

REVIEW PAPER: A NOVEL TECHNIQUE FOR OPTIMIZED ROUTING IN WIRELESS BODY AREA NETWORK USING GENETIC ALGORITHM

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Abstract:-Optimized routing plays an vital role in WBAN when nodes are deployed over body and different body activities like blood pressure, EEG, ECG, FECG (Fetal ECG), blood oxygen level, etc., can be measured and nodes communicate with sink node where all database is maintained and we need to find shortest path so that less time consumes, fast delivery, no delay, no loss of packets. To get optimized routing we have many optimization techniques out of which Genetic Algorithm is best to be used to optimize the signal so that less memory is used, network life time increased, etc. Genetic algorithm is the natural heuristic technique to find best solution to optimization and to the search problems. Location of node is determined by using AAP (Atmospheric Air Pressure) technique. WBAN is useful in different fields range from military to medical. In medical, it is more beneficial for handicapped person or to old age person.

KEYWORDS:- Chromosome, Crossover, Fitness function, Mutation, Sensor nodes, Wireless Body Area Network

1. Introduction:-

WBAN is a network of sensor nodes which are deployed over human body or within body or around human body to measure the psychological signals which are generated within human beings [4]. When one node sends data to other sensor node then sampling, processing and communication is done between nodes. WBAN is used in different areas like medical, emergency service, consumer electronics, sports and fitness, lifestyle (emotion detection), defense, entertainment and gaming and physical health care.

WBAN in medical is used for continuously monitoring and logging vital parameters of patients who are suffering from chronic diseases like diabetic, heart attack, asthma, etc. WBAN is best useful for old age person as well as for handicapped person like in medical application; if the patient who suddenly gets heart attack when no doctor is there then by using WBAN, the nodes which are implanted by patient can alert the hospital, before the patient get attack through measuring changes in the vital signs and a diabetic patient could auto-inject insulin through a pump until the insulin level declines.

Sensor nodes should be connected in some form by using some architecture like Star, Bus, Mesh, Tree, etc. By using Star, there will be a central node (Sink node) with which all other nodes are connected [6]. Star architecture is replaced by other mesh, tree or cluster based algorithms which are called multi-hop architecture which reduce power consumption of sensor nodes.

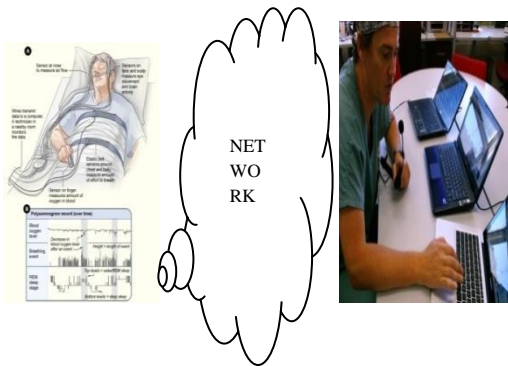


Figure 1.1:- WBAN in Medical Application

In the WBAN, there are some issues like standardization of sensors (specifity, range, precision, type), sensor placement, integration of data into medical database, privacy and security.

WBAN consists of 3-tier architecture namely: Sensor Network Tier, Mobile Computing Network Tier and Remote Monitoring Tier [3]. Sensor nodes capture vital signs like heart rate, blood pressure, electrocardiogram, blood oxygen level, etc from human body and then all the signs which are captured is transferred via Bluetooth, Zigbee , GPRS to the remote monitoring Network.

1. Sensor Network Tier:-Sensor Network Tier is the first tier in which sensor nodes are deployed over human body and these nodes can capture vital signs from human body. In real world, the person who is suffering from heart ache is implanted with sensor nodes through which patient's blood pressure, ECG, blood oxygen level, Cholesterol level.

In this tier, there are different modules like ECG module, Blood oxygen module and for these modules there is Genomote node which are used to process and wirelessly transmit vital data. MAC protocol is used to transmit data between two process.

2. Mobile Computing Network Tier:-In this, patients need some handheld devices like mobile phones, PDA, Tablet through which he/she wirelessly communicate with doctor. Handheld devices consist of operating system, processor, memory, Nand or Nor Flash, USB, UART, SD, etc. All the data through this tier is forwarded to Remote

monitoring Network tier and this is the most important tier without this no communication is possible.

3. Remote Monitoring Network:-It is the 3rd network tier which collects the patient's data and then stored in the database. Only the authenticated doctor check the respective patient's reports which are measured through sensor nodes and then the doctor accordingly prescribe medicine to the patient.

Optimized routing is that in which best path is selected on the basis of cost minimization, load distribution policy, and overall network performance so there are different optimization techniques used in WBAN like Particle Swarm Optimization (PSO), Ant-Colony Optimization (ASO), Genetic Algorithm (GA), Memetic Algorithm (MA), Shuffled Frog Leaping (SFL) out of which GA is best because it is natural heuristic optimization technique. GA is inspired by evolutionary algorithms and in this there is a chromosome like data structure and recombination operators are used to preserve critical information [11]. For reliable routing key concepts to be implemented are as:-

- Network model.
- Assignment of weight.
- Chromosome.
- Selection of chromosome.

