Augmented Vision-Enabled Digital Twin System for Real-Time ICU Patient Monitoring and Emergency Response

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Abstract:

This project introduces a real-time health monitoring system for ICU emergency patients, leveraging Digital Twin (DT) technology integrated with Augmented Vision (AV). The proposed system enables early screening and rapid identification of high-risk individuals using a unique DT-based AV code assigned to each patient. Upon hospital admission for critical conditions such as cardiac or pulmonary emergencies, patients receive wearable biomedical sensors and an AV code printout, which facilitates swift ICU admission. The sensor data is continuously uploaded to a centralized server via IoT. When urgent care is needed, medical personnel can scan a patient's DT AV code using a dedicated AV camera system. The DT Vision Software instantly retrieves the patient's real-time sensor data and displays it in a visual format. This includes color-coded imagery: green Digital Twin images for stable patients and red Medical Reality (MR) images for patients showing signs of severe lung conditions. This system allows healthcare providers to prioritize treatment effectively, potentially saving lives through faster and more informed decision-making.

INTRODUCTION

1.1 Introduction to VR health data visualization

HEART is the most important organ of the human body, pumping blood to tissues and organs throughout the body and maintaining normal metabolism. Heart disease can bring significant impacts on the safety of human life. According to the World Health Organization (WHO), about 17.5 million people die of heart disease each year, accounting for 30% of mortality. Therefore, monitoring heart health in one’s everyday life is of great importance to human beings.

A typical indicator used to evaluate heart health is heart rate variability (HRV), also known as heart rate volatility, which is simply a measure of the variation in time between each heartbeat. On the other hand, it also contains the implicit information on the regulation of cardiovascular system by neuro-humoral factors, and thus can be used to diagnose or prevent cardiovascular and other diseases.

Moreover, according to, measurements of HRV and the quantification of its spectral components are powerful predictors of cardiovascular morbidity and mortality. Therefore, it may help assess the return to work of patients with ischemic heart disease. Clinical analysis of HRV can reflect activity and balance of the cardiac autonomic nervous system (ANS) and related pathological states, etc. In general, low HRV is considered a sign of current or future health problems because it shows your body is less resilient and struggles to handle changing situations.

It is also more common in people who have higher resting heart rates. That is because when your heart is beating faster, there is less time between beats, reducing the opportunity for variability. This is often the case with conditions like diabetes, high blood pressure, heart arrhythmia, asthma, anxiety and depression. In other words, heart health monitoring can be achieved by monitoring HRV. Currently, there are two main categories of heart rate monitoring systems: 1) medical and 2) consumer heart rate monitors.

1.2 Virtual reality redefining health monitoring

Medical heart rate monitors used in hospitals are usually wired and use multiple sensors, such as commonly used electrocardiogram machines in hospitals. Meanwhile, portable medical devices also have been developed, which are called Holter monitors. On the other hand, consumer heart rate monitors are designed for everyday use and are wireless. Specifically, there are two types of consumer heart rate monitors: electrical-based and optical-based. The electrical monitors consist of two parts: 1) a monitor/transmitter worn on a chest strap and 2) a receiver. When a heartbeat is detected, a radio signal is transmitted, which is used by the receiver to display/determine the current heart rate. Instead, the optical-based heart monitoring system measure the heart rate by shining light from an LED light across the skin and evaluating how it scatters off blood vessels, such as the popular smart watches. However, all these existing methods either require professional guidance or additional equipment, which is inconvenient for daily heart rate monitoring and increases cost of devices.

In this context, we raise a question: can we monitor users' HRVs through some daily activities and without additional equipment and professional guidance? Recent studies have shown that both pupils and heartbeat are controlled by same nerves, i.e., sympathetic and parasympathetic nerves. Thus, changes in the pupil are correlated with variations in the heartbeat.

For example, when a person is frightened, the sympathetic nerve strengthens while the parasympathetic nerve weakens, resulting in a faster heartbeat and a smaller pupil diameter. Based on this principle, we explore the quantitative correlation between pupil size and HRV. In addition, with the development of modern technology, the smartphone ownership is growing, and the number of smartphones based on facial recognition unlocking is also increasing. According to, more than 800 million users around the world have smartphones with the function of face recognition and users unlock their phones 50 times on average per day.

Therefore, we consider using the front-facing camera of mobile phones to record the change of user's pupils while he/she unlocks the phone with facial recognition while obeying the privacy policy, so as to achieve HRV monitoring of the user. If it works, pupil-based mobile HRV monitoring can bring some unique advantages over existing methods.

1) Convenience: Monitoring HRV on mobile devices is much more portable than professional equipment and does not require special instruments or professional guidance.

2) Accuracy: HRV monitoring based on mobile device unlocking involves different time periods and different physiological and mental states of users, which provides more samples and thus guarantees the accuracy of HRV monitoring.

In our study, we first investigate the initial qualitative relationship between the heartbeat and the pupil size captured by the front camera of mobile phones. Based on this, we do a further job of infering HRV from pupillary response more comprehensively and accurately.

