AN INTELLIGENT SENSOR BASED SYSTEM FOR PHYSICAL CONDITION PREDICTION AND DISABLE PEOPLE MONITORING (DPM)

[1]NUSRAT JAHAN FARIN, [2]IFTEKHARUL MOBIN, [3]SHARMIN AKTER

[1,2,3]Department of Computer Science and Engineering, University of Liberal Arts Bangladesh
4/A Dhanmondi, Dhaka-1209
E-mail: [1]nusrat.farin.cse@ulab.edu.bd, [2]iftekharul.mobin@ulab.edu.bd, [3]sharmin.akter.cse@ulab.edu.bd

Abstract— In this paper an intelligent continuous Disable People Monitoring (DPM) system is presented. Compared to other similar systems this proposed DPM system have many extra features. It is cost effective and reliable. In this system, microcontroller takes input signals from various on-body and offbody sensors. From the sensor readings, with pre-programmed logic micro-controller identifies monitored human position, movements, pace etc. According to predefined algorithm physical condition is predicted. This paper presents how this system
is built, components connection diagram, and implementation logic. Overall performance of this system is evaluated through experimental tests by creating real time scenarios to investigate reliability. We found that this system demonstrated its accuracy most of the cases perfectly.

Keywords— Human Behavior, Gesture, Sensor, Micro-Controller, Movement Detection, Vibration

I. INTRODUCTION

Physical condition detection and recognition system is very important for monitoring of disable people. Assuring intensive care based on physical condition sometimes become mandatory. Specially in such situation where continuous monitoring and handling is required for a long period of time. It can be used to provide intensive care support for the incapacitate and autistic people as well. Hence, this type of system could be extremely helpful for those people who are mainly responsible for monitoring them.

This paper shows an intelligent self-controlled microcontroller unit (MCU) based smart health monitoring system. The system is specially designed for autistic, disabled or elderly patients. This system assembled with multiple sensors and operated by MCU. It takes input signals from various sensors placed in different position of the monitored human body and surroundings. It combines integrated logic to identify position, movements, pace etc. Several caring centers monitor the mental patients, autistic people by human being. However, this task is not so easy or sometimes extremely difficult for the human to monitor them 24/7 for a long period of time. To resolve this problem an intelligent micro-controller sensor based prototype system is designed and implementation is demonstrated in this paper. It can recognize humans gesture, behavior and predict the abnormal situation or deceptive physical condition. The proposed prototype in this paper detects the human motion such as: walking, running, etc or position within a closed room. It can classify activities like standing, sleeping, sitting position. This system also tracks heart rate with the body temperature and humidity to determine the physical condition and abnormality. The main target to develop this prototype is to track every single gesture, movement along with body temperature, humidity and heart rate of human body and provide an intensive care support. Thus, it facilitates the monitoring committee to look after patients and ensure the security especially for the challenging mental patient or the autistic people. To monitor the human movement or gesture some sensors are used in this system to detect the position, motion speed, vibrating rate, temperature, humidity, heartbeat rate etc. The sensors are attached with the sensor interfacing hardware prototyping board which is named as Arduino. After collecting sensor data of different activities of the human is aggregated by using Arduino is analyzed. This analysis provides automatic signal to the monitoring responsible authority and also provide the decision about the monitored people. Many researches were done about how to recognize the human gesture and behavior (for example [1], [2], [3], [6], [7], [13]) and tracking human movements and gesture precisely. Distributed Omni directional Vision System (DOV S) [5] only detect the human motion like walking but the system doesn't measure the distance of human agent. It does not indicates the real position, where or what axis the agent move. Usually, human behavior can be analyzed from diverse levels of resolution such as full body level [4], upper body [9], [10], lower body [12] etc. However, in our system specific sensors are used for detecting the gesture and human movement behavior. To implement the logic development the Arduino micro-controller software platform is embodied. In our studies no other researches were concerned to develop their prototype model with both hardware and software. Therefore, our proposed prototype system outperformed the others proposed systems and some previous researches like [7], [4]. The proposed system is quit different from the other researches and also provides the circumstantial

