Neural computing for sensor health audit towards Hill station disaster management

Keerthika Ramesh [1]
Electronics and communication engineering
Saveetha Engineering college, Thandalam, Chennai,
Keerthika2510@gmail.com

Logeshwari.L [2]
Electronics and communication engineering
Saveetha Engineering college, Thandalam, Chennai.
logeshwari.15423@gmail.com

Dr. M. Vanitha [3]
Assistant Professor,
Electronics and communication engineering
Saveetha Engineering college.Thandalam, Chennai.
vanitha@saveetha ac in

Abstract. The emerging growth of sensors and integrated device plays an optimum role in recent innovations towards natural disaster management system. Keeping an underground wireless sensor network (UGWSN). Similar to wireless sensor network (WSN) the underground sensor network is created with numerous sensor devices integrated with control unit, communication unit etc. the sensors are placed inside the earthy surface to record and reflect on natural changes inside the ground surface. Installation of sensor nodes in the slopy area of hill stations undergoes various challenges to make the communication in spite of rigid surfaces, soil texture hard stones etc. On the other hand, natural consequences such as heavy rainfall landslides impact the performance of the sensor opted in the surface of the earth. To address these Constraints, various research frameworks are considered. The goal of proposed model is to make efficient communication between wireless sensor network (WSN) placed in the underground area. The proposed system measures the network performance through sensor communication flow without any interrupt, calculates the dead nodes, energy transmission per iteration and optimize the network during loss of signal. Neural boosters are placed at the pathways to detect and reroute the network. The bio-inspired behaviour of chimpanzee based behavioural optimization algorithm act upon the strong nodes during the droppage of energy level and adopt the network performance without making disconnection. The proposed system achieved 99.86% packet delivery ratio (PDR) on testing with 100 dynamic nodes.

INTRODUCTION

Underground wireless sensor network (UGWSN) is a kind of network prototype deployed to analyse the certain area, are region and its natural status through wireless sensors. It is used to monitor, to detect the anomalies, to correct the existing problems over the region by detecting the problems continuously. Inspite of Ad Hoc network, Mannet protocol used to monitor the wireless sensor network performance is considered as the base concept here environmental parameters are discussed. These nodes are connected in a certain prototype model and called adaptively with dynamic performance[1].

The sensor nodes are integrated with the supportive platform, where the control unit is normally build using microcontroller. The environmental parameters such as temperature, humidity, air quality are normally monitored using embedded sensors. These parameters are analysed by the software generated analysis algorithms. The growth of recent technology including artificial intelligence, machine learning created a strong foundation for sensor data analysis.

The sensors collect environmental data and update live into the cloud. To evaluate the status of environmental conditions such as temperature, air quality, air flow rate, humidity relevant sensors are utilized in the wireless sensor network. Similarly, to get clarity on underground status, such as soil strength, soil moisture level, slope analysis, gas presence under the ground etc. these parameters are measured using relevant sensors[2].

The sensor networks collect the real time parameters accurately and process the data into the embedded microcontrollers, application specific integrated circuits, digital signal processors to analyse on presence of abnormality.

WSN are utilized in agriculture mining, industrial monitoring, field monitoring, surveillance monitoring, critical area monitoring, Hazardous monitoring etc. various challenges are present in development, deployment of the sensor network[3].

The key issues in development and maintenance of underground sensor network are that signal attenuation due to solid surfaces, reflection of signals through solid rocks, absorption of signal level through rocks etc. the loss of signal is apparently improved with the help of signal boosters in many cases. To improve the reliability of the sensor devices, frequent auditing of sensors are made. Back up sensor nodes are connected with WSN models to improve the communication continuity. Most of the sensors work with radio frequency (RF) communication enabled channel. The interference is more during the signal dissipation. Hence noise is one of the key problems in underground communication[4].

•To maintain the required amount of energy efficiency in the sensor network, energy auditing is made, sensor power status is kept stable. Loss of energy in nodes are overcome with consistent back up boosters. Proper utilization of energy expand the life span of the sensors.

•Sensor nodes are normally connected with routing protocols. The dynamically changing behaviour of the sensor nodes often rerouted through communication protocols. The topology is selected based on the environment coverage, demand etc[5].

•The precision of the sensor devices is not always high, the loss of acoustic signals during communication is analysed before laying the sensor network. Damage to sensor nodes due to environmental changes, solid surfaces are still the existing drawbacks.

