Promethee for Detecting Cancer in Wireless Body Area Network

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Abstract

Whenever thought about mass deaths of people, it was either from a flood, drought, or an explosion caused by a missile or bomb, but these days the significant risk to the human lives from the disease named "Cancer". Cancer is largest cause of death in the world . To prevent the Cancer Disease from disseminate, regular identifying and monitoring of infected patients is needed. In this regard, Wireless Body Area Network (WBAN) can be used in conjunction with the Internet of Things (IoT) and Multi-Criteria Decision-Making Method (MCDM) for identifying and monitoring the human body for health-related information, which in turn can aid in early diagnosis of diseases. WBAN makes use of the biosensors in, on or around the body, to ensure the measurement of the biological specifications of the human body, which are designed for the healthcare application. This paper proposes a novel WBAN framework for detection of an early stage of Cancer which based on IoT to receive the biosensor signals from the patient and evaluate symptoms of disease and help healthcare professionals to improve and enhance cancer treatment .
Due to resemblance of Cancer symptoms with several other diseases, this paper also presents the Promethee MCDM to help medical professionals identify the disease that the patient might be suffering from or suffer without Cancer. This methodology relies on collected information from the proposed WBAN framework, and it can deal with the complexity of imprecision and confusion arising from the relative priority scales of various disease symptoms.

Keywords: Cancer; Wireless Body Area Network; Internet of Things; Multi-Criteria Decision-Making; Preference ranking organization method for Enrichment Evaluation .

Introduction : Over the years, growth in population has been observed and with this many health issues have come into existence such as cancer, asthma, cardiovascular diseases and various other infectious diseases such as tuberclosis, pneumonia, ebola, cholera, SARS, MERS due to which millions of people have lost their lives. The sustainability of global healthcare systems should focus on early detection of such diseases rather than depending on the delayed treatment. Cancer is largest cause of death in the world .

WBAN network model can split into three-tier levels as follows:

• Tier 1: WBAN with sensor nodes.

• Tier 2: WBAN with personal digital assistant

• Tier 3: WBAN with cloud and medical server.

Tier 1 includes eight sensors (ECG, EMG, EEG, Temperature, Pulse, Motion detector, Glucose, Blood pressure) attached on a human body in WBAN.The intermediary nodes are named as relays. They have a parental node, own a child node, and transmit signals. In general, if a node is at an extreme point (e.g., a foot), it demands that all data delivered be transmitted by several nodes until accessing the PDA. Even the relay nodes can be capable of sensing data. One or more physiological signals can be sensed, sampled, and processed by each sensor node[31]–[35]

Tier 2 requires an framework for Personal Server (PS) running on a Personal Digital Assistant (PDA), a mobile phone or a personal computer device. The PS will take care of several tasks,a user interface, and a medical server interface. This tier of communication is between the sensors and internet through Access Point (AP). The AP can be seen as part of the system, or perhaps positioned strategically in a complex emergency response scenario for dealing emergencies.The goal of tier 2 connectivity is to interconnect WBANs with different networks that are readily
accessible in daily life, as well as wireless networks as well as the World Wide Web.The more technologies WBAN embraces, the better they can integrate into the applications.

The last tier may include other servers besides the cloud server, medical server, also ambulance managers, such as private nurses, professional health service providers. One of the most critical elements of Tier-3 in a medical setting is a database, since it contains the personal records and identity of the patient.Therefore, physicians or clients should be informed of an emergency situation through the network or an SMS (Short

Message Service). Therefore, physicians or patients should be informed of an emergency situation through the web or a Text messaging (Text message Service).In addition, Tier 3 enables a patient to restore all the necessary information that can be used to treat them.

