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Advanced Data Peripheral Glove with Real-time Vital Health Monitoring System

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Abstract: A minimal effort remote glove controller that distinguishes finger signals was created utilizing flex sensors and biosensors. The execution of the flex sensors was contrasted with that of financially accessible ones. A virtual condition was likewise made for the virtualization of the client's hand developments identified by the glove controller. Inside this virtual condition, the client characterized finger signals likewise enabled the client to control components inside the virtual condition which can stretch out to different applications including restoration and body-situated gaming. The plan and improvement of wearable biosensor frameworks for wellbeing observing has gathered bunches of consideration in established researchers and the business amid the most recent years. Predominantly persuaded by expanding human services costs and impelled by late innovative advances in little bio-sensing gadgets, savvy textiles, microelectronics, and remote interchanges, the ceaseless progress of wearable sensor-based frameworks will possibly change the fate of social insurance by empowering proactive individual wellbeing administration and omnipresent checking of a patient's wellbeing condition. These frameworks can involve different sorts of little physiological sensors, transmission modules and handling capabilities, and can along these lines encourage minimal effort wearable subtle answers for persistent throughout the day and wherever wellbeing, mental and movement status observing. The data regarding the vital health conditions of a person is extracted from the microcontroller will be displayed on the system .These results are stored in the local database. This paper endeavors to completely audit the flow of innovative work on wearable frameworks for wellbeing checking and motion location.

Keywords: Flex sensor, Processing, Arduino, Biosensor, health monitoring, wearable systems.

I. INTRODUCTION

Wearable frameworks for wellbeing checking may contain different sorts of smaller than normal sensors, wearable or even implantable. These biosensors are fit for measuring noteworthy physiological parameters like heart rate, circulatory strain, body and skin temperature, oxygen immersion, breath rate, electrocardiogram, and so on. The got estimations are conveyed either by means of a remote or a wired connection to a focal hub, for instance a microcontroller board, which may then thus show the concurring data on a UI or transmit the collected key signs to a medicinal focus. The past outlines the way that a wearable medicinal framework may include a wide assortment of segments: sensors, wearable materials, brilliant materials, actuators, control supplies, remote correspondence modules and connections, control and handling units, interface for the client, programming, and progressed calculations for information removing and basic leadership. For sure, materials can be an interface with around 90% of skin, are adaptable, fit well with human body, and are shabby and dispensable. Advancements for mix are currently accessible. Miniaturized scale advancements empower sensor's mix in the material outline. Science furnishes filaments with new properties, mechanical, optical, electrical and even electronical, which can be utilized as sensors, actuators or systems. Interchanges means are radio, GPS, GSM, Bluetooth, screen, console inserted in material, and shrewd garments can assume an incredible part in walking checking as a gadget itself [7].

A general WHMS design is delineated, in understanding to the portrayed framework's usefulness and segments. Be that as it may, this ought not be seen as the standard framework plan, the same number of frameworks may receive fundamentally shifting compositional approaches (for instance bio-signals might be transmitted in simple frame and without preprocessing to the focal node and bi-directional correspondence amongst sensors and focal hub may not exist). With fast improvement in wearable gadgets, the human-PC cooperation possesses a critical part.

Signal acknowledgment innovation has step by step turned into a hotspot in research of human-PC interaction [1]. Signal acknowledgment innovation fundamentally has two sorts: one kind is signal acknowledgment in view of picture, which has been moderately develop, additionally present issues on higher utilizing range and ecological prerequisites. The other is a motion acknowledgment innovation in view of movement sensor, and a ton of researchers both at home and abroad do look into on this fields [2].

