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Lifetime Improvement in WBAN using dynamic clustering with LEACH-C

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Abstract-*Wireless Body Area Sensors are used to monitor human health with limited energy resources. Different energy efficient routing schemes are used to forward data from body sensors to medical server. It is important that sensed data of patient reliably received to medical specialist for further analysis Analytical study of various routing protocols in the Wireless Body Area Networks (WBANs) which mainly focus link efficiency of networks that had high impact on network performance. We implement and simulate the proposed WBAN routing protocol based on proposed clustering and cost function. At last we evaluate various types of parameters like network lifetime, throughput, residual energy and network path loss etc. purposed approach is much better than previous approaches.*

Keywords: WBAN, Network Performance Throughput, Loss, Energy Consumption.

1 INTRODUCTION

1.1 Wireless Sensor Network: Wireless Sensor Networks (WSNs) are used to monitor certain parameters in many applications like environment monitoring, habitant monitoring, battle field, agriculture field monitoring and smart homes. These wireless sensors are dispersed in sensing area to monitor field. WBAN is new emerging sub-field of WSN. A key application of WBAN is health monitoring. Wireless sensors are placed on the human body or implanted in the body to monitor vital signs like blood pressure, body temperature, heart rate, glucose level etc. Use of WBAN technology to monitor health parameters significantly reduces the expenditures of patient in hospital. With the help of WBAN technology, patients are monitored at home for longer period. Sensors continuously sense data and forward to medical server. In WBANs, sensor nodes are operated with limited energy source. It is required to use minimum power for transmitting data from sensor nodes to sink. One of the major obstacles in WBAN is to recharge the batteries. An efficient routing protocol is required to overcome this issue of recharging batteries. Many energy efficient routing protocols are proposed in WSN technology. However, WSNs and WBANs have different architectures, applications and operate in different conditions. It is impossible to port WSN routing protocols to WBAN. Therefore, energy efficient routing protocol for WBAN is required to monitor patients for longer period. We propose a high throughput, reliable and stable routing protocol for WBAN. Sensors for ECG and Glucose level are placed near the sink

1.2 APPLICATIONS OF WBANS

WBAN applications span a wide area such as military, ubiquitous health care, sport, entertainment and many other areas.The main characteristic in all WBAN applications is improving the user's quality of life [8]. However, the technological requirements of WBANs are application specific.

1.2.1 Medical Applications

WBANs have a huge potential to revolutionize the future of health care monitoring by diagnosing many life threatening diseases and providing real time patient monitoring [10]. Demographers have predicted that the worldwide population over 65 will have doubled in 2025 to 761 million from the 1990 population of 357 million. This implies that by 2050 medical aged care will become a major issue. By 2009, the health care expenditure in the United States was about 2.9 trillion and is estimated to reach 4 trillion by 2015, almost 20% of the gross domestic product. Also, one of the leading causes of death is related to cardiovascular disease, which is estimated to be as much as 30 % of deaths worldwide [11, 12].

Based on advances in technology (in micro-electronic miniaturization and integration, sensors, the Internet and wireless networking) the deployment and servicing of

health care services will be fundamentally changed and modernized.

Wearable WBAN: Wearable medical applications of WBANs can further be classified into the following two subcategories: a) Disability Assistance, b) Human Performance Management. Some of these applications are mentioned bellow:Assessing Soldier Fatigue and Battle Readiness – The activity of soldiers in the battlefield can be monitored more closely by WBANs. [17].

