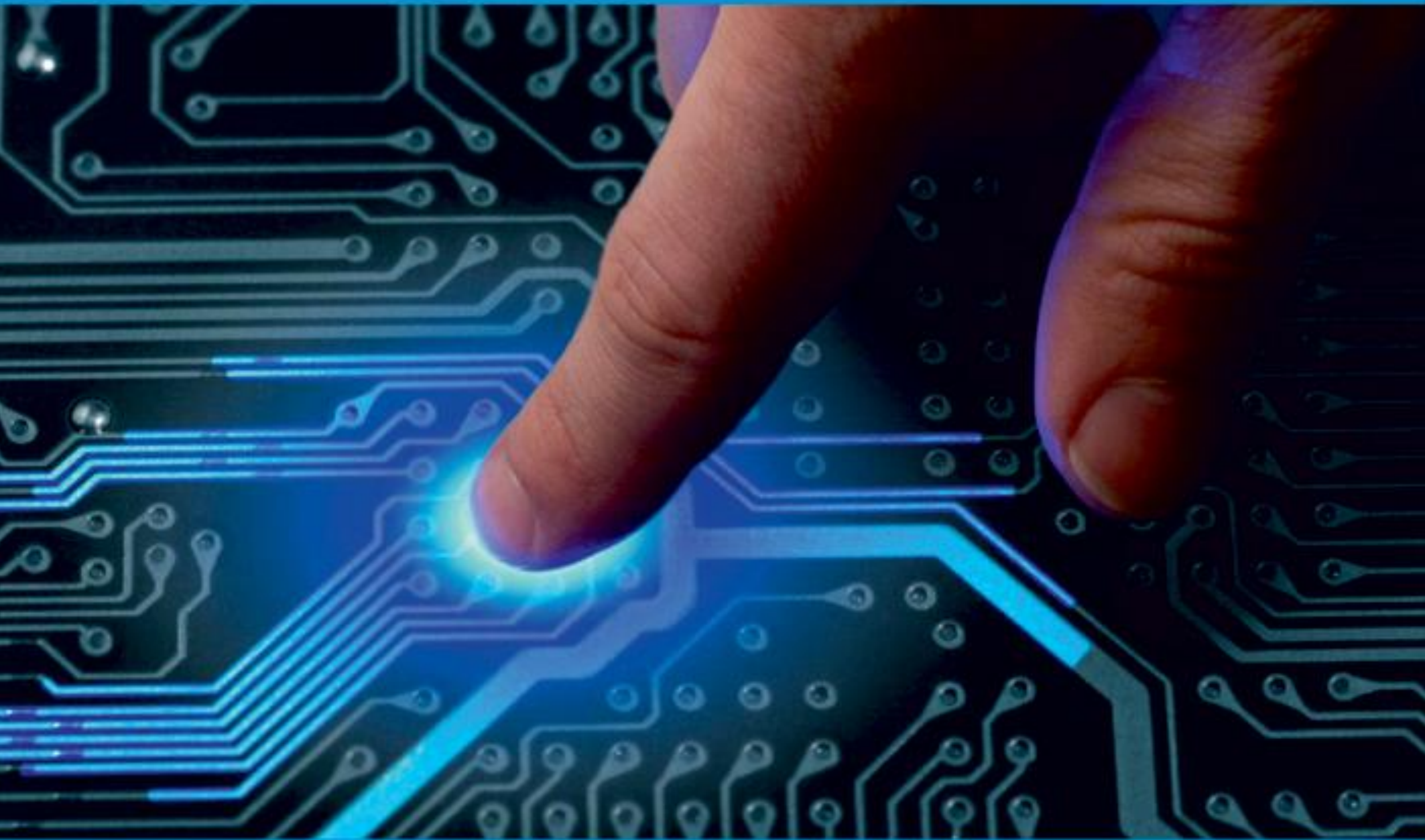
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 2, April 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 2, April 2024 ||