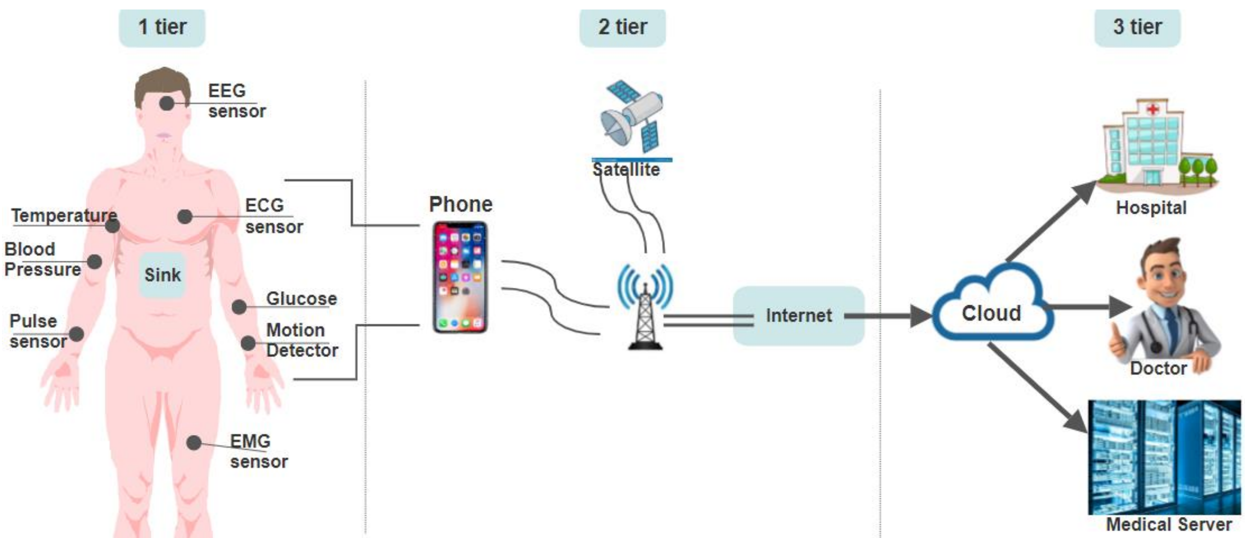

Figure 1: Architecture model of WBAN

Literature Review: In recent years, many wireless body area network-based systems are developed for E-health monitoring. The present section highlights the contribution of various researches employing WBANs in medical diagnosis and health care.

Notably, several outbreaks in recent years have drawn attention with respect to IoT, cloud computing and WBAN; Ebola virus outbreak using J48 decision tree [1], chikungunya outbreak using Fuzzy-C means [2], Zika virus outbreak using fuzzy k-nearest neighbour [3] and MERS-CoV infection outbreak using bayesian belief network [4].Punj et al. [5]presented a small overview of IoT functionality and its affiliation with the sensing and wireless techniques to implement the health-care products in WBAN. Jagadeeswari et al. [6] detailed a study on the recently developing technologies cloud computing, IoT, and android-based applications and analyzed the trials in designing a good health-care system to make early-stage detection of disease and its diagnosis. Yang Z et al. [7] presented a wearable ECG monitoring system based on IoT to display the real-time ECG of the patient. Varatharajan et al. [8] proposed a DTW (dynamic time warping) algorithm for monitoring the gait signals for infected by Alzheimer's disease. Ramano et al. [9] proposed a prototype named as WEALTHY for health monitoring. It has a textile-based wearable interface and appropriate for gathering the information of biomedical like respiration rate, ECG activity, temperature, and oxygen saturation level. Boulis et al. [10] presented a wireless system based on Internet-of-Things, which is used to deal with management problems and remote health diagnosis. The system consists of sensing, transferring, warehouse, and applying on different functions for diagnosing the current health status and access the system anytime. Romero et al. [11]presented an efficient IoT approach based on computational intelligence for diagnosing Parkinson's disease by using wearable devices for healthcare. This system focused on the acquisition of data and processing of signals for monitoring and continuous analysis through the wearable sensors