information about the human gesture, position and possible health condition (e.g heartbeat, temperature etc) which is not included in the past researches [1], [12]. The motion axis (x, y, and z) direction movement, distance measurement, the vibrating rate, heartbeat rate, body temperature and humidity of the agents are included in this research which is completely unique idea and approach. That's why it is lavish efficient than the other investigation of human sensor based monitoring. In our system five types of sensors and an Arduino board have been used for the experiment to detect the human movement behavior and gesture. The name of the sensors are ultrasonic sensor, magnetometer, peizo vibrate sensor, ear clip heart rate sensor, temperature and humidity sensor. In this scheme hardware stuffs are controlled over the MCU (Micro Control Unit) system with Arduino programming.

II. WORKING PROCESS

Recognition of human gesture and behavior is very interesting topics for many researches. It is also very important for different purposes discussed above. There are plenty of researches which work for detecting the human gesture and behavior [1], [2]. But our working process approach to recognize the human with very simple and inexpensive five sensor based system is completely unique and not available in this research area. Human action is determined based on some activities. Such as - Recognition of human gesture and behavior is very interesting topics for many researches. It is also very important for different purposes discussed above. There are plenty of researches which work for detecting the human gesture and behavior [1], [2]. But our working process approach to recognize the human with very simple and inexpensive five sensor based system is completely unique and not available in this research area. Human action is determined based on some activities. Such as -

1) Gesture
2) Position
3) Moving distance
4) Moving direction
5) Body vibration
6) Heart beat rate
7) Body temperature
8) Body humidity and so on

Our research work has been done with the movement direction, moving distance, position, vibration of the body, heart beat rate and temperature as well as humidity of the human body. By using the ultrasonic sensor, magnetometer, peizo vibration sensor, ear clip heart rate sensor and temperature and humidity sensor all these parameter values are estimated. The whole process for detecting of human movement and behavior is given below:

A. Tracking of human behavior, gesture, movement, heart beat, temperature, humidity or position

1) Moving distance based segment detection: Human movement is arbitrated by using the ultrasonic sensor in our system. Usually, ultrasonic sensors are used for robotic research purposes for detecting the moving distance. For using this sensor it can be easier to know that how long the obstacle is situated and at the same time it can be estimated how fast they move here and there. In our system two ultrasonic sensor are used, one for X direction and one for Y direction. In real scenario the number of the sensor may be increased on the basis of the size of the room. For experimental purposes bread board is being used for placing the ultrasonic sensor by X and Y direction.

2) Position based segment detection: Magnetometer GY- 273 module has been used for detecting the moving direction. By using magnetometer sensor module, human movement can be observed in which direction it moves like X, Y or Z axis direction. We can able to navigate not only the exact axis position of human body but also can be identifying the present situation (like sitting, lying or standing).

3) Vibration based segment: Peizo vibration sensor is being used to measure vibrating rate of the human body. Vibration sensor is generally used to detect vibration and shock of an object. By using this sensor the exact vibration rate of the body can be determined. One vibration sensor has been used for our experimental purpose.

4) Heart beat rate and pressure measuring based segment: A device is used for measuring heart beat and pressure in different situation. Using this device the accurate data for heart rate and pressure. By using this data we are able to determine the accurate situation which is determined from the sensor value which actually found in this experiment.

5) Temperature and humidity based segment: Temperature and respective humidity of human body can be determined by the temperature and humidity sensor. One sensor is being used for this experiment. By using this sensor the exact temperature and its respective humidity can be measured that's why this sensor is used.

B. The process of data acquiring and detection of human behavior and gesture

1) Flow Chart:

2) Algorithm: From the flow chart (Fig.1) an algorithm is written below. This algorithm shows a vivid logic of our research of Arduino IDE coding 1. Data acquiring process through this system is described in this section with a flow chart. It will provide a clear idea to understand our prototype system implementation properly. The flow chart view of this proposed system is included in Fig.1.

3) Description of the using Algorithm: The algorithm shown in Algorithm 1 is self explanatory apart from some initial values determination policy of the used sensors. Mostly initial values are different for

different used sensors. The initial distance value of ultrasonic sensor is the lowest possible distance from two adjacent ultrasonic sensors. For vibration sensor, its initial value is the lowest possible value whenever the agent is steady position. The initial value of the Magnetometer is determined from the value, whenever the agent is in steady and standing position.