Achieving this goal entails several key technical challenges. First, the physiological process of pupillary response is intricate: it is possible to extract some features from this process, but it is difficult to identify features that are relevant to HRV. Moreover, having found the features of pupillary response, it is hard to correspond directly to HRV. Last but not least, in mobile scenarios, certain specific challenges are posed.

For example, changes in light intensity or shaking may have a serious impact on the recorded face images. Aiming to address these challenges, we hereby propose Pupil Heart as the first mobile HRV monitoring system exploiting pupillary response (i.e., change of pupil size in time domain). As shown in the figure, Pupil Heart exploits the heart eye relationship in the ANS to infer HRV from pupil size changes for heart health monitoring.

First, we conduct extensive studies to show the general relationship between HRV and pupil size for people in different states. This enables us to identify high-dimensional time-series features associated with HRV by using a 1-D convolutional neural network (1-D CNN). In addition, to handle the diversity of pupillary responses and HRVs in different situations, we employ a recurrent convolutional network [recurrent neural network (RNN)]-based approach to automatically train pupil-HRV model, correlating with users' pupillary responses.

We have prototyped Pupil Heart on mobile phones and conducted extensive experiments to evaluate its performance in predicting HRV. Experimental results show that Pupil Heart is able to accurately predict users' HRV with an average precision of 91.37%. In summary, our main contributions are summarized as follows.

1) We conduct an in-depth study of the relationship between HRV and pupil size in mobile scenarios. To the best of our knowledge, this is the first work to explore the quantitative relationship between people's pupillary response and HRV on mobile devices.

2) High-dimensional time-series features associated with user's HRV are identified by using a 1-D CNN to excavate the general physiological processes of pupillary responses.

3) We use RNN to train the high-dimensional time-series features extracted by 1-D CNN so as to model the relationship between pupil and HRV.

4) We validate the effectiveness of Pupil Heart through an extensive trial by recruiting a total of 60 volunteers.1 The results show that the accuracy of Pupil Heart achieves up to 91.37% on average.

1.3 The future unveiled

Today internet has become one among the vital components of our daily life. It is modified to methodologies how individuals live, work, play and learn. Internet serves as a tool for several purposes like education, finance, business, industries, recreation, social networking, shopping and etc. Future new mega trend of internet is IoT. Visualizing a world wherever several objects will sense, communicate and share data over a personal net protocol or public networks can be done through IoT. The interconnected objects collect the data at regular intervals, analysis and initiate needed action, providing associate intelligent networks for analysing, designing and decision making.

This is the world of Internet of Things. IoT is mostly thought about as connecting object to the internet and victimization that affiliates for management of these objects or remote watching. But definition of IoT is creating a brilliant invisible network which may be detected, controlled and programmed.

The products developed based on IoT include embedded technology that permits them to exchange information, with one another or the internet and it is assessed that 8-50 billion devices are connected by 2020. Since these devices come online, they provide better life style, create safer and more engaged communities and revolutionized healthcare. In low and middle economical gain countries, there is more and more growing range of individuals with persistent diseases because of totally different risk factors like nutrient imbalance and physical inactivity.

According to WHO report, 4.9million individuals die from carcinoma from the consumption of snuff, over weight a pair of 2.6million, 4.4million for increased cholesterol and 7.1million for high pressure. Chronic diseases are extremely variable in their symptom, evolution and treatment. Some, if not monitored and treated early, will end the patient's life. For several years the standard measure of glucose level, pressure level and heart beat were calculated in specialized health centres. Due to the technological development, there is a great variety of running sensors giving important signs such as blood pressure cuff, glucometer and pulse monitor together with electrocardiogram, which permits the patient to take their vital signs daily.

The readings taken daily are sent to doctors and enable them to suggest the medicine and physical exercise routine that enable them to improve the quality of life and overcome such disease. Internet of Things applied to the care and watching of patients is more and more common within the health sector, seeking to boost the standard of life of individuals. The Arduino is a programmable device that can sense and interact with its environment. The combination of Internet of Thing with Arduino is the new approach of introducing IoT in healthcare monitoring system of patient.

The entire concept of IoT stands on sensor, gateway and wireless network that modify user to communicate and access the information. IoT offer more guarantee within the health awareness. As a saying goes "Health is wealth" it's exponentially crucial to form utilization of innovation for better well-being. Arduino Uno collects the information from the sensor and transfers it to the IoT website. An embedded system is a computer system designed to do one or a few dedicated and/or specific functions often with real-time computing constraints.

It is embedded as part of a complete device often including hardware and mechanical parts. By contrast, a general-purpose computer, such as a personal computer (PC), is designed to be flexible and to meet a wide range of end-user needs. Embedded systems control many devices in common use today. Embedded systems contain processing cores that are typically either microcontrollers or digital signal processors (DSP).