3. Proposed model : This paper demonstrates a framework of the energy-efficient Internet of Things (IoT) model for real-time health monitoring system, which uses the number of wearable biosensors to examine the health status of the patient. In this scheme, the five biosensor nodes (S1, S2, S3, S4, S5) are deploy (say human body) at different positions such as biosensor S1 for body temperature, S2 for oxygen levels, S3 for blood pressure (BP), S4 for electrocardiography, S5 for electroencephalogram (EEG) and all these have similar power and computation potential. The sink biosensor is stationary in the middle of the subject's body. The various tasks (disease) are assigned to each biosensor node as shown in figure 2.These biosensors generate biomedical signals, including body temperature, data related to oxygen

Algorithm1: Detecting and monitoring Cancer patients

Step 1: A user register in the system via mobile application using some personal details including mobile number, date of birth card numberetc. as a unique identification.

Step 2: After registering, user enters whether suffering from the symptoms like fever, cough, pain, unusual bleeding, weight loss , skin changes etc.

Step3: All health related information gathered by biosensors in WBAN and sent to the patient private account at Cloud.

Step4: The doctors categorize data from user's database into different groups based on their symptoms.

Step5: If the doctors detects user to be infected by Cancer, then an electronic medical record is sent to patient containing the details of diagnosis and recommendations to attend the treatment centre.

Step6: If the patient situation is serious then an ambulance for Cancer patients will be dispatched by the health care system.

Step 7: The system continuosly monitors and regularly checks the user until the patients recover.

Step 8: If the patient is a Cancer uninfected person then always give him an electronic report. Yet in this case, the electronic medical record includes the outcome of the diagnosis and the disease that patient has risk to suffer from Cancer. To do so, Promethee approach discusses the priority scales of various disease criteria and it may assist practitioners in assessing the weights of specific diseases based on the symptoms and alternatives.

Table 1: Personal information of users

S. No.	**Attributes**	**Description**
1.	Name	User name
2.	DOB	User date of birth
3.	Mob	User mobile number
4.	Age(In Years)	Age of user
5.	Gender	Gender of the user
6.	Address	Patient home address
7.	Email	User email address

Case study : In this section, we will implement the Promethee technique for helping specialists and consultants to predict and detect which diseases that patient has a chance to be infected by it, and then advising him in an electronic healthcare record to go to the right specialist. We collect four patient's data from the cloud and classifies which patients are infected or uninfected with Cancer or other diseases. By using the proposed method the healthcare experts founded that the patient does suffer from or suffer not have Cancer . By examining collected data from the proposed healthcare system they established that he suffers from these symptoms: S = (Fever, Cough, Breathing issue, Abdominal pain, Fatigue, Headache, Sore throat,Chest pain, Diarrhea, Nausea, Rhinnorhoea, Vomiting). Then the specialists and consultants patient data by mobile for gathering more information about the patient’s status.

The steps are as follows:

Step 1 : Select healthcare experts for support in decision making to predict out of six patients in which the patient is infected or uninfected with Cancer.

Step 2 : Construct a decision criteria (symptoms) with the help of health-care experts.

Table 2: Decision Matrix

Patients	Fever	Cough	Pain	Unusual bleeding	Weight loss	Skin changes
Patient 1	104	80	9	8	50	6
Patient 2	102	79	5	5	49	5

Patient 3	100	76	3	7	48	4
Patient 4	98	75	1	4	46	3
Patient 5	99	75	6	2	45	2
Patient 6	101	72	4	3	42	1

Step 3: Normalize the Evaluation matrix :

Rij= $(Y_{ij}- \min(Y_{ij})/\max(Y_{ij})-\min(Y_{ij})$ - for valuable criteria (1)

Rij = $[\max(Y_{ij})-Y_{ij}]/ \max(Y_{ij})-\min(Y_{ij})$ - for non valuable criteria (2)

Where Rij is evaluation matrix$Y_{ij}$is attribute value where i=1…..m j = j……n $\max(Y_{ij})$ is maximum value of each criteria , $\min(Y_{ij})$ is minimum value of each attribute.