Algorithm 1 Determine the gesture of monitoring people

Require: Collect data from some embedded sensors.
Ensure: Gesture and movement detection of an agent.

$Vv \leftarrow Vibration\ sensor\ value$
$Rv, Lv \leftarrow Right\ and\ Left\ Ultrasonic\ Sensor\ Value$
$MX, MY, MZ \leftarrow Magnetometer\ X, Y, and\ Z\ axis\ value$
$init_val \leftarrow Initial\ Values\ of\ the\ used\ sensors$
$HnP \leftarrow Heart\ rate\ and\ Pressure\ of\ monitoring\ People$
$Tv \leftarrow Temp.\ and\ Humi.\ values\ of\ the\ used\ sensor$

```
loop
  if HnP > init_val && Tv > init_val then
    if Vv < init_val && Rv && Lv < init_val then
      The agent is not moving
      if MX = init_val then
        The agent is in middle position
      else if MX < init_val then
        The agent trends to left side
      else if MX > init_val then
        The agent trends to right side
      end if
      if MY > init_val then
        The agent is stoop to forward
      else if MY = init_val then
        The agent is in the straight position
      else if MY < init_val then
        The agent is stoop to backward
      end if
      if MZ = init_val then
        The agent is sitting
      else if MZ < init_val then
        The agent is standing
      else if MZ > init_val then
        The agent is lying
      end if
    else if Vv > init_val && Rv && Lv <= init_val then
      The agent is walking normally
    else
      The agent is running or moving frequently
    end if
  else
    The agent is in abnormal situation
  end if
end loop
```

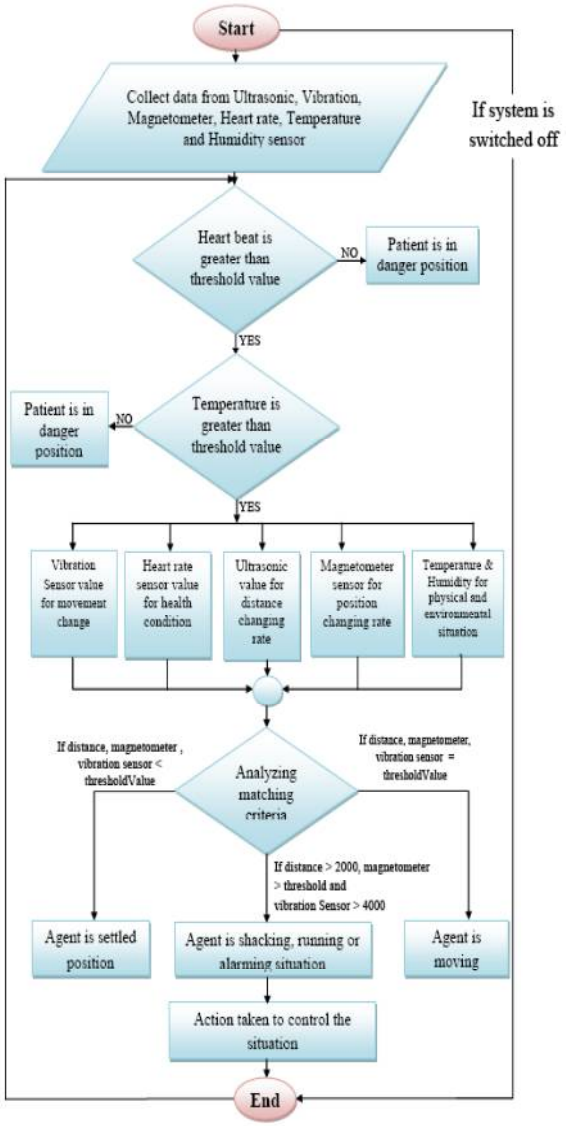

Fig. 1: Flow chart of the prototype

III. EQUIPMENT SET-UP

A. Circuit Diagram

All sensor modules are attached with the Arduino according to the circuit diagram shown in Fig.2. In Fig.2 the circuit diagram shows how ultrasonic sensor, vibration sensor and magnetometer are connected with arduino board. A0 the analog pin of Arduino is connected with the output pin of vibration sensor and A4 and A5 is connected with SDA and SCL pin of magnetometer. Trig and Echo pin of ultrasonic sensor is connect with D7 and D8, the digital pin of Arduino. For ultrasonic sensor trig pin is used for output and echo pin is for input.