International Conference on Recent Development in Engineering and Technology – ICRDET 24

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Dhaanish Ahmed Institute of Technology, KG Chavadi, Coimbatore, Tamilnadu, India

IoT Based Cardiac Patient Monitoring System Using Fuzzy Logic

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ABSTRACT: This paper deals with monitoring sensors and fuzzy logic technology to check the timely availability of information about the health status of chronic heart disease patients. Cardiac disease patients are compulsory required to undergo continuous health monitoring; one method is to provide home healthcare communication technology. The IOT is a new era of intelligence computing and provides a way to communicate around the world. The collection of data from the sensor is used to communicate with remote service seekers like emergency service providers, doctors, and insurance providers. The fuzzy scheme for the proposed system is used to implement this technique. Interference mechanisms and system output under various conditions in cardiac patients are analyzed. Step-by-step diagnosis and detection of the physiological states of the patient's body is a promising way to avoid unnecessary data collection. Additionally, the proposed model is cost-effective and result oriented which provides easy self - monitoring.

KEYWORDS: heart, fuzzy logic, home healthcare, Internet of things

I. INTRODUCTION

The greatest part of people suffered from various chronic heart diseases, as the quality of life of resident people has been improved and daily health monitoring becomes more and more important for easy analysis and diagnosis. We plan to elucidate on how resent advancement in wireless communication have empowered tremendous improvement in health monitoring services. The detection stage of chronic heart diseases influences the health condition of people who are living alone. The analyzation is done by separating the parameters taken from the sensor so that the specific set of ranges are evaluated using fuzzy logic. With the help of IoT broadcasting of the second data provide manual monitoring at home easily.

II. SYSTEM ANALYSIS

This system contributes high-cost sensors and data collection is done using request-reply manner or in continuous stream so handling of large amount of data with minimum data losses impossible and also result in packet loss due to packet fragmentation, latency for data becomeshigh. Continuous data collection from the sensors is not required in event-driven approach. Usually, data gathered on occurred fusion centre makes the decision. In this scheme, instead of implementing fusion centre, case detection and choice mechanisms are executed by the sensor nodes. Events are defined by means of some threshold values of the parameters. Assume, three sensor parameters I1, I2 and I3 are defined for any health-care system M.
M = {I1, I2, I3}

III. PROPOSED SYSTEM

This system is cost effective and continuous data collection is done using event driven approach so that the events are defined by means of given threshold conditions.it provides step by step diagnosis and easy detection of physiological stages of patient body without loss of packets. This particular event-driven data collecting will indeed minimize the application of communication resource as well as reduce overhead to a large extent. It can make sense of the health data

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if we mention state on the particular parameters. Thus, in our system, we use fuzzy rules rather than the threshold parameters.

IV. EXISTING SYSTEM

Health-care applications need to acquire different types of sensor-data. The sensors-data need to be collected in precise and timely manner. When health sensor-data are forwarded to the data aggregator node, more sensing data may be accumulated along the route. Thus, a huge traffic may be generated during data collection. Handling such a large amount of data while and minimum data loss is challenging.
Improper handling may result in unbalanced and inefficient energy dissipation. In most cases, the data is forwarded or collected through multiple hops either in a request-reply manner or in continuous streams. Furthermore, it has also been observed in the back-end system. Huge amount of data may lead to burdened payload which results in packet fragmentations and due to packet fragmentation, the latency for data collection becomes longer. To tackle the above issues, an event driven knowledge collection technique is proposed.

V. DATA COLLECTION FROM SENSORS

This system contains both local part and remote part. The local part deals with the collection of data from various cardiac diseases analysis sensors. The remote part contributes storing and distributing of data to processing unit. It processes the collected raw data to generate meaningful information that can be unanalysed. Furthermore, many supplementary sensors can also be integrated to this remote monitoring system as recommended by specialized doctors. The data can also be uploaded to cloud through multi-hop wireless communication from the data aggregator and may be accessed and visualized by care-givers. Additionally, the data may be used to detect anomalies and generate alerts.