- **Sleep Staging** – Sleep is an important behavior and regular physiological function which consumes one-third of our everyday life. A large population is suffering from sleep disorders - an average of 27% of the world population5. The consequences of such disorders can be quite severe and lead to cardiovascular diseases, sleepiness at work place and drowsy driving. The effect of sleep disorder on work performance is estimated to cost 18 billion in lost productivity. Therefore, sleep monitoring has gained great interest in the recent years. Sleep disorders can be realized through a polysomnography test which requires analysis of a number of bio potentials recorded overnight in a sleep laboratory.
- **Asthma** – A WBAN and accompanying sensors are capable of monitoring allergic agents in the air and providing real time feedback to a physician, which can help millions of patients suffering from asthma.
- **Wearable Health Monitoring** – WBANs in conjunction with sensors and other devices on the human body can provide real time health monitoring. For instance, a Gluecocellphone which is a cell phone with a glucose module can be used for patients with diabetes. The cell phone receives glucose diagnoses from the glucose module which may then be stored or sent to a doctor for analysis [17].
- **Implant WBAN**: This class of applications is relative to nodes implanted in the human body either underneath the skin or in the blood stream.
- **Diabetes control** – 6.4% of the world's adult population, which represent 285 million people, suffered from diabetes in 2010. This number is estimated to reach 438 million by 2030, 7.8% of the adult population6. Research has shown Diabetes to result in long-term medical issues if not carefully monitored and treated7. Frequent monitoring provided by WBANs is capable of reducing the risk of fainting, enables proper dosing, and eliminates risks of loss of circulation, later life blindness and more complications.
- Cardiovascular Diseases – Cardiovascular diseases are known as the major cause of death for 17 million peopleannually8, which can be significantly reduced or prevented with appropriate health care strategies. Myocardial Infarction (MI) can be greatly reduced by monitoring episodic events and other abnormal conditions through WBAN technology.

IN/ON-BODY APPLICATIONS

- **Cancer Detection –** Cancer death rates are estimated to increase by 50%, reaching up to 15 million by 20209. WBAN based sensors capable of monitoring cancer cells in the human body will enable physicians to continually diagnose tumors without biopsy providing more timely analysis and treatment.
- **Remote Control of Medical Devices:** The ubiquitous Internet connectivity of WBANs allows for networking of the devices and services in home care known as Ambient Assisted Living (AAL), where each WBAN wirelessly communicates with a back-end medical network [19].
- **Patient Monitoring –** One key application of WBANs is its use in monitoring vital signals, as well as providing real time feedback and information on the recovery process in health monitoring applications. More specifically, they sense and wirelessly transmit vital signal measurements such as heart rate, body temperature, respiration rate, blood pressure, body implant parameters and chest sounds. WBANs are also capable of administration of drugs in hospitals, remote monitoring of human physiological data, aid rehabilitation and provide an interface for diagnostics.

1.2.2 Non-Medical Applications: Non-Medical applications of WBANs can be further classified into five subcategories as follows:

- **Real Time Streaming:**These classes of applications involve video streaming such as capturing a video clip by the camera in a cellular phone, trading shows for sport goods along with the latest fashion designs and 3D video.
- **Entertainment Applications:** This category consists of gaming applications and social networking. Appliances such as microphones, MP3-players, cameras, head-mounted displays and advanced computer appliances can be used as devices integrated in WBANs. They can be used in virtual reality and gaming purposes (game control with hand gesture, mobile body motion game and virtual world game), personal item tracking, exchanging digital profile/business card and consumer electronics.
- **Emergency (non-medical):** Off-body sensors (eg. built into the house) are capable of detecting a non-medical emergency such as fire in the home or flammable/poisonous gas in the house and must urgently communicate this information to body-worn devices to warn the wearer of the emergency condition [17].
- **Emotion Detection:** Recent research has shown the effective realization of human emotions via speech and visual data analysis. More specifically, wearable sensing technologies have enabled emotion detection through the induction of physical manifestations throughout the body that leads to the production of signals to be measured via simple bio-sensors. For

instance, fear increases respiration rate and heart-beat, which results in palm sweating and more.

- **Secure Authentication:** This application refers to utilizing both physiological and behavioral biometrics such as iris recognition, fingerprints and facial patterns. This is one of the key applications of WBANs due to duplicability and forgery, which has motivated the use of new behavioral/physical characteristics of the human body, in essence multi-modal biometric, gait and electroencephalography [5]

1.3 Performance Metrics

Given below are some key parameters considered for performance of WBAN. Dentition of performance metrics is given in following subsections.

1) Network lifetime: It represents the total network operation time till the last node die.

2) Stability period: Stability period is the time span of network operation till the rest node die. The time period after the death of rest node is termed as unstable period.

3) Throughput: Throughput is the total number of packets successfully received at sink.

4) Residual Energy: In order to investigate the energy consumption of nodes per round, we consider residual energy parameter to analyses energy consumption of network.

5) Path Loss: Path loss is the difference between the transmitted power of transmitting node and received power at receiving node. It is measured in decibels (dB).