B. Digital LCD Wrist Cuff Arm Blood Pressure Monitor Heart Beat Meter Machine

To analyze the sensor data a device is used. The device name is Digital LCD Wrist Cuff Arm Blood Pressure Monitor Heart Beat Meter Machine. This device is placed on the arm of the monitoring

people.This device can measure systolic, diastolic and pulse at the same time. So, the sensor values can be verified. The values of these device for different situation is equivalent to the sensor value.

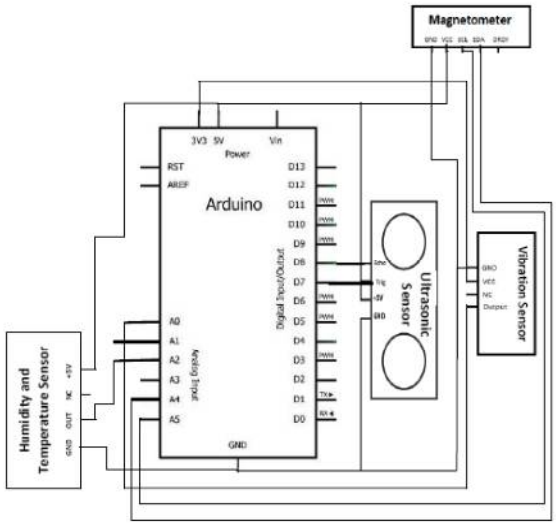

Fig. 2: Circuit Diagram

IV. METHODOLOGY

In the experiment the used sensors are connected with two bread board which are internally connected. Connected sensors are placed in the agent body for collecting data. Data are collected through the serial monitor output of the Arduino IDE. CoolTerm [21] terminal monitor has been used for saving data as a .csv file format which helps to find the data in exel format. The CSV file is being used to draw the chart with GNU plot [20]. The heart rate and pressure for different situation of the agent is also collect to analyzing the data that found from sensors and can decide various decisions such as whether the object or agent is in standing, sleeping, running or walking etc. The results supports the view that human gesture and movement describe as a sequence of movement, vibrating rate, changing derection of axis, temperature and humidity of the agent body and heart beat and pressure rate. Different epistle is created for the collected values of different sensor using GNU plot. By analyzing the graph we can determine the situation of the agent body. At that time when the sensor value in the graph is very low that means the agent is in normal and steady position. But when the values are so high it means that the agent is moving or walking or running.

V. RESULTS ANALYSIS

By analyzing the graph Fig.4, 7, 8, 9 we can determine the vibration rate with respect to time and situation.The value remain almost same and the curve change a little bit when the monitoring person remain in steady or in normal position. But sometimes it is noticeable that x and y-axis value is changed but z-axis is not changed that means the monitor