The rest of the paper is constructed with detailed background study in Section II. The system architecture framing, drawbacks of existing system is explored in Section III. The proposed methodology is expanded in Section IV. The results and discussions, interpretation of obtained results are given in Section V. Further the results are concluded with future expansion.

BACKGROUND STUDY

Liu et al. (2023) The authors took the research on frequency switchable wireless underground sensor network. The presented system discussed on frequency triggered under water wireless communication network through multi-layer neural network with adaptive Q-learning. Various comparative study is made in terms of different routing protocol, the simulation is validated with effective convergence and energy efficiency [6].

Sureshkumar et al. (2020) the author explored a wireless communication system using fuzzy-based authentication and clustering model (FSAC) that considers various data patterns transmitted through packets with the sensor integrated platforms. These sensor integrated data packets come with authentication information helpful to avoid attacks. To evaluate the routing path efficiency the algorithm optimizes at every iteration. The presented system results 12% energy increases compared with existing systems[7].

Goyal et al. (2020) The author presented a system in which secure authentication model is developed. The data aggregated method provides cluster-based arrangement for UWSN protocol. The network is connected with unique cluster head selected randomly from the sensor nodes. The cluster head is authenticated at every gateway node to ensure the secure user entry into the appropriate nodes. During network operations, the nodes are not getting compromised on reliability. The presented approach is compared with existing state of art approaches.[8].

Kavitha et al. (2021) the author proposed a cryptographic enabled network clustering structure is deployed to provide privacy preserving optimal multiple network. The presented approach focused on dynamic clustering model applied in heterogenous network. In terms of area the source nodes are grouped into random network. The presented approach provides high data privacy through elliptic curve cryptographic technique[9].

Li et al. (2020) the presented system explores the idea of encryption with elephant-based optimization technique. The optimization technique is used to provide adaptive outcomes alter the functionality of the communication system. Using digital signature based encryption and decryption process, an effective privacy preserved model is created. The performance of the communication network is evaluated using Peak signal to noise ratio (PSNR), Mean square error (MSE). The major challenge in the existing systems is that loss of node energy during the dynamic operation. Reconnection takes more time[10].

SYSTEM DESIGN

Considering various existing research works, the primary information is gathered on underground wireless sensor network. Due to soil rigidity, soil texture, unexpected water flow due to heavy rain, land slide that break the surface of the hills etc. in the similar way damage to the sensors need to be detected. The attenuation of signal due to large rigid surfaces are considered. The proposed system is focused on creating an optimized network model, adopt the algorithm flow towards the dynamic changes happening in the network. The proposed system is tested with wireless sensor network created with random sensor as underground nodes. The proposed approach is developed using MATLAB 2021 software. It is high level computing language for making scientific computing task, numerical computing etc. the proposed system considers signal processing and network toolbox for evaluating the network simulation, further statistical and neural network toolbox is utilized for development of optimization algorithm, neural computing process.

METHODOLOGY

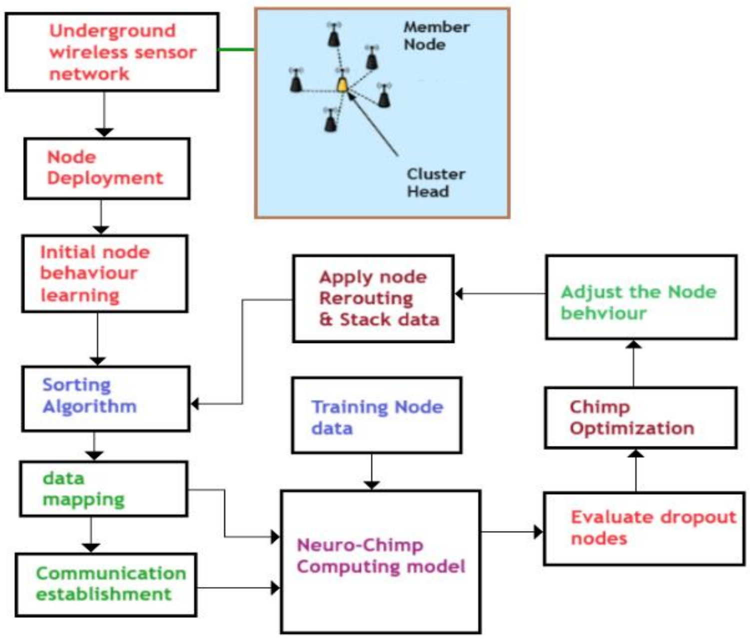

Fig. 1. System architecture for proposed UGWSN

Fig 1. Shows the system architecture of proposed neuro-chimp computing model for under ground wireless sensor network (UGWSN) system.