2. REVIEW OF LITERATURE

Afridi et al. "HEAT: Horizontal Moveable Energy-efficient Adaptive Threshold-Based Routing Protocol for Wireless Body Area Networks" Approaches of using Wireless Body Area Sensor Network (WBASN) in health care applications are getting much popularity. WBASN is a hot topic among the research community. Our proposed Horizontal moveable Energy-efficient Adaptive Threshold-based (HEAT) protocol is well suited for horizontally moving (walking) human body. The on body nodes attached at arms and legs of human body move forward and backward to sink during horizontal movement. We use direct communication for emergency data and multi-hop communication strategy for normal data transmission. Simulation results show that our proposed protocol performs better in terms of stability period and network lifetime.

M. Ambigavathi et al. "Priority based AODV routing protocol for critical data in Wireless Body Area Network" Wireless Body Area Networks (WBANs) is one of the most promising approaches for improving the quality of life, by allowing remote patient monitoring and other ubiquitous health monitoring applications. In this type of networks, traffic routing plays an important role, which collects the information from bio sensors and sends it towards the sink. Some data are very critical under certain situations and should be ensured with high end-to-end reliable transmission and lower delivery delay. This paper introduces a new Priority Queuing Algorithm for AODV routing protocol, which differentiates various types of traffic based on the critical data. The proposed protocol has been simulated using different scenarios and obtained results are analysed using NS2 simulator.

Muhammad MoidSahndhu et al. "BEC: A novel routing protocol for balanced energy consumption in Wireless Body Area Networks" Wireless Body Area Networks (WBANs) are getting growing interest because of their suitability for wide range of medical and non-medical applications. These applications demand WBAN to stay functional for a longer time which requires energy-efficient operation. In this paper, we propose a new routing protocol for Balanced Energy Consumption (BEC) in WBANs. In BEC, relay nodes are selected based on a cost function. The nodes send their data to their nearest relay nodes to route it to the sink. The nodes closer to the sink send their data directly to it. Furthermore, the nodes send only critical data when their energy becomes less than a specific threshold. In order to distribute the load uniformly, relay nodes are rotated in each round based on a cost function. Simulation results show that BEC achieves 49% increased network lifetime than OINL (On Increasing Network Lifetime) algorithm.

Kshitiza Singh et al. "An energy efficient fuzzy based adaptive routing protocol for Wireless Body Area Network" The Wireless Body Area Network (WBAN) is the new arising sub-field of Wireless Sensor Networks(WSN) that made the already existing conventional healthcare methods to reach a new level of smart human monitoring. The scarcity in terms of power supply to the network makes network lifetime to be one of the main challenge for which an energy efficient routing technique is required. In this paper, an energy efficient fuzzy based adaptive routing protocol is proposed which is a fuzzy based clustering protocol that makes use of direct transmission technique depending upon the criticality and the location of the Sensor Nodes (SN). The simulation results show that the proposed technique improves the stability period and lifetime of the network.

Karthiga I. et al. "A study on routing protocols in wireless body area networks and its suitability for m-Health applications" Wireless sensor networks are spatially distributed network of autonomous nodes that are used in the monitoring of physical and environmental conditions. Since these sensors have limited energy to work with, their storage and processing capabilities are very much basic. One such field that requires state of art WSN technology is the m-health applications. Some of the factors that are needed to be considered are data consistency, security and sensor validation. Continuous efforts have been taken to improve the system architecture of the sensors that constitute these networks. The eventual aim of this study is to layout the base containing all the regulated positive approaches from the established routing protocols and arriving at a more innovative routing protocol that satisfies m-Health's

required critical factors such as consistency and accuracy.

M. M. Sandhu et al. "FEEL: Forwarding Data Energy Efficiently with Load Balancing in Wireless Body Area Networks" In this paper, we propose a reliable, energy efficient and high throughput routing protocol for Wireless Body Area Networks (WBANs). In Forwarding Data Energy Efficiently with Load Balancing in Wireless Body Area Networks (FEEL), a forwarder node is incorporated which reduces the transmission distance between sender and receiver to save energy of other nodes. Nodes consume energy in an efficient manner resulting in longer stability period.

3. METHDOLOGY

Wireless body area network is an extension of wireless sensor network. In the process of WBAN sensor nodes has been placed on the human body parts to sense various types of information. Sensed information has been transmitted over the network using sink node. Sink node available in the network use different information for data collection from the sensor nodes. Sensor node transmits information based on routing protocol for data transmission over the network. In the purposed work different nodes have been used for data forwarding and data aggregation over the network.