The key characteristic, however, is being dedicated to handle a particular task. They may require very powerful processors and extensive communication, for example air traffic control systems may usefully be viewed as embedded, even though they involve main frame computers and dedicated regional and national networks between airports and radar sites (each radar probably includes one or more embedded systems of its own).

In general, "embedded system" is not a strictly definable term, as most systems have some element of extensibility or programmability. For example, hand held computers share some elements with embedded systems such as the operating systems and microprocessors that power them, but they allow different applications to be loaded and peripherals to be connected.

Moreover, even systems that do not expose programmability as a primary feature generally need to support software updates. On a continuum from "general purpose" to "embedded", large application systems will have subcomponents at most points even if the system as a whole is "designed to perform one or a few dedicated functions", and is thus appropriate to call "embedded".

1.4 EXISTING SYSTEM

The system used for health monitoring is the fixed monitoring system, which can be detected only when the patient is in hospital or in bed. Recently accessible systems are huge in size and available only in the hospitals in Intensive Care Unit. Nowadays, zig bee and blue tooth can be used to transmit the patient information to their loved ones or to their concerned doctors.

1. No database-based system available to compare or to analyse a person's history of tracking and biomedical data.
2. No updated technology for scanning like AR, VR and MR.
3. No image-based output in current method.

Drawbacks of the existing system

In existing system, patient needs to get hospitalized for regular monitoring of the patient. It is not possible once he/she is discharged from the hospital. This system cannot be used at home. The existing systems are measuring the health parameters of the patient and send it through zig bee, Bluetooth protocol etc., These are used for only short-range communication to transfer the data. Not all the time the doctor can fetch these details

1.5 PROPOSED SYSTEM

The Project proposes real-time health data monitoring with Digital Twin with Augmented Vision for the ICU emergency treatment patients, suggesting that this symptom could be used as screening tool to help identify people with potential high-risk cases who could be recommended to treat immediately.

For faster treatment in a hospital, it generates a scan able Augmented Vision (AV) code print. Also, the wearable bio-medical sensor data's also uploading to server system by IoT. By our proposed system, every patient is being addressed by their unique DT based AV code with them.

Whenever people are admitted with severe problems in hospitals such as heart pain, lung problem etc they will be provided with the AV code and wearable sensors and will be admitted in ICU. In among the many peoples in the treatment in the hospital, the senior as to inspect everyone for the treatment in emergency manner to treat him faster and save their life.

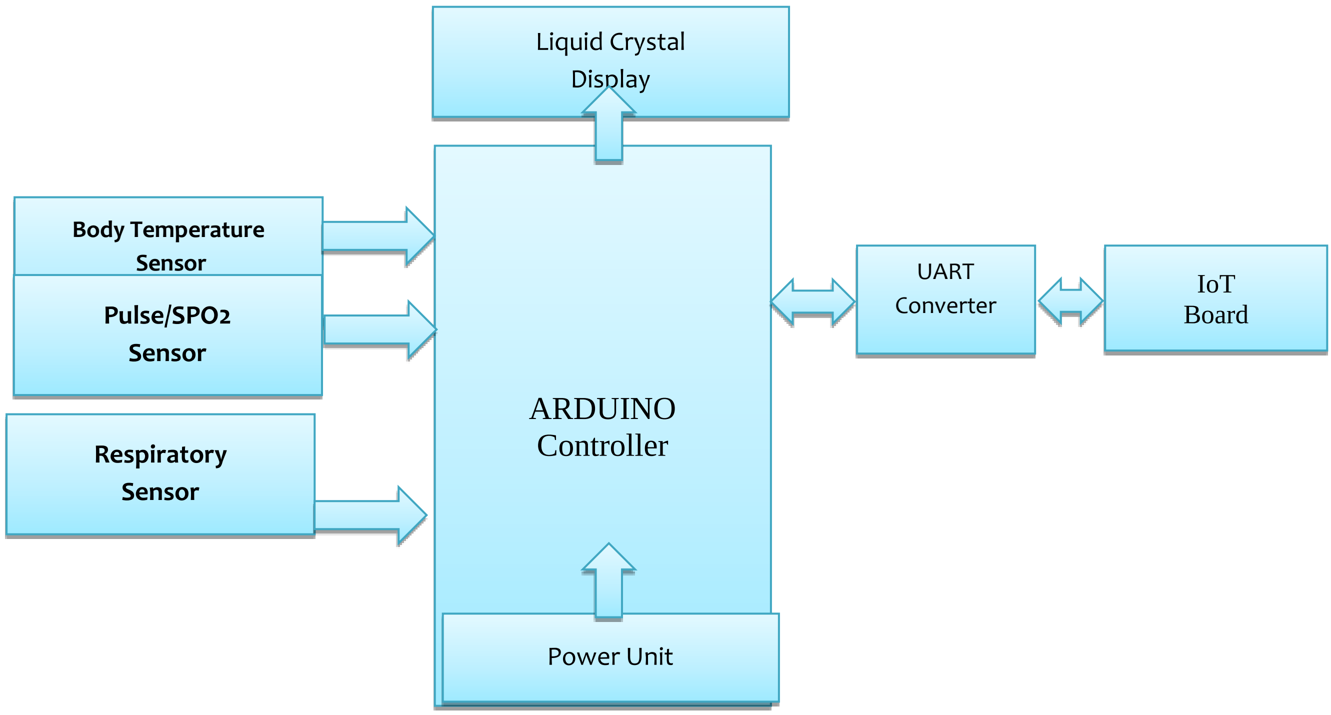
They have to show their own DT code to the DT vision camera cum scanner available, immediately the DT vision Software System fetch the respective persons biomedical senor values from the server also according to the current sensor values and database data's the DT vision Software System will show us the details in real-time images and for normal datasets i.e. green DT images for entry permitted persons and red MR images for the lung affected Persons with the data sets respectively .