VI. TEMPERATURE SENSOR LM35

LM is a precision IC temperature sensor with its output proportional to the temperature. LM in its principle is a Silicon Band gap Temperature Sensor. The LM135 series are precision, easily-calibrated, integrated circuit temperature sensors. Operating as a 2-terminal zener, the LM135 has a breakdown voltage directly proportional to absolute temperature at 10 mV/°K. With less than 1Ω dynamic impedance, the device operates over a current range of 400 µA to 5 mA with virtually no change in performance. When calibrated at 25°C, the LM35 has typically less than 1°C error over a 100°C temperature range. Unlike other sensors, the LM35 has a linear output.
Applications for the LM35 include almost any type of temperature sensing over a 55°C to 150°C temperature range. The low impedance and linear output make, interfacing to readout or control circuitry are especially easy.
The LM35 operates over a –55°C to 150°C temperature range while the LM135 operates over a –40°C to 125°C temperature range. The LM335 operates from –40°C to 100°C. The LMx35 devices are available packaged in hermetic TO transistor packages while the LM335 is also available in plastic.

FEATURES

- Directly Calibrated to the Kelvin Temperature Scale
- 1°C Initial Accuracy Available
- Operates from 400 µA to 5 mA
- Less than 1-Ω Dynamic Impedance
- Easily Calibrated
- Wide Operating Temperature Range
- 200°C Over range
- Low Cost

VII. HEART BEAT SENSOR

A person's heartbeat is the sound of the valves in his/her heart contracting or expanding as they force blood from one region to another. The number of times the heart beats per minute (BPM), is the heart beat rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse.

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- ***Manual Way***:

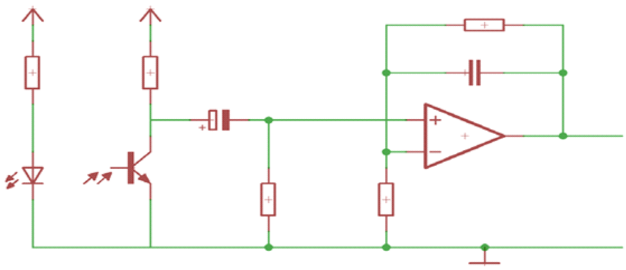
Heart beat can be checked manually by checking one's pulses at two locations- wrist (the **radial pulse**) and the neck (**carotid pulse**). The procedure is to place the two fingers (index and middle finger) on the wrist (or neck below the windpipe) and count the number of pulses for 30 seconds and then multiplying that number by 2 to get the heart beat rate. However pressure should be applied minimum and also fingers should be moved up and down till the pulse is felt.

- **Using a sensor**:

Heart Beat can be measured based on optical power variation as light is scattered or absorbed during its path through the blood as the heart beat changes.

VIII. HEARTBEATSENSOR WORKING

The basic heartbeat sensor consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses cause a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate.
This signal is actually a DC signal relating to the tissues and the blood volume and the AC component synchronous with the heart beat and caused by pulsatile changes in arterial blood volume is superimposed on the DC signal. Thus the major requirement is to isolate that AC component as it is of prime importance.



To achieve the task of getting the AC signal, the output from the detector is first filtered using a 2 stage HP-LP circuit and is then converted to digital pulses using a comparator circuit or using simple ADC. The digital pulses are given to a microcontroller for calculating the heat beat rate, given by the formula-
BPM(Beats per minute) = 60*f , Where f is the pulse frequency.