In the purposed work various sensor nodes have been deployed over the network that used for sensing information. These nodes have to be route selection on the basis of energy consumption over the network. Energy is the main constraint for network lifetime. Energy awareness has to be achieved on selection of path defined by the system.

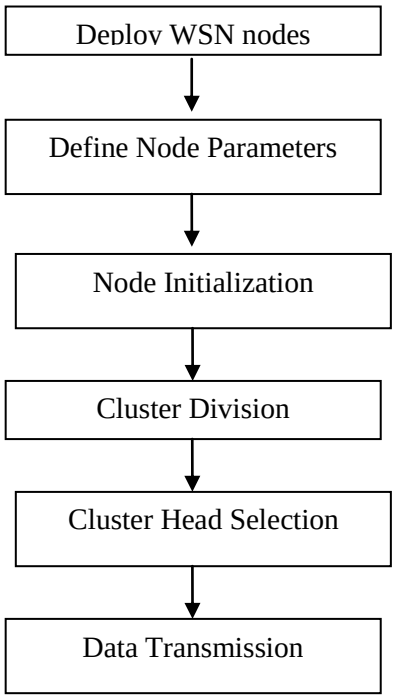

Fig 3.1 Flow of Purposed Work

This figure represents flow of the purposed work that has to be carried out for data transmission over the network. In the purposed work various steps must be carried out for achievement of desired objectives. In the purposed work energy aware cluster based routing strategy has been used for network deployment.

In this deployment various phases has been used for development various phases has been initialized for sensing and transmitting information over the network.

4. RESULTS

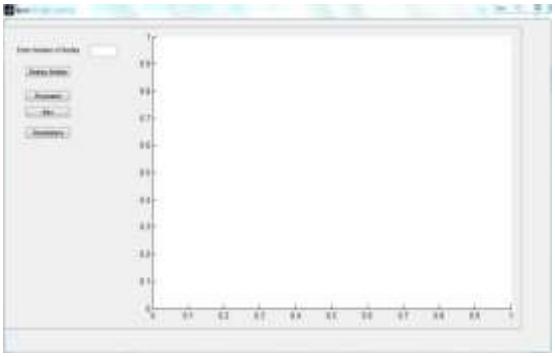

Fig 4.1: Graphical User Interface

This scenario is use to represent the graphical user interface. a graphical user interface (GUI), is a type of user interface that allows users to interact with nodes through graphical icons and visual indicators.

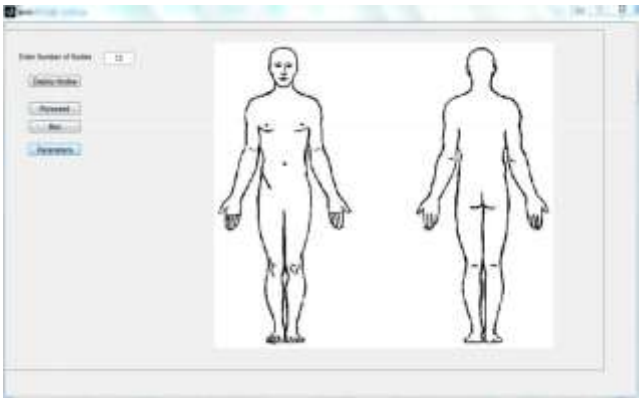

Fig 4.2: Localization of nodes

This figure represents human body structure that has been used for data transmission by deployed sensors on different body parts. Sensor nodes can be attached to different body parts of human and sink node is placed at chest. All the nodes have a particular id and location that has been used for distance computation.

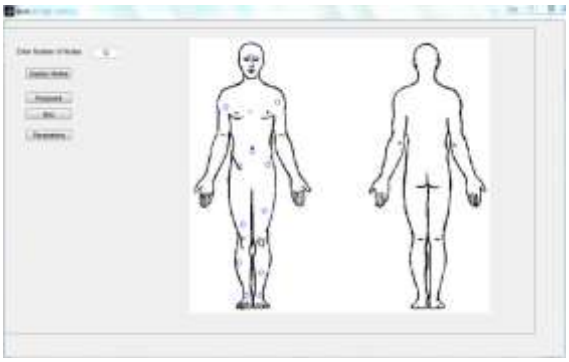

Fig 4.3: Representation of base station

This figure is use to represent the Base station & cluster head. Circle is use to represent the nodes & cluster head. Cross is use to represent the Base Station. Cluster heads can do some aggregation and reduction of data in order to save energy. A base-station may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data