ADVANTAGES

1. First time in Technology **DT Vision** system utilizes for the real-time update and track of people.

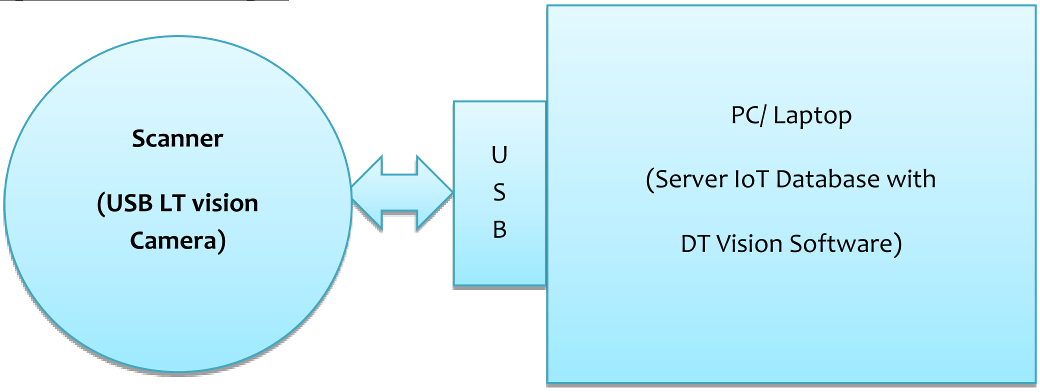
2. The Images based output and tracking with DT vision system

3.3 Block Diagram:



Scanning ans Server data base Monitoring Unit or Mobile app:

PC /laptop or Mobile with apk:



MATERIALS AND METHODOLOGY

2.1 MODULES

1. ARDUINO
2. BODY TEMPERATURE SENSOR
3. RESPIRATORY SENSOR
4. HEARTBEAT SENSOR
5. IOT –NODEMCU
6. LCD
7.POWER SUPPLY

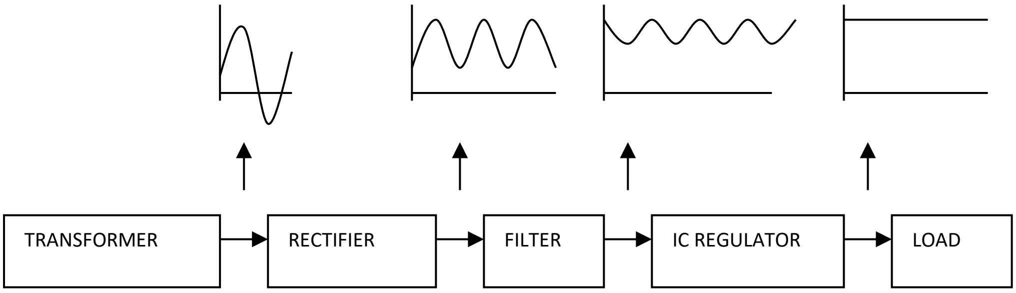
2.2 MODULE DESCRPTION

POWER SUPPLY

Block Diagram

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.



Working principle Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

Bridge rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. this path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 v0lts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.

IC voltage regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

- For ICs, microcontroller, LCD --------- 5 volts
- For alarm circuit, op-amp, relay circuits ---------- 12 volts

ARDUINO

Arduino interface boards provide the engineers, artists, designers, hobbyists and anyone who tinker with technology with a low-cost,easy-to-use technology to create their creative ,interactive objects, useful projects etc., A whole new breed of projects can now be built that can be controlled from a computer.

WHAT IS ARDUINO?

Arduino is a open source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. It's an open-source physical computing platform based on a microcontroller board, and a development environment for writing software for the board.

In simple words, Arduino is a small microcontroller board with a USB plug to connect to your computer and a number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors, laser diodes, loudspeakers, microphones, etc. They can either be powered through the USB connection from the computer or from a 9V battery. They can be controlled from the computer or programmed by the computer and then disconnected and allowed to work independently.