In the proposed system underground wireless sensor network is evaluated and optimized through simulation of network nodes in hill stations. The installation of nodes in the hill station is one of the difficult tasks since the texture, solidity of the soil is rigid and uneven. the communication between the nodes is interrupted through various natural consequences like heavy rain, land slide etc. the proposed system considers these constraints and evaluated a learning model with creation of underground wireless sensor network (UGWSN) with random nodes created with random distance and energy. The nodes are deployed with random velocity.

- The amount of energy loss and attenuation is formulated, the dead node evaluation, bit rate is evaluated in terms of Neuro-Chimp optimization model. Neural network through resilient network is utilized for energy drop analysis followed with chimp optimization model for adjusting the nodes dynamically.
- Dynamic neuro-chimp model for detection of energy loss in an automated way, adjust the sensor nodes positions through optimization

System Module Design

The system modules are evaluated as follows

Sensor nodes configurations

The proposed approach is simulated using MATLAB software with networking and parallel computing toolbox. The network nodes are initiated with random energy levels E, random assignment of distance d within the nodes are configured. Using Dijkstra's algorithm (DA) the best Euclidean distance is evaluated to connect the nodes. The distance d in the initial condition is explored as distance(d)=0; When acceleration of energy increases from initial level to next level the velocity v is added up. Hence the distance is calculated as

$$Best\_Node = dist(v) + weight(v, u) < dist(u), \qquad (1)$$

then the node is getting connected. The process is getting completed until the full iteration get reached Q, the maximum number of iterations with Q(n) nodes.

The energy is dynamically getting updated into the nodes towards every iteration, as the network behaviour getting changes the node performance is deviated. The difference between the initial velocity and enhanced velocity of the network nodes are explored.

The system modules are evaluated as follows

Creation of underground sensor nodes

The nodes are created using random distribution of 100x100 nodes in which 100 cluster heads are selected. The cluster head controls the underground sensor nodes connected under it say 5 to 10 nodes in average. The initial assignment of the node distance, energy are provided through sorting algorithm.

Deployment of nodes

Once the initial positions of the nodes are assigned, the position, cost, energy is assigned through random distribution scale. The nodes are deployed with initial velocity. Further using sorting algorithm, quick search algorithm the nodes are deployed into the communication window.

Energy drop detection

The system design with Resilient neural network is implemented to detect the energy drop in the node, node disconnection due to any disasters such as heavy rainfall, land slide are detected. The neuro-chimp computing model is developed with the existing neural network model.

Dynamic Optimization

To enhance the performance of the existing network model, to adjust the position of the network, chimp optimization technique is utilized. The chimp optimization is based on behavioural aspects of the biological model called chimpanzee. The activity of the chimp changes from time to time keeping the jumping nature from one place to another. Even though the migrating behaviour of the chimp confuses, it takes clear decision on holding the branch. The action taking behaviour of the chimp is considered as the metaphor for handling the data distribution and rearranging the network nodes according to the nearest best node available. The chimp behaviour is differentiated as four categories. Based on the node selection, best node selection, shortest and strongest distance is connected.

Implementation Summary

- The underground wireless sensor nodes are created using quick search algorithm, deployment is made using random distribution network.
- The nodes are initiated with base velocity '0' started and accelerated through uniform velocity and then random velocity to show the dynamic behaviour. The energy, distance and cost values are assigned dynamically.
- The nodes are opted to Neural computing model where the Resilient network is employed for testing the energy consumption level automatically.
- The chimp optimization is evaluated to dynamically change the network nodes according to the demand. The dead nodes , damage of nodes due to heavy rainfall, land slide are detected through random triggering and simulated the performance of the Neuro chimp computing model.