IX. ELECTROCARDIOGRAPHY (ECG or EKG)

It is the process of recording the electrical activity of the heart over a period of time using electrodes placed on the skin. These electrodes detect the tiny electrical changes on the skin that arise from the heart muscle's electrophysiologic pattern of depolarizing during each heartbeat.
In this way, the overall magnitude and direction of the heart's electrical depolarization is captured at each moment throughout the cardiac cycle.The graph of voltage versus time produced by this non- invasive medical procedure is referred to as an electrocardiogram.
During each heartbeat, a healthy heart has an orderly progression of depolarization that starts with pacemaker cells in the sinoatrial node, spreads out through the atrium, passes through the atrioventricular node down into the bundle of His and into the Purkinje fibres, spreading down and to the left throughout the ventricles. This orderly pattern of depolarization gives rise to the characteristic ECG tracing.

X. ACCELEROMETER (ADXL335)

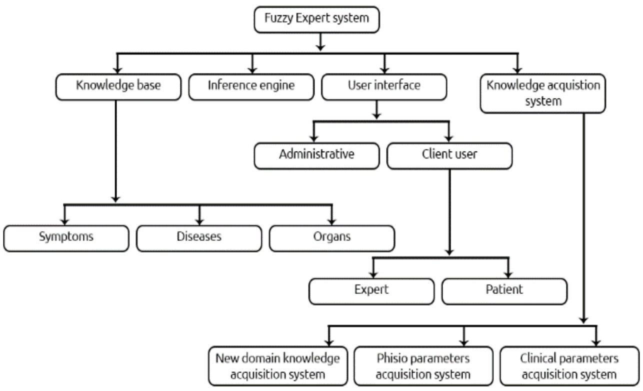
The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 *g*. It can measure the static acceleration of gravity

in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration.The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.
The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package
Small, Low Power, 3-Axis ±3 *g* Accelerometer ADXL335 with Information furnished by analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by analog Devices for its use, nor for any infringements of patents or other rights of third parties that may result from its use.
The ADXL335 output is ratio metric, therefore, the output sensitivity (or scale factor) varies proportionally to the supply voltage. The zero *g* bias output is also ratio metric, thus the zero *g* output is nominally equal to VS/2 at all supply voltages.
The output noise is not ratio metric but is absolute in volts; therefore, the noise density decreases as the supply voltage increases. This is because the scale factor (mV/*g*) increases while the noise voltage remains constant .

FEATURES
3-axis sensing
Small, low profile package
4 mm × 4 mm × 1.45 mm LFCSP
Low power of 350μA (typical)
Single-supply operation: 1.8 V to 3.6 V
10,000 *g* shock survival
Excellent temperature stability
BW adjustment with a single capacitor per axis

APPLICATIONS
Cost sensitive
Low Power
Motion- and tilt-sensing

SYSTEM OUTPUT
The output from the fuzzy system is used to detect if the heart condition is bad, critical or normal. Depending on the fuzzy output, the actions and alerts like starting the ECG, alerting heart specialist *etc*. are generated
The input variables are fuzzified whereby the membership functions defined on the input variables are applied to their actual values, to determining the degree of truth for each rule antecedent.



Our system contains various sensors, which measure some physical properties of a human body. Diagnosis is performed by studying several parameters of a human body known as symptoms and several symptoms are verified one after another before obtaining a final conclusion.