Anyone can buy this device through online auction site or search engine. Since the Arduino is an open-source hardware designs and create their own clones of the Arduino and sell them, so the market for the boards is competitive. An official Arduino costs about $30, a clone often less than $20.

The name "Arduino" is reserved by the original makers. However, clone Arduino designs often have the letters "duino" on the end of their name, for example, Freeduino or DFRduino. The software for programming your Arduino is easy to use and also freely available for Windows, Mac, and LINUX computers at no cost.

Microcontroller

Microcontroller can be described as a computer embedded on a rather small circuit board. To describe the function of a microcontroller more precisely, it is a single chip that can perform various calculations and tasks, and send/receive signals from other devices via the available pins. Precisely what tasks and communication with the world it does, is what is governed by what instructions we give to the Microcontroller. It is this job of telling the chip what to do, is what we refer to as programming on it.

However, the uC by itself, cannot accomplish much; it needs several external inputs: power, for one; a steady clock signal, for another. Also, the job of programming it has to be accomplished by an external circuit. So typically, a uC is used along with a circuit which provides these things to it; this combination is called a microcontroller board. The Arduino Uno that you have received, is one such microcontroller board. The actual microcontroller at its heart is the chip called **Atmega328**. The advantages that Arduino offers over other microcontroller boards are largely in terms of reliability of the circuit hardware as well as the ease of programming and using it.

Open-source hardware

Open-source hardware shares much of the principles and approach of free and open-source software. The founders of Arduino wanted people to study their hardware, to understand how it works, make changes to it, and share those changes with the world. To facilitate this, they release all of the original design files (Eagle CAD) for the Arduino hardware. These files are licensed under a Creative Common Attribution Share-Alike license, which allows for both personal and commercial derivative works, as long as they(people) credit Arduino and release their designs under the same license.

The Arduino software is also open-source. The source code for the Java environment is released under the GPL and the C/C++ microcontroller libraries are under the LGPL

HISTORY OF ARDUINO

While teaching a physical computing class at the Interaction Design Institute Ivrea in 2005, Massimo Banzi's students were unwilling to spend the 76 euros for the BASIC Stamp microcontrollers commonly used in such applications. Banzi and his collegues looked for alternatives, finally settling on the *wiring* platform developed by one of Banzi's students. In his own words:

"…we started to figure out how could we make the whole platform even simpler, even cheaper, even easier to use. And then we started to essentially reimplement the whole thing as an open source project."

Once they had a prototype, a student wrote the software that would allow *wiring* programs to run on the new platform. Upon seeing the project, visiting professor Casey Reas suggested that there might be wider applications than just design schools for the new product. The prototype was redesigned for mass production and a test run of 200 boards was made. Orders began coming in from other design schools and the students looking for Arduinos, and the Arduino project was born and **Massimo Banzi** and **David Cuartielles** became its founders. "ARDUINO" is an Italian word, meaning "STRONG FRIEND". The English version of the name is "Hardwin". As of May 2011, more than 300,000 Arduino units are "in the wild".

Design Goals

- Work with a Mac (as most design students use one)
- USB connectivity (Mac Books don't have serial ports
- Look nice
- Cheap (about 20 euros, the cost of going out for pizza in Europe)
- More powerful than a BASIC stamp
- Something you could build/fix yourself

Simple and easy to use by someone without formal electronics training

Business Models

Since the entire project is open source, anyone can build and sell Arduino-compatible devices. So in this sense, the Arduino project relies heavily on its branding for it's financial success. Other projects manufacture compatible and cheaper boards, however people are loyal to the Arduino branded boards because they associate quality and a certain image to the final product.

By the Numbers

International Journal of Scientific Research in Engineering and Management (IJSREM)
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Year	Units Sold
2005	200
2006	10 000
2010	120 000
2011	300 000

Competitors

Before Arduino, the largest players in the design/hobbyist market segment were the PIC microcontroller family (made by Microchip) and the BASIC Stamp (made by Parallax). Since the introduction of the Arduino, other large companies have tried to enter the hobbyist market, including Texas Instruments, and even Microsoft. However, the open-sourced tools of the Arduino and the size of its community are large barriers for new platforms to overcome.

PHYSICAL COMPUTING

Physical Computing is an approach to learn how humans communicate through computers that starts by considering how humans express themselves physically.

ARDUINO Board Layout

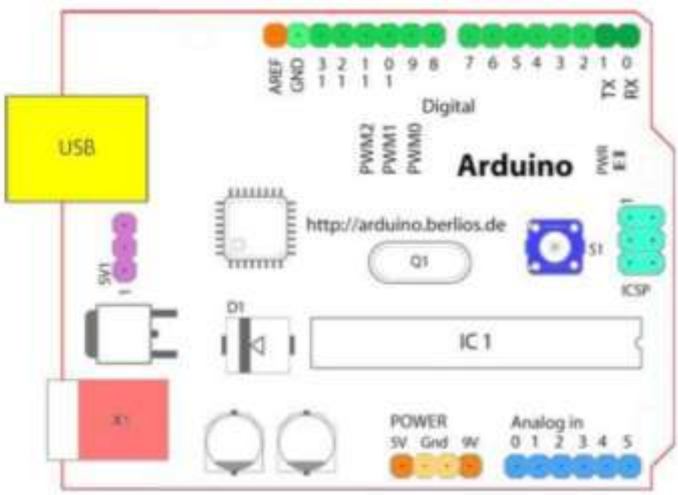


Figure 4.3 ARDUINO board layout

ATmega8(Microcontroller)