Table 3: Maximum Value and Minimum Value

Max	104	80	9	8	50	6
Min	98	72	1	2	42	1
Max-Min	6	8	8	6	8	5

Fever, Pain , unusual bleeding , weight loss and skin changes are valuable criteria and cough is non valuable criteria .

Table 4: Evaluation Matrix

Patient	Fever	Cough	Pain	Unusual bleeding	Weight loss	Skin changes
1	1	0	1	1	1	1
2	0.6	0.125	0.5	0.5	0.875	0.8
3	0.3	0.5	0.25	0.83	0.75	0.6
4	0	0.625	0	0.33	0.5	0.4
5	0.166	0.625	0.625	0	0.375	0.2
6	0.5	1	0.375	0.166	0.125	0

Step 4). Calculate the Evaluative difference: - compute the estimate difference of i^{th}alternative with respect to additional alternatives.

D(M1-MN) where d is difference of M1-MN of row wise in each criteria calculate each difference of alternatives .

Table 5 : Evaluative Difference

Difference	Fever	Cough	Pain	Unusual bleeding	Weight loss	Skin changes
D(p1-p2)	0.4	-0.125	0.5	0.5	0.125	0.2
D(p1-p3)	0.7	-0.5	0.75	0.17	0.25	0.4
D(p1-p4)	1	-0.025	1	0.67	0.5	0.6
D(p1-p5)	0.834	-0.625	0.375	1	0.625	0.8
D(p1-p6)	0.5	-1	0.625	0.834	0.875	1
D(p2-p1)	-0.4	0.125	-0.5	-0.5	-0.125	-0.2
D(p2-p3)	0.3	-0.375	0.25	-0.33	0.125	0.2
D(p2-p4)	0.6	-0.5	0	0.17	0.375	0.4
D(p2-p5)	0.434	-0.5	-0.125	0.5	0.5	0.6
D(p2-p6)	0.1	-0.875	0.125	0.334	0.75	0.8
D(p3-p1)	-0.7	0.5	-0.75	-0.17	-0.25	-0.4
D(p3-p2)	-0.3	0.375	-0.25	0.33	-0.125	-0.2
D(p3-p4)	0.3	-0.125	0.25	0.5	0.25	0.2
D(p3-p5)	0.134	0	-0.375	0.83	0.325	0.4
D(p3-p6)	-0.2	-0.5	-0.125	0.664	0.625	0.6
D(p4-p1)	-1	0.625	-1	-0.67	-0.5	-0.6
D(p4-p2)	-0.6	0.5	-0.5	-0.17	-0.375	-0.4
D(p4-p3)	-0.3	0.125	-0.25	-0.5	-0.25	-0.2
D(p4-p5)	-0.166	0	-0.625	0.33	0.125	0.2
D(p4-p6)	-0.5	-0.375	-0.375	0.164	0.375	0.4
D(p5-p1)	-0.834	0.625	-0.375	-1	-0.625	-0.8
D(p5-p2)	-0.434	0.5	0.125	-0.5	-0.5	-0.6
D(p5-p3)	-0.134	0.125	0.375	-0.83	-0.375	-0.4
D(p5-p4)	0.166	0	0.625	-0.33	-0.125	-0.2
D(p5-p6)	-0.334	-0.375	0.25	-0.166	0.25	0.2
D(p6-p1)	-0.5	1	-0.625	-0.834	-0.875	-1
D(p6-p2)	-0.1	0.875	-0.125	-0.334	-0.75	-0.8
D(p6-p3)	0.3	0.5	0.125	-0.664	-0.625	-0.6
D(p6-p4)	0.5	0.375	0.375	-0.164	-0.375	-0.4
D(p6-p5)	0.334	0.375	-0.25	0.166	-0.25	-0.2

Step 5).Decide the Preference function Pj(b,c)

Pj(b,c) =0 (D(M1 –MN)<=0 (if any cell is less than 0 replace by 0 Pj(b,c)=0)) (12)

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Where Pj is the preference function. Those values are less then 0 replace by 0.