In GA, the chromosomes with the highest fitness function are selected and then crossover and mutation process is done until objective function is achieved. The equation for the fittest function is as under:-

$$\text{Fitness}(s) = [W_{\text{cost}} \times \text{cost}(s)] + [W_{\text{time}} \times \text{cost}(s)] + [W_{\text{Reliability}} \times \text{reliability}(s)]$$

The value of fitness function might be higher than standard value and there is a penalty function which will be used to keep the fitness function value within limit.

GA generates a transmission schedule consists of transmission rounds. In the transmission schedule, from sensor nodes data is collected and then passed to the base station or sink node and it consists Of routing paths that network have to follow to maximize lifetime. From figure 1.2 we can clearly see that the nodes are deployed over body and by

using Genetic Algorithm optimized routing can be made possible. Different possible routes are shown in the form of tree structure as in figure 1.3.

For achieving fault tolerance and to extend the lifetime of network, relay nodes are used for gathering data. Relay nodes are those nodes which are having higher energy than other common sensor nodes and are used as cluster heads.

Following are the steps used implementation of GA for estimating reliability in WBAN:-

1. Generate random population
2. Fitness function
3. New population
4. Selection
5. Crossover
6. Mutation
7. Accepting
8. Replace
9. Test
10. Loop

GA is best suitable for heuristic based solution space.

Packet error rate(PER) is determined when sensor nodes send data to each other and to rectify error some mitigation techniques are used namely retransmission mechanism, the error correcting codes, and the hybrid ARQ [2]. Through retransmission mechanism, power consumption is increased by sending some additional packets. Then Error correcting code: LT code is utilized that does not require any additional packet as LT code has less power consumption. For the security purposes, there is a new key development scheme for WBAN namely LIRA in which light channel and radio channel is used as information transmission medium [7]. In this scheme, light channel is used for sensor initialization and radio channel is used for sensor authentication and in this sensor nodes has its separate unique secret keys with Body Control Unit (BCU) and a device BCU which collects information from all sensors and then informs the user (patient, nurse) and then conveys the central telemedicine system (server) that data gathered from sensors (ECG, blood oxygen, etc). There is Light Source Unit (LSU) to transmit secret key to the Body Control Unit (BCU) over Visible Light Channel (VLC) and each sensor node. Key verification is done at each sensor node. Automatically localization of nodes is possible in WBAN by knowing about Atmospheric Air Pressure (AAP) [5]. AAP is the solution when the patient mistakenly muddle-up nodes or misplace

nodes i.e. wrong placement of nodes. Nodes which are worn by the patient in the form of arm-bands, adhesive pads, leg straps can be mistakenly wear at wrong place when the patient has to take shower or during swimming, he/she forgot where nodes has to actually placed then there AAP is the solution.

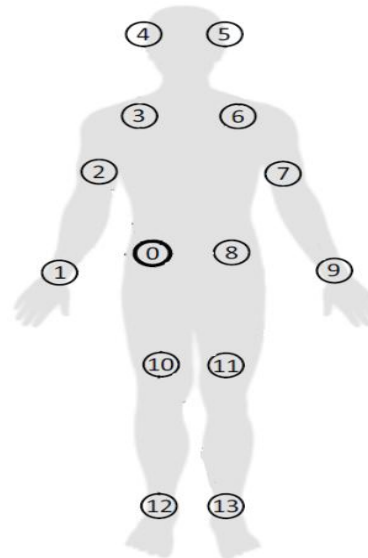


Fig 1.2. Position of nodes on different places.

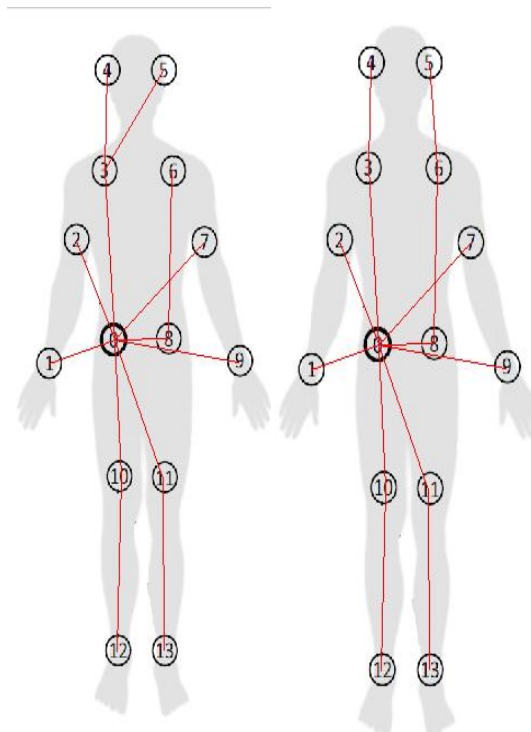


Fig 1.3 Best possible routes.