- 16 MHz
- 8 Kbyte Flash RAM (1K taken by the boot loader)
- 1 Kbyte RAM (Example: for auto/local variables and stack)
- 14 digital Input/ Output **Ports**

Single chip USB to async. Serial data transfer interface

- USB 2.0 compatible
- Transmit and receive LED drive signals
- 256 Byte receive,128 Byte transmit buffer
- Data transfer rate from 300bits/sec to 2 Mb/sec

Fig 4.4 Android Software Architecture

The OFF-the shelf adapter

- must be a DC adapter (i.e. it has to put out DC, not AC)
- should be between 9V and 12V DC

- must be rated for a minimum of 250mA current output, although you will likely want something more like 500mA or 1A output, as it gives you the current necessary to power a servo or twenty LEDs if you want to.
- must have a 2.1mm power plug on the Arduino end, and
- the plug must be "centre positive", that is, the middle pin of the plug has to be the + connection.

Current rating: Since you'll probably be connecting other things to the Arduino (LEDs, LCDs, servos) you should get an adapter that can supply at least 500mA, or even 1000 mA (1amphere). That way you can be sure you have enough juice to make each component of the circuit function reliably.

The Arduino's on-board regulator can actually handle up to 20V or more, so you can actually use an adapter that puts out 20V DC.

The reasons you don't want to do that are twofold: you'll lose most of that voltage in heat, which is terribly inefficient. Secondly, the nice 9V pin on the Arduino board will actually be putting out 20V or so, which could lead to potential disaster when you connect something expensive to what you thought was the 9V pin. Our advice is to stick with the 9V or 12V DC adapter.

ARDUINO flavors!!

There have been many revisions of the USB Arduino. some of them are

1. Arduino UNO:

This is the latest revision of the basic Arduino USB board. It connects to the computer with a standard USB cable and contains everything else you need to program and use the board. It can be extended with a variety of shields: custom daughter-boards with specific features. It is similar to the Duemilanove, but has a different USB-to-serial chip the ATMega8U2, and newly designed labeling to make inputs and outputs easier to identify.

1.Arduino Mega 2560:

A larger, more powerful Arduino board. Has extra digital pins, PWM pins, analog inputs, serial ports, etc. The version of the Mega released with the Uno, this version features the Atmega2560, which has twice the memory, and uses the ATMega 8U2 for USB-to-serial communication.

2. Arduino Duemilanove:

The Duemilanove automatically selects the appropriate power supply (USB or external power), eliminating the need for the power selection jumper found on previous boards. It also adds an easiest to cut trace for disabling the auto-reset, along with a solder jumper for re-enabling it.

Note: around March 1st, 2009, the Duemilanove started to ship with the ATmega328p instead of theATmega168.

3. Arduino Fio:

An Arduino intended for use as a wireless node. Has a header for an *XBee* radio, a connector for a *LiPo* battery, and a battery charging circuit.

4. LilyPad Arduino:

A stripped-down, circular Arduino board designed for stitching into clothing and other fabric/flexible applications. Needs an additional adapter to communicate with a computer

5. Arduino Diecimila:

The main change in the Arduino Diecimila is that it can be reset from the computer, without the need to physically press the reset button on the board. The Diecimila uses a low dropout voltage regulator which lowers the board's power consumption when powered by an external supply (AC/DC adapter or battery). A resettable polyfuse protects your computer's USB ports from shorts and surges.

It also provides pin headers for the reset line and for 3.3V. There is a built-in LED on pin 13. Some blue Diecimila boards say "Prototype - Limited Edition" but are in fact fully-tested production boards (the actual prototypes are red).

6. Lilypad Arduino 03

This revision has a 6-pin programming header that's compatible with FTDI USB cables and the Sparkfun FTDI Basic Breakout. It adds support for automatic reset, allowing sketches to be uploaded without pressing the reset button on the board. The header is surface mounted, meaning that the board has no pokey bits sticking out the back.

7. Arduino NG Rev.C

Revision C of the Arduino NG does not have a built-in LED on pin 13 - instead you'll see two small unused solder pads near the labels "GND" and "13". There is, however, about 1000 ohms of resistance on pin 13, so you can connect an LED without external resistor.

8. Arduino Extreme

The Arduino Extreme uses many more surface mount components than previous USB Arduino boards and comes with female pin headers. It also has RX and TX LEDs that indicate when data is being sent to or from the board.