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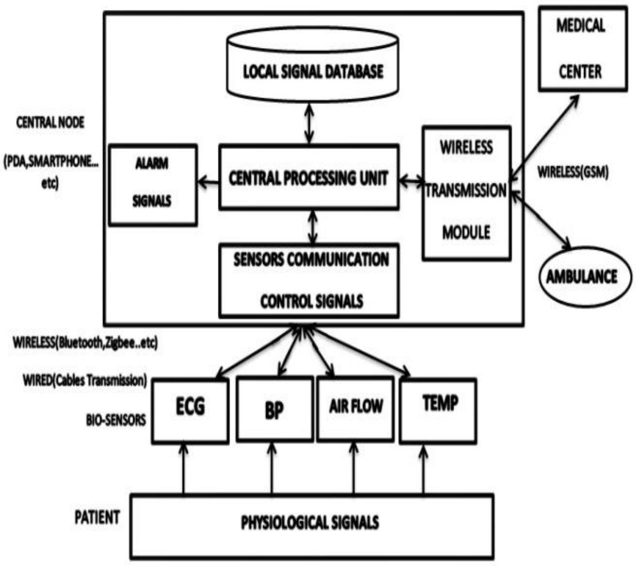

Fig.1.Architecture of WHMS

Wang [3] outlined an accelerometer-based advanced pen with a direction acknowledgment calculation for written by hand digit and motion acknowledgment, the increasing speed flag of time arrangement is changed over into an element vector, and by utilizing the probabilistic neural system (PNN) classifier to group the include vectors, the pen's exactness is higher in the wake of testing, yet, the preparation procedure of PNN is mind boggling and has a vast measure of count. Zhu[4] proposed online hand signal which can't dispose of the gadget motion constrain, everybody signals has a little individual variety, thusly is definitely not appropriate for generally utilized as a part of wearable gadgets acknowledgment utilizing neural system based division, yet which can't get rid of the device gesture limit, everyone gestures has a little individual variation, this way is not suitable for widely used in wearable devices.

TABLE I BIOSENSORS AND BIOSIGNALS

Type of Bio-signals	Type of sensors	Description of measured data
Electrocardiogram (ECG)	Skin/Chest Electrodes	Electrical activity of the heart (continuous waveform showing the contraction and relaxation phases of the cardiac cycles).
Blood Pressure (systolic & diastolic)	Arm Cuff-based monitor	Refers to the forces exerted by circulating blood on the walls of blood vessels, especially the arteries.
Respiration Rate	Piezoelectric/ piezoresistive sensors	Number of movements indicative of inspiration and expiration per unit time.
Body Temperature	Temperature probe	A measure of the body’s ability to generate and get rid of heat.

II. PHYSIOLOGICAL SIGNALS AND BIOSENSORS

A. Airflow sensor

The nasal airflow sensor is a sensing device commonly used to monitor the breathing airflow rate of a patient who needs respiratory support. This equipment is used to sense, measure and record breathing signals under the patients breathing abnormalities [7]. In this project, the airflow sensor is connected to the hardware peripheral, which is used for converting the sensor data into a pulse data with maximum peak of 5 volts. The pulse data is then transferred to the serial

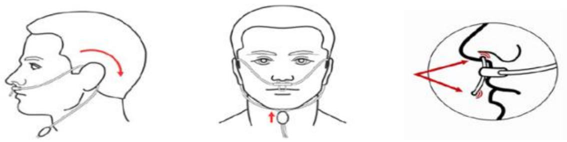

Figure 2 . Airflow sensor connected to patient

receptor which is connected to the system with the baud rate of 9600 bps. The airflow sensor is as shown in Fig 2.

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B. **Temperature sensor**

Nominal human body temperature, also known as normothermia, is the typical temperature range found in humans. The normal body temperature range is typically specified as 97.7–99.5 °F (36.5–37.5 °C). In adults, body temperature fluctuation about 0.9°F (0.5°C) depending on the body's needs and activities. In this project, the sensor measures the key features for body temperature monitoring. The temperature sensor is shown in Fig. 3 and pseudo code in Fig. 4. It is important to measure body temperature to detect number of diseases that are accompanied by typical changes in body temperature and thereby improves the efficiency of treatment by the physician. The body temperature measurement values are shown in table II.