Table 6 : Preference function

Preference values	Fever	Cough	Pain	Unusual bleeding	Weight loss	Skin changes
P(p1-p2)	0.4	0	0.5	0.5	0.125	0.2
P(p1-p3)	0.7	0	0.75	0.17	0.25	0.4
P(p1-p4)	1	0	1	0.67	0.5	0.6
P(p1-p5)	0.834	0	0.375	1	0.625	0.8
P(p1-p6)	0.5	0	0.625	0.834	0.875	1
P(p2-p1)	0	0.125	0	0	0	0
P(p2-p3)	0.3	0	0.25	0	0.125	0.2
P(p2-p4)	0.6	0	0	0.17	0.375	0.4
P(p2-p5)	0.434	0	0	0.5	0.5	0.6
P(p2-p6)	0.1	0	0.125	0.334	0.75	0.8
P(p3-p1)	0	0.5	0	0	0	0
P(p3-p2)	0	0.375	0	0.33	0	0
P(p3-p4)	0.3	0	0.25	0.5	0.25	0.2
P(p3-p5)	0.134	0	0	0.83	0.325	0.4
P(p3-p6)	0	0	0	0.664	0.625	0.6
P(p4-p1)	0	0.625	0	0	0	0
P(p4-p2)	0	0.5	0	0	0	0
P(p4-p3)	0	0.125	0	0	0	0
P(p4-p5)	0	0	0	0.33	0.125	0.2
P(p4-p6)	0	0	0	0.164	0.375	0.4
P(p5-p1)	0	0.625	0	0	0	0
P(p5-p2)	0	0.5	0.125	0	0	0
P(p5-p3)	0	0.125	0.375	0	0	0
P(p5-p4)	0.166	0	0.625	0	0	0
P(p5-p6)	0	0	0.25	0	0.25	0.2
P(p6-p1)	0	1	0	0	0	0
P(p6-p2)	0	0.875	0	0	0	0
P(p6-p3)	0.3	0.5	0.125	0	0	0
P(p6-p4)	0.5	0.375	0.375	0	0	0
P(p6-p5)	0.334	0.375	0	0.166	0	0

Step 6).Analyze the aggregated preference function : For valuable criteria weight is 2 and for non valuable criteria weight is 1 . In weightage matrix is weights are multiplied then Total of the row values are

called aggregated preference values. In aggregated matrix values are assign to criteria according to aggregated preference values.

Wj*P(M1-MN)

Table 7: Aggregated Preference Function

Patients	Fever	Cough	Pain	Unusual bleeding	Weight loss	Skin changes
1	…..	3.45	4.54	7.54	7.268	7.668
2	0.125	…..	1.75	3.09	4.068	4.218
3	0.5	1.035	…..	3	4.153	3.778
4	0.625	0.5	0.125	…..	1.31	1.878
5	0.625	0.75	0.875	1.582	…..	1.4
6	1	0.875	1.35	2.125	1.375	…..

Step 7). **Determining the outranking leaving and outranking entering flows: -** Average the rowwise elements is leaving flow and average of column wise is enteringflow.Average the row wise is leaving flow and average the column wise is entering flow.

Leaving flows=1/m-1* pi (b,c) (a is not equal to b)

Entering flow = 1/m-1*pi (c,b) (a is not equal to b)

Table 8 : Leaving Flow and Entering Flow

Patients	Fever	Cough	Pain	Unusual bleeding	Weight loss	Skin changes	Leaving flow
1	…..	3.45	4.54	7.54	7.268	7.668	30.466

2	0.125	…..	1.75	3.09	4.068	4.218	13.251
3	0.5	1.035	…..	3	4.153	3.778	12.466
4	0.625	0.5	0.125	…..	1.31	1.878	4.438
5	0.625	0.75	0.875	1.582	…..	1.4	5.232
6	1	0.875	1.35	2.125	1.375	…..	6.725
Entering flow	2.875	6.61	8.64	17.337	18.174	18.942	……

Step 8).Determine the outranking flow -The flows of positive and negative preferences are aggregated into net flows of preferences.