9. Arduino Mini 04

On this version of the Arduino Mini, two of the pins changed. The third pin became reset (instead of ground) and fourth pin became ground (instead of being unconnected). These boards are labelled "Mini 04".

Still there are Arduino Serial, Arduino Serial v2.0, Arduino Nano 3.0, Arduino Nano 2.x, Severino(S3V3), Arduino Stamp 02, Mini USB adapter 03, Mini USB Adapter, Arduino Bluetooth.

Temperature sensor:

Temperature sensors are vital to a variety of everyday products. For example, household ovens, refrigerators, and thermostats all rely on temperature maintenance and control in order to function properly. Temperature control also has applications in chemical engineering. Examples of this include maintaining the temperature of a chemical reactor at the ideal set-point, monitoring the temperature of a possible runaway reaction to ensure the safety of employees, and maintaining the temperature of streams released to the environment to minimize harmful environmental impact.

While temperature is generally sensed by humans as “hot”, “neutral”, or “cold”, chemical engineering requires precise, quantitative measurements of temperature in order to accurately control a process. This is achieved through the use of temperature sensors, and temperature regulators which process the signals they receive from sensors.

From a thermodynamics perspective, temperature changes as a function of the average energy of molecular movement. As heat is added to a system, molecular motion increases and the system experiences an increase in temperature. It is difficult, however, to directly measure the energy of molecular movement, so temperature sensors are generally designed to measure a property which changes in response to temperature. The devices are then calibrated to traditional temperature scales using a standard (i.e. the boiling point of water at known pressure). The following sections discuss the various types of sensors and regulators.

Temperature Sensors

Temperature sensors are devices used to measure the temperature of a medium. There are 2 kinds on temperature sensors: 1) contact sensors and 2) noncontact sensors. However, the 3 main types are thermometers, resistance temperature detectors, and thermocouples. All three of these sensors measure a physical property (i.e. volume of a liquid, current through a wire), which changes as a function of temperature. In addition to the 3 main types of temperature sensors, there are numerous other temperature sensors available for use.

4.3.1 Contact Sensors

Contact temperature sensors measure the temperature of the object to which the sensor is in contact by assuming or knowing that the two (sensor and the object) are in thermal equilibrium, in other words, there is no heat flow between them.

Examples (further description of each example provide below)

- Thermocouples
- Resistance Temperature Detectors (RTDs)
- Full System Thermometers
- Bimetallic Thermometers

Noncontact Sensors

Most commercial and scientific noncontact temperature sensors measure the thermal radiant power of the Infrared or Optical radiation received from a known or calculated area on its surface or volume within it.

An example of noncontact temperature sensors is a pyrometer, which is described into further detail at the bottom of this section.

Thermometers

Thermometers are the most common temperature sensors encountered in simple, everyday measurements of temperature. Two examples of thermometers are the Filled System and Bimetal thermometers.

Filled System Thermometer

The familiar liquid thermometer consists of a liquid enclosed in a tube. The volume of the fluid changes as a function of temperature. Increased molecular movement with increasing temperature causes the fluid to expand and move along calibrated markings on the side of the tube. The fluid should have a relatively large thermal expansion coefficient so that small changes in temperature will result in detectable changes in volume. A common tube material is glass and a common fluid is alcohol. Mercury used to be a more common fluid until its toxicity was realized. Although the filled-system thermometer is the simplest and cheapest way to measure temperature, its accuracy is limited by the calibration marks along the tube length. Because filled system thermometers are read visually and don't produce electrical signals, it is difficult to implement them in process controls that rely heavily on electrical and computerized control.

Bimetal Thermometer

In the bimetal thermometer, two metals (commonly steel and copper) with different thermal expansion coefficients are fixed to one another with rivets or by welding. As the temperature of the strip increases, the metal with the higher thermal expansion coefficients expands to a greater degree, causing stress in the materials and a deflection in the strip. The amount of this deflection is a function of temperature. The temperature ranges for which these thermometers can be used is limited by the range over which the metals have significantly different thermal expansion coefficients. Bimetallic strips are often wound into coils and placed in thermostats. The moving end of the strip is an electrical contact, which transmits the temperature thermostat.

Resistance Temperature Detectors

A second commonly used temperature sensor is the resistance temperature detector (RTD, also known as resistance thermometer). Unlike filled system thermometers, the RTD provides an electrical means of temperature measurement, thus making it more convenient for use with a computerized system. An RTD utilizes the relationship between electrical resistance and temperature, which may either be linear or nonlinear. RTDs are traditionally used for their high accuracy and precision. However, at high temperatures (above 700°C) they become very inaccurate due to degradation of the outer sheath, which contains the thermometer. Therefore, RTD usage is preferred at lower temperature ranges, where they are the most accurate.

There are two main types of RTDs, the traditional RTD and the thermistor. Traditional RTDs use metallic sensing elements that result in a linear relationship between temperature and resistance. As the temperature of the metal increases, increased random molecular movement impedes the flow of electrons. The increased resistance is measured as a reduced current through the metal for a fixed voltage applied. The thermistor uses a semiconductor sensor, which gives a power function relationship between temperature and resistance.