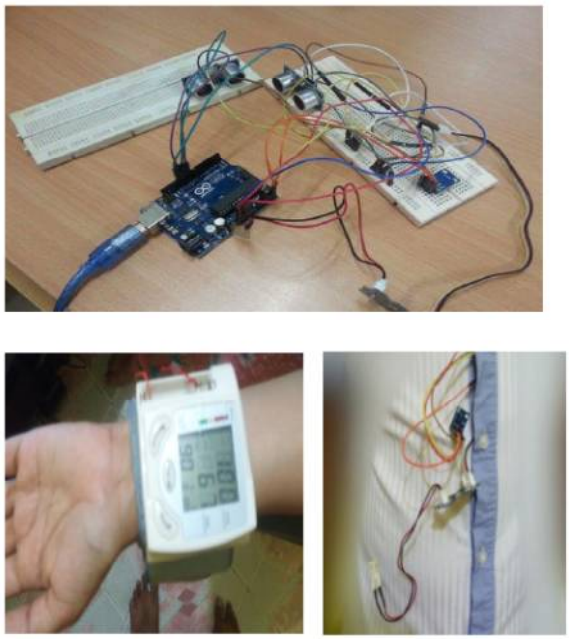

Fig. 3: Experimental Environment

people is standing or lying or sitting but he/she moves to left or right. At the time of position change like standing to sitting, or sitting to lying, or standing to lying the z-axis value will be changed.In the jumping time it also change similarly. In Fig.4 and 5, at the time when distance is increased that means monitoring person is moving. If the distance value is constant or value verify at a low range, it means the object is not moving anywhere. When time difference is low and at the same time distance is high, then it can determine that the object is moving very fast and also the object is moving simultaneously.

In this experiment the co-relation between the sensor value is observable. These graph of sensor value is co-relate with the value of heart rate and pressure which is found from a device that we use in the experiment which means our experiment gives correct data. At the time of walking or running the heart rate and pressure becomes high and at the same time the vibration, magnetometer and ultrasonic sensor value also change in same way. So we can determine that by this experiment we can able to monitor a autistic and disable people.

