor networks. IEEE Communications Surveys & Tutorials, 20(1), 39-95.
- Islam, M. M., Hassan, M. M., Lee, G. W., & Huh, E. N. (2012). A survey on virtualization of wireless sensor networks. Sensors, 12(2), 2175-2207.
- Albreem, M. A., Sheikh, A. M., Alsharif, M. H., Jusoh, M., & Yasin, M. N. M. (2021). Green Internet of Things (GIoT): applications, practices, awareness, and challenges. IEEE Access, 9, 38833-38858.
- Sadeeq, M. A., & Zeebaree, S. (2021). Energy management for internet of things via distributed systems. Journal of Applied Science and Technology Trends, 2(02), 59-71.
- Vermesan, O. (Ed.). (2022). Next Generation Internet of Things–Distributed Intelligence at the Edge and Human-Machine Interactions. CRC Press.
- Gardašević, G., Katzis, K., Bajić, D., & Berbakov, L. (2020). Emerging wireless sensor networks and Internet of Things technologies—Foundations of smart healthcare. Sensors, 20(13), 3619.
- Farash, M. S., Turkanović, M., Kumari, S., & Hölbl, M. (2016). An efficient user authentication and key agreement scheme for heterogeneous wireless sensor network tailored for the Internet of Things environment. Ad Hoc Networks, 36, 152-176.
- Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. Future generation computer systems, 29(7), 1645-1660.
- Angelopoulos, A., Michailidis, E. T., Nomikos, N., Trakadas, P., Hatziefremidis, A., Voliotis, S., & Zahariadis, T. (2019). Tackling faults in the industry 4.0 era—a survey of machine-learning solutions and key aspects. Sensors, 20(1), 109.
- Ali, E. S., Hasan, M. K., Hassan, R., Saeed, R. A., Hassan, M. B., Islam, S., ... & Bevinakoppa, S. (2021). Machine learning technologies for secure vehicular communication in internet of vehicles: recent advances and applications. Security and Communication Networks, 2021.
- Abraham, A., Falcon, R., & Koeppen, M. (Eds.). (2017). Computational Intelligence in Wireless Sensor Networks: Recent Advances and Future Challenges.
- Corke, P., Wark, T., Jurdak, R., Hu, W., Valencia, P., & Moore, D. (2010). Environmental wireless sensor networks. Proceedings of the IEEE, 98(11), 1903-1917.
- Schmitt, M. A. (2022). Deep Learning in Business Analytics: A Clash of Expectations and Reality. arXiv preprint arXiv:2205.09337.
- Mittal, A., Hooda, R., & Sofat, S. (2017). Lung field segmentation in chest radiographs: a historical review, current status, and expectations from deep learning. IET Image Processing, 11(11), 937-952.

- Hu, F., Xie, D., & Shen, S. (2013, August). On the application of the internet of things in the field of medical and health care. In 2013 IEEE international conference on green computing and communications and IEEE Internet of Things and IEEE cyber, physical and social computing (pp. 2053-2058). IEEE.
- Li, H., Hua, J., Li, J., & Li, G. (2020). Stock forecasting model FS-LSTM based on the 5G Internet of things. Wireless Communications and Mobile Computing, 2020.
- Ding, Y., Jin, M., Li, S., & Feng, D. (2021). Smart logistics based on the internet of things technology: an overview. International Journal of Logistics Research and Applications, 24(4), 323-345.