Leaving flow – entering flow

1/m-1* pi (b,c) -1/m-1*pi (c,b)

Table9: Outranking Flow

Patient	Outranking flow	Rank
1	27.591	1
2	6.641	2
3	3.826	3
4	-12.899	5
5	-12.942	4
6	-12.217	6

Result: For any countryside and healthcare agencies, the Cancer disease is a worldwide challenge. In this paper, we suggested the MCDM technique for detecting and monitoring Cancer. The social interactions and symptoms of the user's body are capture information and symptoms, we classified users into infected or uninfected persons. If a user has infected person, the treatment method of Cancer determine through the planned system. We proposed an Promethee MCDM technique to estimate certain diseases based on the report symptoms of the patient. We collect six patient's data from the cloud and classifies which patients are infected or uninfected with Cancer or other diseases. We can assist specialists in determining the weights of different diseases based on the symptoms and alternatives .OutRanking the criteria i.e Patients infected with the cancer . By using the proposed (Promethee) health care system the healthcare experts founded that the patient does have or does not have Cancer . By proposed method we founded that Patient 1 is more infected as compare to other patients

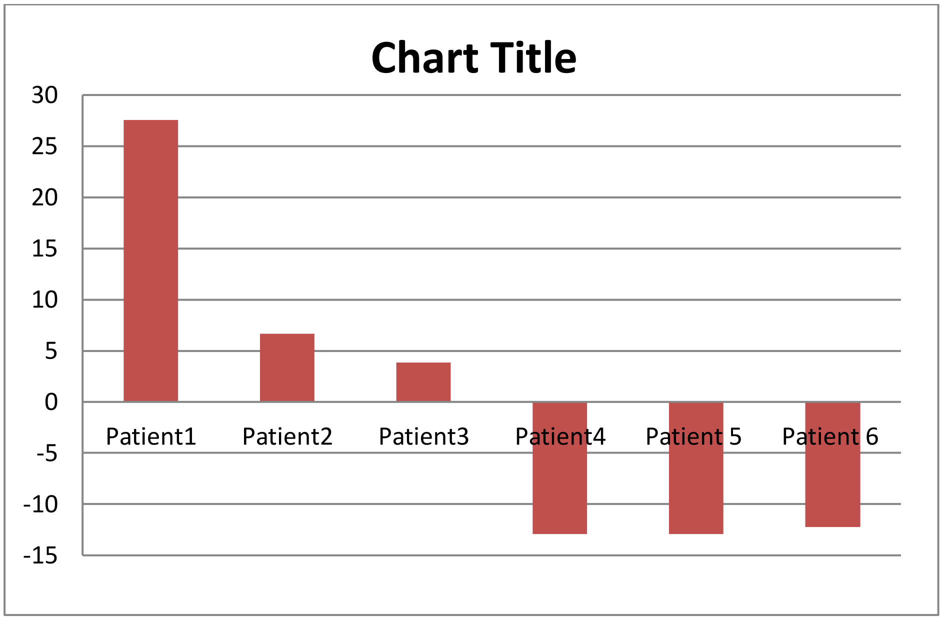

Figure 2: patients infected with Cancer

Conclusions and future work

Cancer is a communicable disease that has a high death rate as it transmits from one person to another directly. Now it is a global concern for all the people for early detection and prevention of themselves from Cancer. In this paper, an intelligent and energy-efficient IoT based WBAN model for identify and monitor the Cancer is proposed. If the user is classified as COVID infected, WBAN is fitted in the user's body for continuous monitoring. Due to the transmission of the signal from the various biosensor to the cloud, it is a significant challenge of energy efficiency, which causes more power consumption. Therefore, proposed model use the LoRa module as a relay node, which is a cognitive approach to increase power efficiency as well as the network lifetime of WBAN.

In the future, various other classification methods can be used for better accuracy and developing a sustainable energy-efficient model for WBAN.

Conflicts of interest

Authors declare that there is no conflict of interest.

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