Figure 3 . Temperature sensor

1. **Start**
2. Read analog input
3. Convert analog to digital
   Volt = Analog value * Given voltage input
   Value = Volt / 1024
4. Print Temperature
5. Go to 3
6. **End**

Figure 4 . Pseudo Code of Temperature algorithm

TABLE II. TEMPERATURE EVALUATION

SL. No.	Body Temperature Measurement Values		
	Parameter	**Range in °C**	**Range in °F**
1.	Hypothermia	< 35.0	< 95.0
2.	Normal	36.5–37.5	97.7–99.5
3.	Fever or Hyperthermia	> 37.5–38.3	> 99.5–100.9
4.	Hyperpyrexia	> 40.0–41.5	> 104–106.7

C. Electrocardiogram(ECG)

The heartbeat sensor is a digital pulse module which is further connected through the interrupt module of the hardware so it can be calculated with beats per second, hence targeting the final value of total beats per minute. The ECG sensor and pseudo code is shown in Fig 5. and Fig 6.

Figure 5. ECG Sensor

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1. **Start**
2. Set heartbeat byte in bits
3. Read digital heartbeat
4. **If** (Heartbeat is present), **Then**
   Find Heartbeat until n < k
   T1 = Millis ()
5. T2 = Millis ()
6. Rate = T2 – T1
7. Rate = Rate/k
8. Rate = 60000/Rate
9. Set rate to Heartbeat
10. Print Heartbeat
11. Reset data
12. Go to 3
13. **End**

Figure 6. Pseudo Code of Heartbeat algorithm

The measurement values of various parametes are shown in the table III. The experimental hardware setup is as shown in Fig. 5 where all the sensors are interfaced with board.

TABLE III. MEASUREMENT

SL. No.	**Measurement Values**		
	Parameter	**Range**	**Unit**
1.	Body Temperature	0-50	Degree Celsius (°C)
2.	Respiratory rate	0-60	PPM (Peaks per minute)
3.	Breathing intensity	0-3, 3	Volts
4.	Pulse	25~250	PPM (Peaks per minute)
5.	SpO_2	35-100	Percentage

D. Blood Pressure Sensor(BP):

Fig 7.Blood pressure (BP)

TABLE IV. MEASUREMENT

SL. No.	Measurement Values		
	Parameter	**Systolic (mm Hg)**	**Diastolic (mm Hg)**
1.	**Hypotension**	< 90	< 60
2.	**Desired**	90–119	60–79
3.	**Prehypertension**	120–139	80–89
4.	**Stage 1 Hypertension**	140–159	90–99
5.	**Stage 2 Hypertension**	160–179	100–109
6.	**Hypertensive Crisis**	≥ 180	≥ 110

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III. ARRANGEMENT OF THE WEARABLE SENSING GLOVE

Motion of the hand is achieved via 19 bones, 19 joints, and 29 muscles [9]. Each finger (except the thumb) has three bones a distal, middle, and proximal phalanx and three joints a proximal interphalangeal (PIP) joint, metacarpophalangeal (MCP) joint, and DIP joint. The metacarpal and phalanx bones meet the wrist at the carpometacarpal (CMC) joints. The IP joints, including the PIP and DIP joints, have one degree of freedom (DOF) for the flexion/extension, and the MCP joints have two DOFs for the flexion/ extension and abduction/adduction [10].
The cross segment of a finger is appeared in Fig. 7 amid flexion/ expansion. Since the lengths of each finger component, C_1, C_2, and C_3, can be measured ahead of time, the position of the fingertips can be portrayed as takes after:

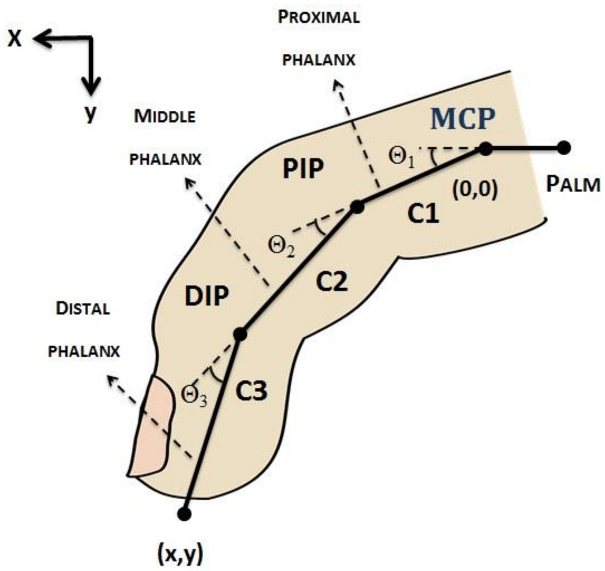

Fig 8. Cross section of finger

$x = C_1\cos(\theta_1) + C_2\cos(\theta_{12}) + C_3\cos(\theta_{123})\ldots(1)$
$y = C_1\sin(\theta_1) + C_2\sin(\theta_{12}) + C_3\sin(\theta_{123})\ldots.\ (2)$

where θ_{12} and θ_{123} are the summation of θ_1, θ_2 and θ_1, θ_2, θ_3, individually.

IV. COMPONENTS OF THE SYSTEM

The Core Device Schematics:
The Core construction of the device consists of the below mentioned major modules.

Microcontroller module:
This module makes use of force sensors, biosensors like temperature sensor, heartbeat sensor, blood pressure sensor, airflow sensor, battery (5V), Encoder (HT12E), Decoder (HT12D), Microcontroller Board.

GSM module:
This Module will be used in case the patient's health condition is found to be at risk, based on his answers, the emergency services will be contacted.

Database Module:
The data regarding the vital health conditions of a person is extracted from the microcontroller will be displayed on the system. These results are stored in the local database.

V. IMPLEMENTATION OF THE WEARABLE SENSING GLOVE

The force sensors or the bio sensors give the feed to the transmitter. These electrical driving forces are additionally arranged for a computerized recurrence [5].
These are additionally encouraged into the RF transmitter. These are transmitted by means of RF signs to the collector module which is associated the pc utilizing a microcontroller.

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Fig 9. Demonstration of Data Glove

The microcontroller translates the data to nourish it to the pc to get in the data for performing important actions. The information is gathered from the glove utilizing flex or a weight sensor which is additionally handled into encoded information utilizing the RF encoder and further is prepared into RF decoded data in the collector side utilizing an appropriate decoded gadget, is further fed into microcontroller to play out the required operation on the PC [5].
Transmission of measured information in the general setting of WHMS should be performed for three distinct purposes: 1) for imparting the gathered physiological signs from the biosensors to the framework's focal hub [6].
2) The data regarding the vital health Conditions of a person is extracted from the microcontroller will be displayed on the system and the results are stored in the local database.
3) For sending the accumulated estimations from the wearable system to a remote medical station or to a physician's cellphone [7].

VI. APPLICATIONS

1) Design And Manufacturing
In this area, glove-based systems are used to interact with computer-generated (typically virtual reality) environments. Using a computer screen or a head mounted display, the user, who can be located either on site or remotely over the Internet can visualize environments or artifacts that are being designed before their actual construction or manufacturing eliminating the need for expensive mockups.
2) Virtual Desktop
The user can grab a document by making a fist, and release it by opening the fist.
3) Information Visualization
Computer graphics is often used to create visual representations to aid in the understanding of data. Good data visualization techniques are especially useful. Glove applications based on continuous data recording.
4) Robotics
Glove-based systems can potentially make robot programming a central issue in robotics—more natural and easier, particularly when methods based on teleoperation or automatic programming are used. This is particularly true for multi-DoF systems that require the control of a large number of joints, which is difficult to accomplish with standard control techniques. In automatic programming, the robot learns its behavior automatically, for example, observing a demonstration performed by a human This method is receiving growing attention as robots are increasingly used in no structured environments, in tasks unpredictable a priori, and by no specialized personnel. After Sturman's seminal work showed the feasibility of using gestures as interfaces for robot control several researchers pursued this approach.
5) Sign Language Understanding
After the pioneering project of Grimes with the Digital Entry Data Glove, many projects used glove-based systems for automatic understanding of gestural languages used by the deaf community. The systems developed in these projects differed in characteristics such as number of classify- able signs, which could range from a few dozen to several thousand, types of signs, which could be either static or dynamic, and percentage of signs correctly classified. The simplest systems were limited to understanding of finger spelling or manual alphabets (a series of hand and finger static configurations that indicate letters). The more complex systems aimed at understanding sign languages, a series of dynamic hand and finger configurations that indicate words and grammatical structures.
6) Medical and Health Care
In this area, most projects have explored the viability of using glove-based systems as tools for hand functional assessment. Clinical assessment of hand function requires acquisition of a number of data, including pinch and grip strength, sensitivity to temperature, and most importantly, the range of motion of hand joints. Quantitative