RESULTS AND DISCUSSIONS

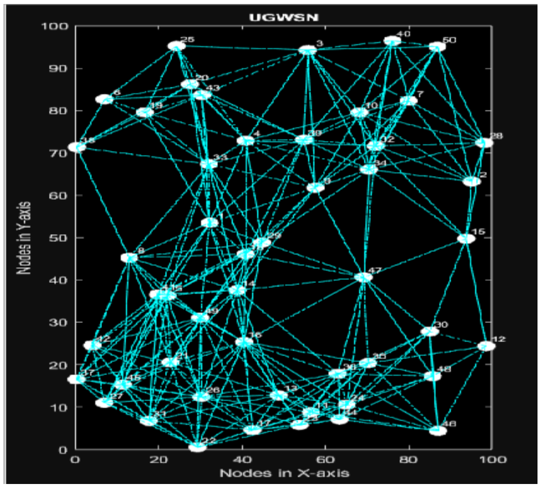

Fig 2. Deployed structure of UGWSN

Fig 2. Shows the deployed structure of UGWSN utilized for deetction and alert system(DAS) on hill stations. The random nodes are created with dynamic energy and dynamic distance

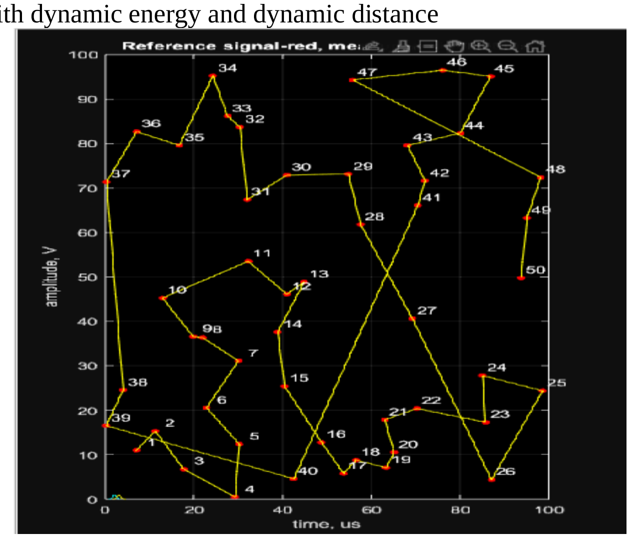

Fig 3. Initial network structure

Fig 3. Shows the initial network structure of UGWSN. The initial energy is dynamically applied with each nodes. The energy level is getting varied after the transmission begins.

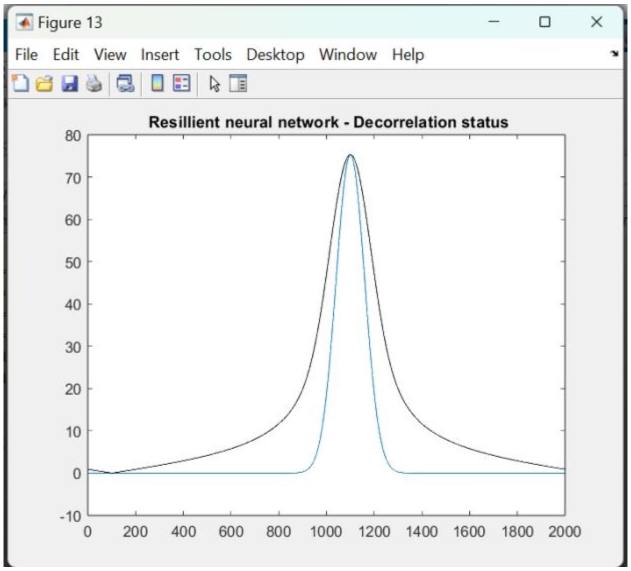

Fig 4. Detection of signal loss

Fig 4 shows the decorrelation of transmitted signal strength and received signal strength measured through the resillient neural network enabled neural computing system. During the detectin of signal loss, the preceeding node and its energy level, power level is verified to validate the damage of the sensor.

CONCLUSION

To protect nature conservation, to secure the environment various recent developments are focused. An underground wireless sensor network is one of the crucial systems developed for monitoring the natural changes. Beneath the earth, various parameters are measured and monitored to provide immediate alert during natural disasters. The proposed approach act as a auditing model for underground sensor network. The proposed system is developed with neural computing block combined with bio-inspired chimp behaviour simulation. The proposed approach achieved throughput of 1388160.000000 kbps and the packet delivery ratio is almost 99.86%. with the help of neural computing blocks, the signal attenuation loss is detected through correlation and decorrelation status. The amount of loss is evaluated and immediate power level, signal strength, data existence is measured to check the sensor damage. The ultimate goal of the system is to produce an efficient model that adopt the dynamically changing environment and audit the health of the underground sensor network. Further the system can be improved using deep learning model and sensor performance analysis using reinforced learning model.

ACKNOWLEDGMENTS

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