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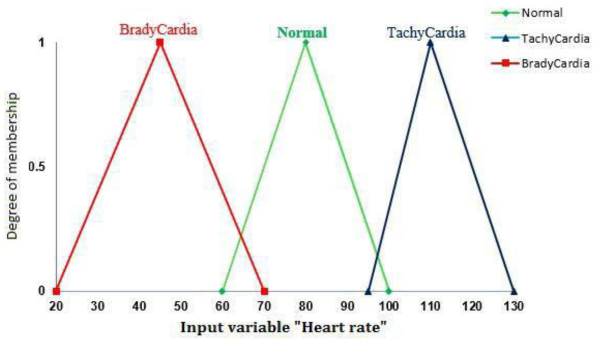
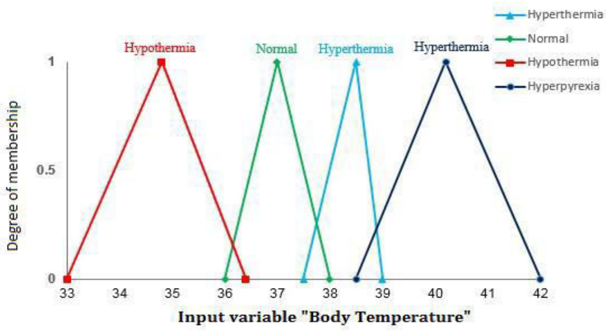
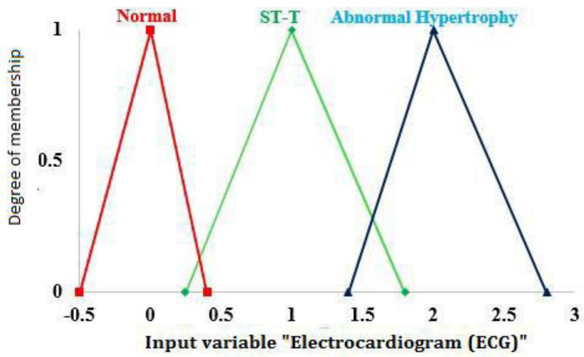




The membership criteria for body temperature are based on systolic and diastolic pressure. Normal body temperature is as normal body temperature 37◦C but it may vary during the daytime, so a ranges between 36.5◦C and 37.5◦C is considered as normal.



Electrocardiogram (ECG) is a test that measures the electrical activity of the heart. It uses ultrasound to evaluate the heart muscle, heart valves, and risk for the heart disease. ECG parameter range is divided into three fuzzy sets, namely, ‘Normal’, ‘ST-T Normal’ and ‘Hypertrophy’.

The fuzzy expert system computes the probabilities and determines output value in terms of percentage of the risk of heart disease from zero percent to hundred percent. Decisions are described through the output membership functions that are mentioned. These functions determines whether the alert will be generated or normal monitoring is sufficient.

The fuzzy system is programmed on the Arduino board which is used as a data aggregator unit in the healthcare monitoring system. The data aggregator only transmits sensor-data according to the fuzzy rules.

Thus unnecessary transmission of all sensor-data is avoided. Only required data will be transmitted and alert will be generated in case of emergency health condition. Moreover, ECG is resource demanding as it requires high sampling rate. So, preventing it from working unnecessary.

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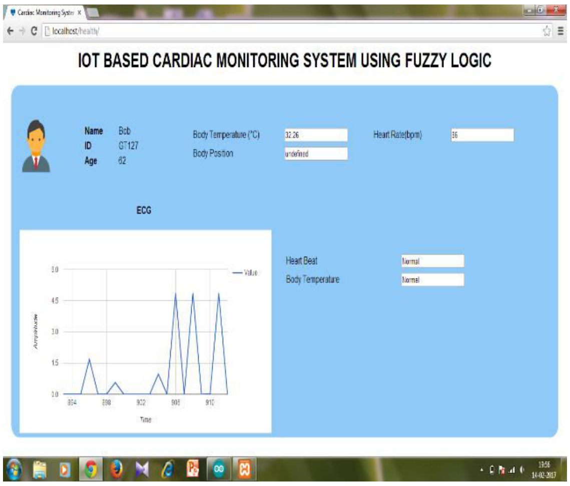

XI. CONCLUSION

The proposed system constitutes an effort toward the design of an intelligent, flexible and integrated fuzzy logic - based home health care system. Decisions are described through the output membership functions. These functions determines whether the alert will be generated or normal monitoring is sufficient. The generation of accuracy of knowledge can enhance performance of whole system. The proposed system constitutes an effort toward the design of an intelligent, flexible and integrated fuzzy logic-based home healthcare system.

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