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measurements of range of motion are usually performed using mechanical or electronic goniometers, but the process is time-consuming and can have limited accuracy. Some of the application and features of medical health care are:

a. Medical Education and Training
b. Motor Rehabilitation
c. Lower Medical cost
d. Virtual reality dentistry
e. Efficiency
f. Realistic

VII. RESULTS FOR GESTURE

Fig 9 represents the positions for all the fingertips of the hands with respect to the keys on the keyboard were noted. Switch buttons were attached to these potions. A wedge was inserted between the finger and the buttons to reduce strain on the joints and to make the device ergonomically sound. The aim was that when the user taps a finger on any flat surface, with the familiar sense of position of a keyboard, the corresponding key will be registered by the device.

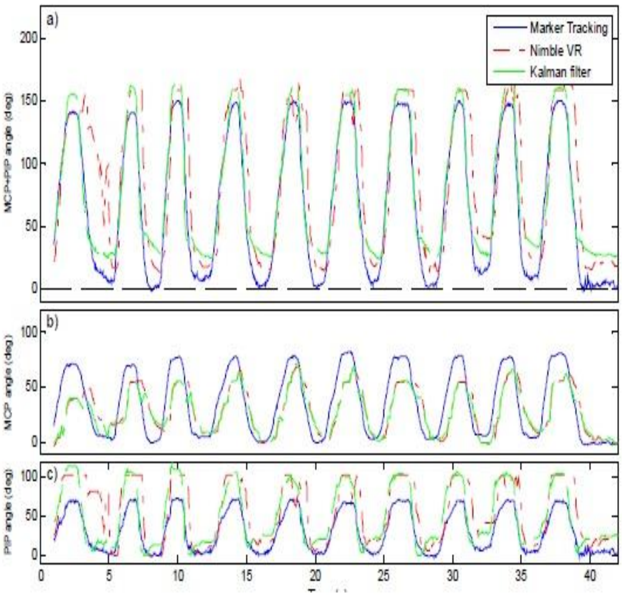

Fig 9 active index flexion comparison between existing system and proposed system

VIII. EXPERIMENTAL RESULT FOR HEALTH

An experimental test bed setup for WBAN has been done using the sensors and the experimental results are analyzed as given below.

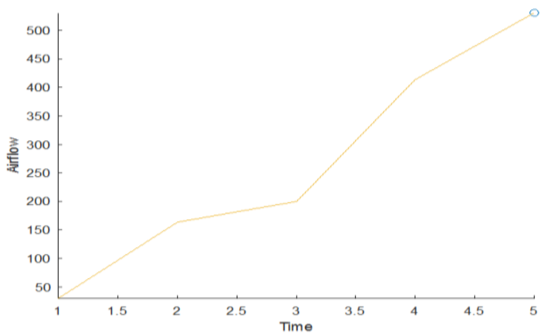

Figure 10. Airflow curve with time

The nasal airflow is monitored and the breathing airflow rate is recorded with respect to time as shown in Fig. 10. Similarly the measurement of patients temperature minute to minute needs to be observed and recorded as in Fig. 10 for necessary action.

