FITNESS ANALYSIS KIT (FAK)

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ABSTRACT

Fitness Analysis Kit (FAK) is a portable kit, which helps to keep track of one's fitness. It is developed in such a manner so that it can be used to measure and analyze basic fitness parameters of human body like weight (W), height (H), body temperature (BT), blood pressure (BP), blood sugar level (BSL) and heart rate (HR).

In this paper fitness analysis has been discussed by using different kind of sensors. Objective to develop this kit is to integrate all physical parameters in one kit along with its implication on day to day activities of human life. The Paper is started with the formal explanation of FAK and then moved to some constructional details of the kit like specifications of various instruments, use of different sensors for measuring physical parameters and their analysis using Microcontroller unit along with required conditioning circuit.

***Keywords:* FAK, W, H, BT, BP, BSL, HR**

I. INTRODUCTION

Developmental stage of Fitness analysis kit is divided into two parts:

1. Sensor interfacing circuit
2. Signal conditioning unit

Sensor interfacing circuit is constructed using different type of sensors for measurement of physical parameters. Our developed kit is able to detect six basic parameters of human body. Theory of Analytical stage of all those parameters using sensors are described respectively.

1. **Weight**

For measuring weight we are using **strain gauge**. Strain gauges are sensors which are used in variety of physical measurements. They change resistance when they are stretched or compressed. Because of this property, strain gauges often are bonded to a solid surface and used for measuring acceleration, pressure, tension and force. We can use the measurement of tension to determine the weight applied to the load cell. Fundamentally, strain is a change in length per unit length.

If a strip of conductive metal is stretched, it will become skinnier and longer, which will result an increasing electrical resistance. On the contrary, if you compress the strain gauge, it will broaden and shorten, hence the electrical resistance will decrease. If these stretches don't exceed strain gauge's elasticity, the strip can be used for measuring weight.

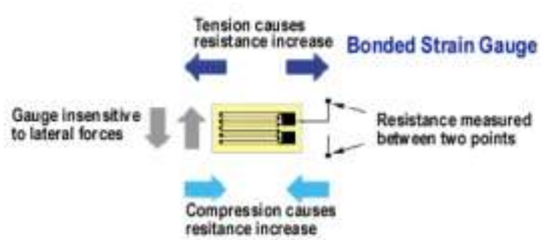

Figure 1. Strain Gauge

II. HEIGHT

The height of a person is measured by the visibility on a surveillance camera. The detailed description of the method is as follows-

First distance from the camera is determined. To do this we can use the view angle, under which the bottom of the object (the feet of the person) is visible, the altitude of the camera from the floor and the orientation of its optical axis. If we know the distance, the estimation of height can be done easily from the view angle of the object's top point.

The architecture of our framework is shown in the Figure below. Shapes are segmented from the frames using a continuously synthesized background. To get more accurate bottom and top points of the shape, we should accomplish shadow compensation. Upon having the shapes cleared, the next task is to compensate the effect of the geometrical distortion of the camera, and finally to estimate the height of the shape.

Figure 2. Measurement of Height

III. BODY TEMPERATURE

To measure the human body temperature we are using a non-contact method. Intensity of the invisible infrared light that naturally emanates from every surface in this Universe is measured. This light is proportional to the surface temperature, so by measuring its brightness a microprocessor can compute the temperature.

Figure 3. Infrared Thermometer

IV. BLOOD PRESSURE

For blood pressure measurement the pressure sensor is being used. It is a fully piezoresistive silicon pressure sensor for use in invasive blood pressure monitoring. The sensor is designed to be used with automated assembly equipment and can be dropped directly into a customer's disposable blood pressure housing. The sensor is designed to meet the requirements as described in the Association for the

Advancement of Medical Instrumentation (AAMI) specification for Blood Pressure Transducers. The pressure sensor consists of a pressure sensing element mounted on a ceramic substrate. Thick-film resistors on the ceramic substrate are laser-trimmed for compensation and calibration. A plastic cap is attached to the ceramic substrate to provide an easy method of attachment to the people assembly and protection for the sensing element. A dielectric gel is placed over the sensor to provide electrical and fluid isolation.

Figure 4. Pressure Sensor

V. BLOOD SUGAR LEVEL

The **Glucometer Sensor** is used for measuring sugar level in blood. Firstly, set up meter with calibration chip for particular lot of strips used. Insert Strip (Disposable Biosensor). This turns meter on and it performs internal tests and applies voltage to cell. Collect sample by touching drop of blood to strip opening Blood fills chamber by capillary action. Meter senses wetting (by drop in impedance), turns off cell, and starts the incubation time. The incubation time allows dissolution of chemicals, enzymatic reaction to occur and solution to become homogeneous. When incubation time is completed, potential is applied so that reacted mediator is converted back to original oxidation state. The current is monitored, compared to a calibration curve, and then concentration is reported.