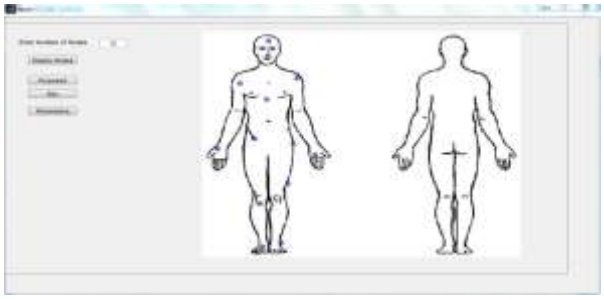

Fig 4.4: Represent Data Transfer

This figure is use to represent the data transfer between the nodes. The data is transfer between the nodes & cluster head. Nodes send the data to the cluster head & cluster head sends the data to the base station. Cluster heads can do some aggregation and reduction of data in order to save energy. A base-station may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data.

Fig 4.5: Represent Dead nodes

This graph is use to represent the Dead nodes in the graph. Dead nodes mean these nodes whose energy is zero. The Red line is used to represent the BEC protocol and blue line is used to represent the dynamic clustering.

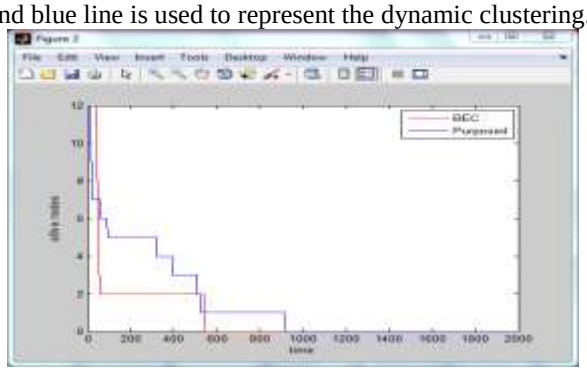

Fig 4.6: Represent alive nodes

This graph is use to represent the Alive nodes in the graph. Alive nodes are those nodes whose send and receive data successfully during transmission& whose energy level is not zero. The Red line is used to represent the BEC protocol and blue line is used to represent the dynamic clustering.

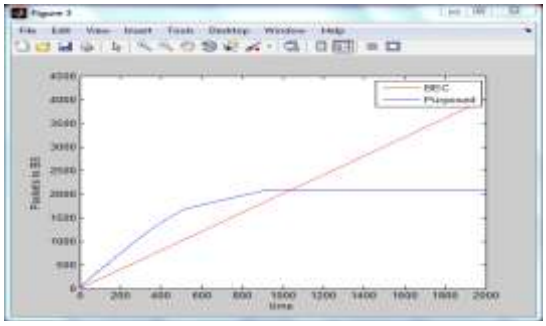

Fig 4.7: Represent Packet to BS

This Figure is use to represent to Packet to base station. It means how much packets received by base station successfully. The Red line is used to represent the BEC protocol and blue line is used to represent the dynamic clustering.

5. CONCLUSION& FUTURE SCOPE

Wireless Sensor Networks (WSNs) are used to monitor certain parameters in many applications like environment monitoring, habitant monitoring, battle field, agriculture field monitoring and smart homes. These wireless sensors are dispersed in sensing area to monitor field. WBAN is new emerging sub-field of WSN. Wireless Body Area Sensors are used to monitor human health with limited energy resources. Different energy efficient routing schemes are used to forward data from body sensors to medical server. It is important that sensed data of patient reliably received to medical specialist for further analysis.

In this purposed WBAN energy aware clustering based routing protocol has been purposed that has been used for sensing information from human body and transmits this to base station for processing. In this whole network has been divided into different cluster and cluster members have been used for election of best cluster head on the basis of maximum energy and minimum distance

from cluster head. In this cluster head selection is dynamically that changes after every round. On the basis of dynamic cluster head selection every node has opportunity to act as a cluster head in single round. Cluster head transmit hello packet to all the nodes that contain information about available bandwidth, id, route and energy available. All the nodes receive packet and start transmission of data to a particular cluster head. Cluster head is responsible for data transmission to base station either directly or via other cluster head available in the network.

At last we got various types of parameters i.e. network lifetime, throughput, residual energy and network path loss etc. On the basis of these parameters we conclude that our system gives us better results.

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