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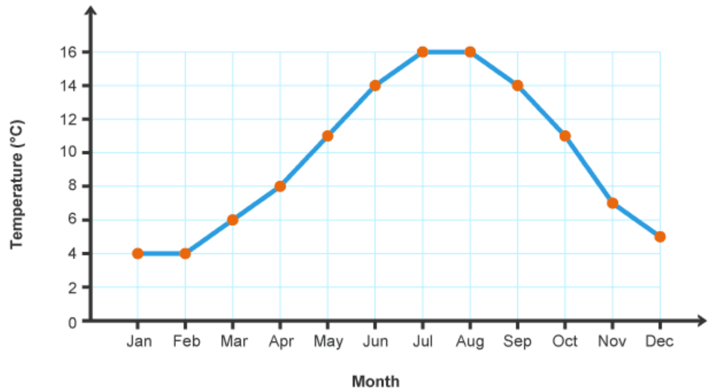

Figure 11. Generation of temperature sensor information

Blood flow is the blood volume that flows through any tissue in a determined period of time (typically represented as ml/min) in order to bring tissue oxygen and nutrients transported in blood. Blood flow is directly affected by the blood pressure as blood flows from the area with more pressure to the area with less pressure. Blood is pumped from the left ventricle of the heart out to the aorta where it reaches its higher pressure levels. Blood pressure falls as blood moves away from the left ventricle until it reaches 0 mm Hg, when it returns to the heart's right atrium. Figure 12 represents pressure changes.

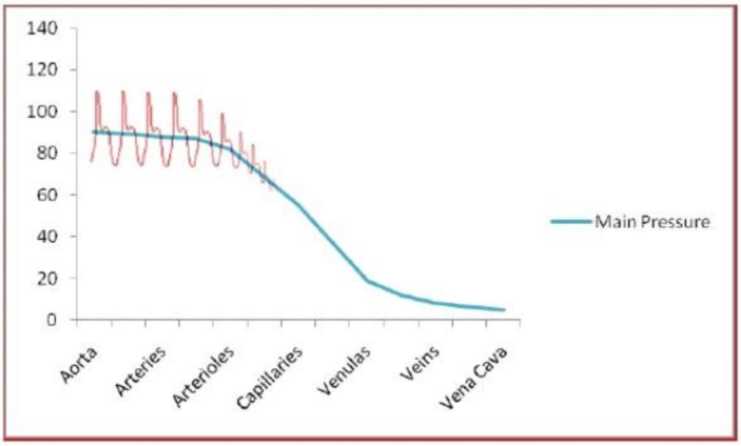

Fig 12. Pressure changes on blood vessels

In Fig 13 the P wave represents atrial depolarization and the QRS complex represents ventricular depolarization. The T wave represents ventricular repolarization. And the U wave represents papillary muscle repolarization.

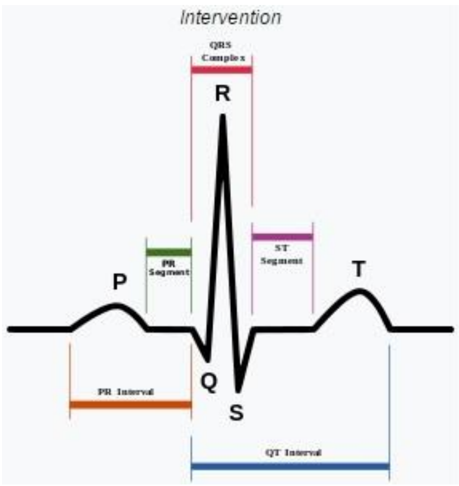

Fig 13. ECG Waves

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IX. CONCLUSION

This paper presents constructing an efficient hand gesture recognition system is an important aspect for easily interaction between human and machine and state-of-the-art in research and development of wearable sensor-based systems for health monitoring.
As it is shown by the current technology status, wearable health monitoring systems have the potential to revolutionize healthcare by providing low-cost solutions for ubiquitous, all-day, unobtrusive personal health monitoring and are expected to enable early detection and better treatment of various medical conditions as well as disease prevention and better understanding and self-management of chronic diseases.

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