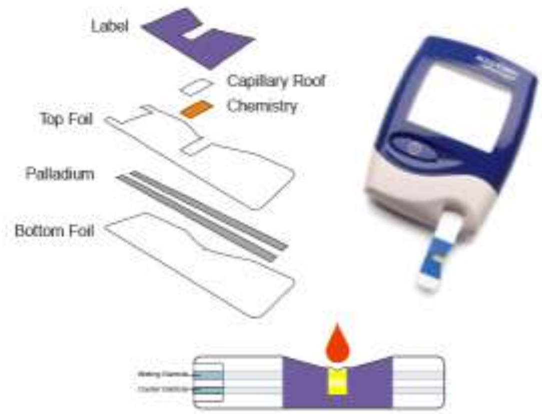

Figure 5. Glucometer

VI. HEART RATE

For monitoring heart rate a microcontroller based heart rate measurement system is used, that uses optical sensors to measure the alteration in blood volume at fingertip with each heartbeat. The sensor unit consists of an infrared light-emitting-diode (IR LED) and a photodiode, placed side by side as shown below. The IR diode transmits an infrared light into the fingertip (placed over the sensor unit), and the photodiode senses the portion of the light that is reflected back. The intensity of reflected light depends upon the blood volume inside the fingertip. So, each heart beat slightly alters the amount of reflected infrared light that can be detected by the photodiode. With a proper signal conditioning, this little change in the amplitude of the reflected light can be converted into a pulse. The pulses can be later counted by the microcontroller to determine the heart rate.

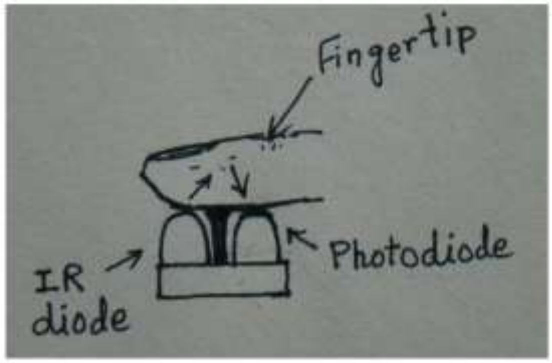

Figure 6. Fingertip Heart Rate Monitor

VII. SIGNAL CONDITIONING UNIT

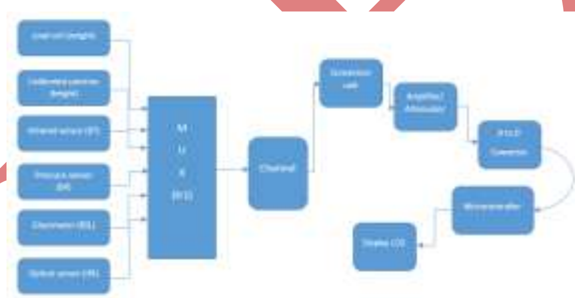

Figure 7. Block Diagram of Signal Conditioning

Sensors Unit

1. Load cell (Strain Gauge)

Strain gauges are sensors which are used in variety of physical measurements. They change resistance when they are or compressed. Because of this property, strain gauges often are bonded to a solid surface and used for measuring acceleration, pressure, tension and force. We can use the measurement of tension to determine the weight applied to the load cell. Fundamentally, strain is a change in length per unit length. For instance, if a 1 m long beam is stretched to 1.000002 m, the strain is 2 micro strains. One characteristic of strain gauges are gauge factor, and is defined as fractional change in resistance divided by the strain. For example, if we have strain gauge with gauge factor of 2, for the previous example the resistance change would be (2*2)*10^-6 =4*10^-6 => 4μΩ. Normally strain gauge resistance value are around 120 – 350 Ω, however there are some gauges with resistance as low as 30Ω or as high as 3kΩ.

2. Calibrated Cameras

To determine the height of an object visible on a surveillance camera, we should first determine its distance from the camera. To do this we can use the view angle, under which the bottom of the object (the feet of the person) is visible, the altitude of the camera from the floor and the orientation of its optical axis. If we know the distance, the estimation of height can be done easily from the view angle of the object's top point.

3. Infrared Sensor

It is a non-contact method by detecting intensity of the invisible infrared light that naturally emanates from every surface in this Universe. This light is proportional to the surface temperature, so by measuring its brightness a microprocessor can compute the temperature.