II. BRIEF LITERATURE SURVEY

Ghosh *et.al*[1] proposed a modulation technique, i.e. Discrete Frequency Shift Key(DFSK) for ultralow power wireless sensor node applications, which has been shown to be the most energy-efficient transmission technique for short-distance wireless communication systems. The proposed DFSK technique significantly relaxes the frequency stability requirement in the transmitter RF front-end at the cost of a little increased transmission power, which, in turn, significantly simplifies the circuit complexity as well as reduces the overall circuit power consumption within the transmitter.

Hamada *et.al*[2] proposed a packet error mitigation technique named as LT code, to realize a highly reliable wireless body area network (WBAN). By using LT code, received signal strength (RSS) is measured as radio propagations around the human body between two antennas attached to the participants, calculated packet error rate (PER) based on the measurement results of RSS and to mitigate the packet error, evaluate the application of LT code to WBAN.

Wang *et.al*[3] presented a distributed WBAN network for medical supervision. The system contains three layers: sensor network tier, mobile computing network tier, and remote monitoring network tier. It provides collection, demonstration, and storage of the vital information such as ECG, blood oxygen, body temperature, respiration rate. Furthermore, it also provides medical service management and disease warning.

Ortiz *et.al*[4] proposed multi-hop in BANs to improve the network performance by reducing energy consumption and, thus, extending network lifetime and work presents the Adaptive Multihop tree-based Routing (AMR) protocol that is extensively evaluated in a real test bed deployment. Fuzzy logic is proposed to evaluate several node and network parameters in order to improve network performance in terms of throughput and energy consumption.

Lo *et.al*[5] presented a new scheme to automatically identify the locations of wearable sensor nodes in WBAN. Instantaneous atmospheric air pressure readings are compared to map nodes in physical space and enhancement enables unassisted sensor node placement, providing a practical solution to obtain and continuously monitor node locations without anchor nodes or beacons. In future it could even be extended to traditional WSNs to explore collaborative localization with different sensors and

radio signal-based area and distance-measuring localization schemes.

Imtiaz *et.al*[6] presented the AMR protocol that is extensively evaluated in a real test bed deployment and improved multihop tree based routing protocol using Kruskal's algorithm. Network simulator 3 (NS3) to simulate and found that our algorithm is better than AMR if many of nodes.

Kovačević *et.al*[7] proposed a novel multi-channel key deployment scheme for wireless body sensor networks. The proposed key deployment scheme requires no public key cryptography and therefore is suitable for CPU-constrained sensor nodes. In future, work will be on the implementation of public key cryptography to deploy the initial key in the presence of a very strong attacker.

Momoda *et.al*[8] discussed two MAC protocols suited for a cooperator-assisted BAN, named as a hybrid TDMA/CSMA and a TDMA realizable on the IEEE 802.15.4e standard and evaluated the packet error rate and power consumption by computer simulations where the stored Received Signal Strength Indication (RSSI) data are used.

Chaudhary *et.al*[9] proposed an energy efficient FECG signal optimization using genetic algorithm in which battery life of FECG sensor is increased and lowering the load on buffer memory. In the future, other bio-inspired algorithm can be used and other compression techniques can also be applied to the FECG signal to facilitate its smooth and fast transfer over the network.

Santhosha *et.al*[11] improves the quality of service of network by using Genetic Algorithm to maximize reliability and improves network lifetime.

III. HOW APPROACHES ARE BEHAVED IN DIFFERENT ENVIRONMENT:-

To implement optimized routing in WBAN, various simulators have been used to show the behavior of network like calculating the interaction between nodes in WBAN using some mathematical formulas and shows graphically node's packet delivery ratio or normal residual energy of nodes. There are many simulators which are being used in WBAN such as NS3, MATLAB.

NS is called as Network Simulator and it consists of many versions as NS-1, NS-2, NS-3.

Network simulator is software through which researchers test new protocols and make any change in existing protocols in a very controllable environment. By using Network simulator, hierarchical network can be designed by using nodes like routers, switches, links, hubs, computers, bridges, etc. NS-2 uses C++ (core of simulator) and OTCL (for scripts describing the network topology). To store packets NS-2 never frees memory so NS-3 is better than NS-2 in terms of memory management. In NS-3, C++ is used with modern hardware capabilities compilation time and simulation script is written in C++ which actually is not possible in NS-2.

MATLAB is termed as mathematical laboratory which is developed by Mathworks and it has very interactive GUI (Graphical User Interface). MATLAB is widely used by research and academic institutions and users come from background like engineering, science and economics. MATLAB requires no programming skills and it calculates result very quickly. In MATLAB, new algorithms can be implemented quickly, easily plotting of graphs, creation of user interfaces and interfacing with programs written in other languages like C, C++, JAVA and FORTRAN.

IV. CONCLUSION:-

WBAN is most vast vital research field in which sensor nodes are deployed over human body and with the help of sensors patient's physiological signals or vital signs are measured. We have reviewed the working of many algorithms but Genetic Algorithm is used as an optimization technique to improve network lifetime and less memory is used. By using optimized routing, best path can be selected so that data reached to its destination in shortest span time with on time delivery. It is very helpful for old age person as well as for handicapped person.

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