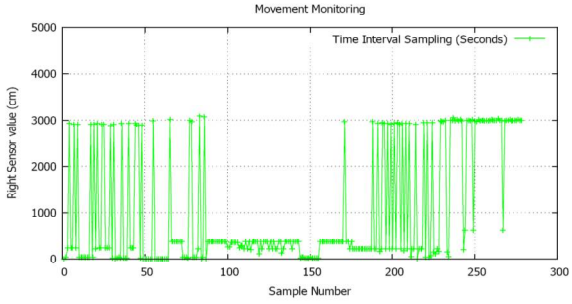

Fig. 4: Distance from right sensor respect to time

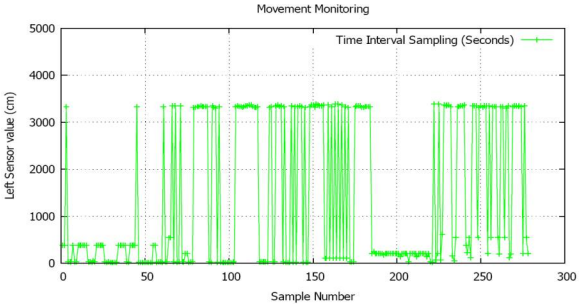

Fig. 5: Distance from left sensor with respect to time

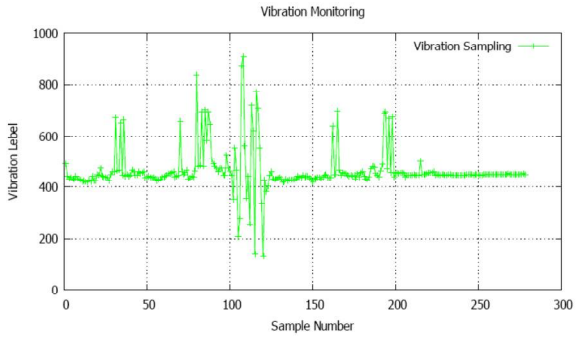

Fig. 6: Estimate the vibration rate versus time

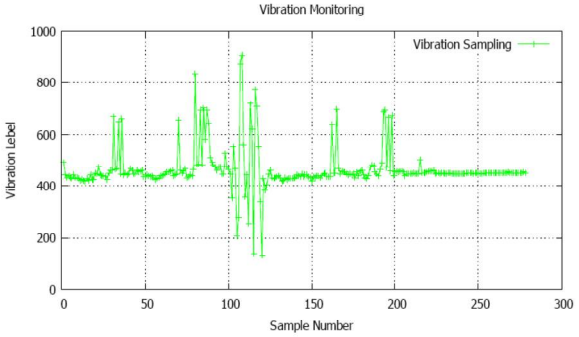

Fig. 7: Movement towards X-axis with respect to time

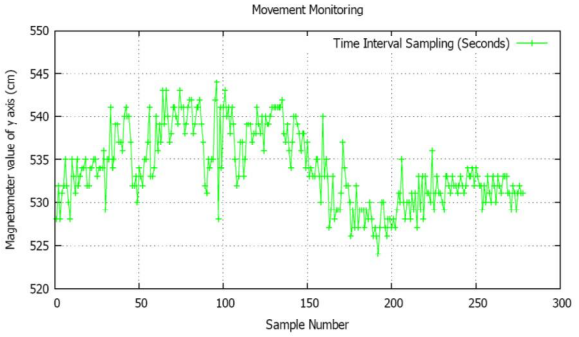

Fig. 8: Movement towards Y-axis with respect to time

CONCLUSION

In this paper our demonstration showed that this system can categorize the gesture and behavior of a human with used sensors very fast. From the simulation result it is revealed that The proposed system allows to measure heart rate, detect position as well as distance from a particular place, temperature and relative humidity of human body precisely. By using this system we can automatically detect the action , mood, physical condition of a human. These sensors which are used in our system is available in local market and also very cheap rather than other sensors. General people can easily use this sensor at a very low cost. Currently in our study there is no cheap system available which can determine the human gesture or behavior using these. That's why our idea and prototype of this proposed system is unique. This noble system can be used for disabled and autistic people to manage them in secure way and uphold their life standard.

FUTURE WORK

Still we are in the process of improvement. In this paper we deal with the numeric data which is found from our experiment that helps us to make decision about the agent's behavior or gesture. In future we will add some other features to develop the system and make it easy to user through mobile application. This system can be incorporated with cloud computing and enriched the prototype system. This noble system can be used for disabled and autistic people to manage them in secure way and uphold their life standard.

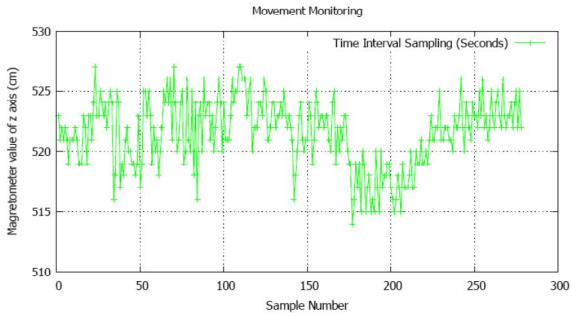

Fig. 9: Movement towards Z-axis with respect to time

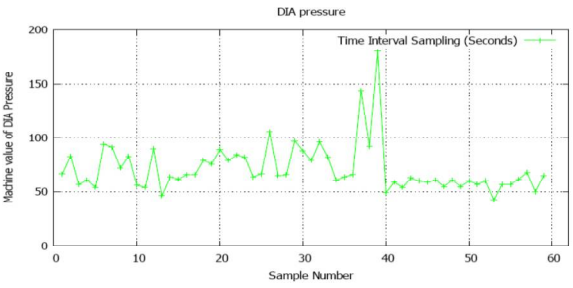

Fig. 10: Diastolic Pressure with respect to time

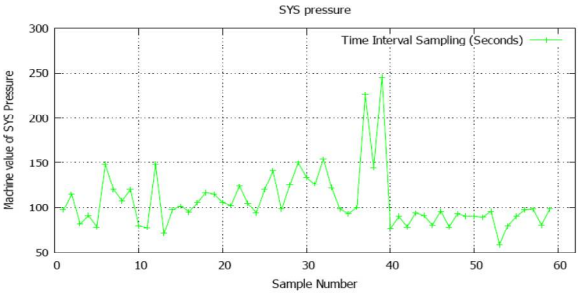

Fig. 11: Systolic Pressure with respect to time

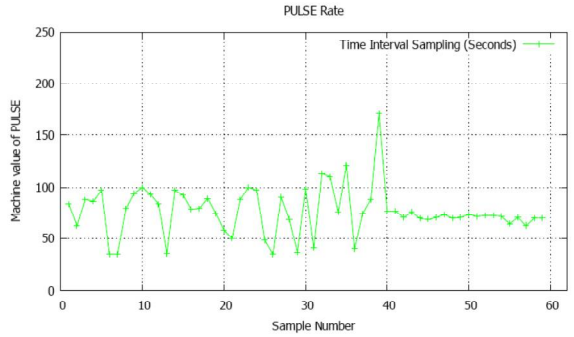

Fig. 12: Heart rate with respect to time

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