4. Pressure Sensor

It is a fully piezoresistive silicon pressure sensor for use in invasive blood pressure monitoring. The sensor is designed to be used with automated assembly equipment and can be dropped directly into a human disposable blood pressure housing. The sensor is designed to meet the requirements as described in the Association for the Advancement of Medical Instrumentation (AAMI) specification for Blood Pressure Transducers. The pressure sensor consists of a pressure sensing element mounted on a ceramic substrate. Thick-film resistors on the ceramic substrate are laser-trimmed for compensation and calibration. A plastic cap is attached to the ceramic substrate to provide an easy method of attachment to the customer's assembly and protection for the sensing element. A dielectric gel is placed over the sensor to provide electrical and fluid isolation.

5. Glucometer

The chemistry is relatively complex and the sample chamber contains many constituents (e.g., stabilizers, processing aids, etc.). However, for this discussion it will be treated more simply as an enzyme and mediator. An enzyme overcomes many of the problems associated with a variable biological sample matrix. Because glucose and enzymes do not readily exchange electrons directly with an electrode, an electrochemical measurement requires a mediator to facilitate (or mediate) the electron transfer. The chemistry is summarized as:

Glucose first reacts with the enzyme glucose dehydrogenase. Glucose is oxidized to gluconic acid and the enzyme is temporarily reduced by two electrons transferred from glucose to the enzyme. The reduced enzyme next reacts with the mediator (Mox), transferring a single electron to each of two mediator ions. The enzyme is returned to its original state, and the two Mox are reduced to Mred. At the electrode surface, Mred is oxidized back to Mox and the measured current is used to determine the concentration of glucose in the sample.

6. Optical Sensors

The sensor unit consists of an infrared light-emitting-diode (IR LED) and a photodiode, placed side by side as shown below. The IR diode transmits an infrared light into the fingertip (placed over the sensor unit), and the photodiode senses the portion of the light that is reflected back. The intensity of reflected light depends upon the blood volume inside the fingertip. So, each heart beat slightly alters the amount of reflected infrared light that can be detected by the photodiode. With a proper signal conditioning, this little change in the amplitude of the reflected light can be converted into a pulse. The pulses can be later counted by the microcontroller to determine the heart rate.

8:1 MUX

A **multiplexer** (or **mux**) is a device that selects one of several analog or digital input signals and forwards the selected input into a single line. A multiplexer of 2^n inputs has n select lines, which are used to select which input line to send to the output. Multiplexers are mainly used to increase the amount of data that can be sent over the network within a certain amount of time and bandwidth. A multiplexer is also called a **data selector**.

Channel

It is a physical transmission medium such as a wire, or to a logical connection over a multiplexed medium such as a radio channel. A Channel is used to convey an information signal, for example a digital bit stream, form one or several senders/transmitters to one or several receivers. A channel has a certain capacity for transmitting information, often measured by its bandwidth in Hz or its data rate in bits per second.

Conversion Unit

The function conversion unit is to convert any type of signal into electrical signal. Mainly it is a type of electrical transducer which is used to convert a signal in one type of energy to electrical form.

Amplifier/Attenuator

It is an electronic device that increases the power of a signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with a larger amplitude. This block also performs the function of attenuator, as the attenuator is an electronic device that reduces the power of a signal without appreciably distorting its waveform.

A to D Converter

This block has a Analog to Digital conversion (ADC) unit. It is a device that converts a continuous physical quantity to a digital number that represents the quantity's amplitude.

Microcontroller

A Microcontroller unit is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip as well as a typically small amount of RAM.

LCD Display

This is a flat panel display and abbreviated as Liquid Crystal Display (LCD). It uses the light modulating properties of liquid crystals. Liquid crystal do not emit light directly. These are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such a preset words, digits, and 7-segment displays as in a digital clock.

VIII. CONCLUSION

Fitness analysis kit is developed here within a small scale for regularly medical fitness checkup. Our day to day life is getting busy day by day. So, we don't enough time to visit a doctor for our health checkup. Sometimes in rural areas doctors are not available. So, several deaths occur due to lack of awareness. FAK is configured in a very simple way. So, that it can be easily used by common people. Keeping this thing in mind, we have chosen LCD display for direct indication of parameters. In this device we used all low cost sensors and signal conditioning unit. So, the total cost is affordable to common people and the size of the device is also compact. In future, this device can be modified by indicating the normal values of parameters with a comparison of the measured one. After then without intervention of any medical expert we will able to detect health risk issues. We also can improve it by interfacing several sensors unit for measurement of more physical parameters.

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