RTD Structure

Temperature sensors are vital to a variety of everyday products. For example, household ovens, refrigerators, and thermostats all rely on temperature maintenance and control in order to function properly. Temperature control also has applications in chemical engineering. Examples of this include maintaining the temperature of a chemical reactor at the ideal set-point, monitoring the temperature of a possible runaway reaction to ensure the safety of employees, and maintaining the temperature of streams released to the environment to minimize harmful environmental impact.

While temperature is generally sensed by humans as “hot”, “neutral”, or “cold”, chemical engineering requires precise, quantitative measurements of temperature in order to accurately control a process. This is achieved through the use of temperature sensors, and temperature regulators which process the signals they receive from sensors.

From a thermodynamics perspective, temperature changes as a function of the average energy of molecular movement. As heat is added to a system, molecular motion increases and the system experiences an increase in temperature. It is difficult, however, to directly measure the energy of molecular movement, so temperature sensors are generally designed to measure a property which changes in response to temperature. The devices are then calibrated to traditional temperature scales using a standard (i.e. the boiling point of water at known pressure). The following sections discuss the various types of sensors and regulators.

HEART BEAT SENSOR:

Features:
1.Heat beat indication by LED
2.Instant output digital signal for directly connecting to microcontroller
3. Compact Size
4.Working Voltage +5V DC

Applications
1.Digital Heart Rate monitor.
2.Patient Monitoring System.
3.Bio-Feedback control of robotics and applications.

Heart beat sensor is designed to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

Specification:

Parameter Value

1.Operating Voltage +5V DC regulated.
2.Operating Current 100 mA.
3.Output Data Level 5V TTL level.
4.Heart Beat detection Indicated by LED and Output High Pulse.
5.Light source 660nm Super Red LED.

Pin Details:

Board has 3-pin connector for using the sensor. Details are marked on PCB as above.

Pin Name Details:

1 +5V Power supply Positive input.
2 OUT Active High output.
3 GND Power supply Ground.

Using the Sensor:

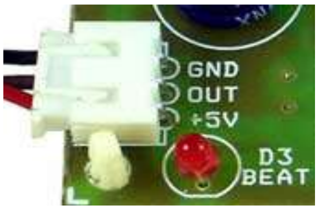
· Connect regulated DC power supply of 5 Volts. Black wire is Ground, Next middle wire is Brown which is output and Red wire is positive supply. These wires are also marked on PCB.

· To test sensor, you only need power the sensor by connect two wires +5V and GND. You can leave the output wire as it is. When Beat LED is off the output is at 0V.

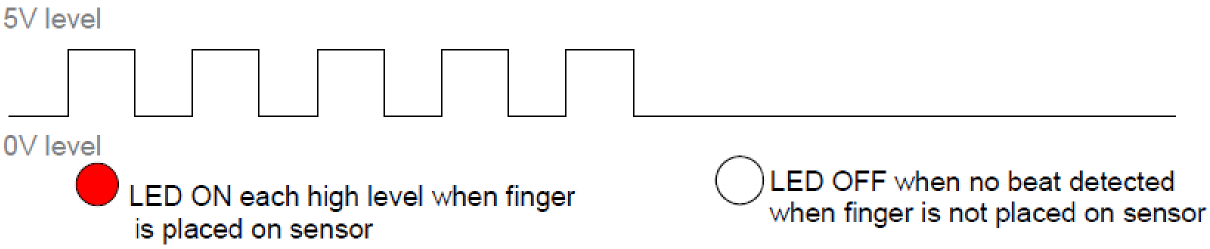
· Put finger on the marked position, and you can view the beat LED blinking on each heart beat.

· The output is active high for each beat and can be given directly to microcontroller for interfacing applications.

Heart beat output signal:



1.5V level
2.0V level
3.LED ON

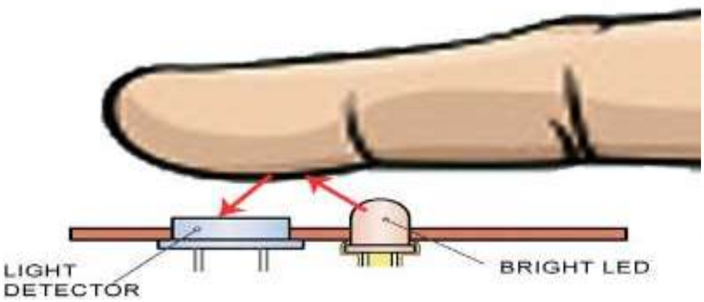


Working:

The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified and triggered through an amplifier which outputs +5V logic level signal. The output signal is also indicated by a LED which blinks on each heart beat.

SENSOR PRINCIPLE:

The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified and triggered through an amplifier which outputs +5V logic level signal. The output signal is also indicated by a LED which blinks on each heart beat.

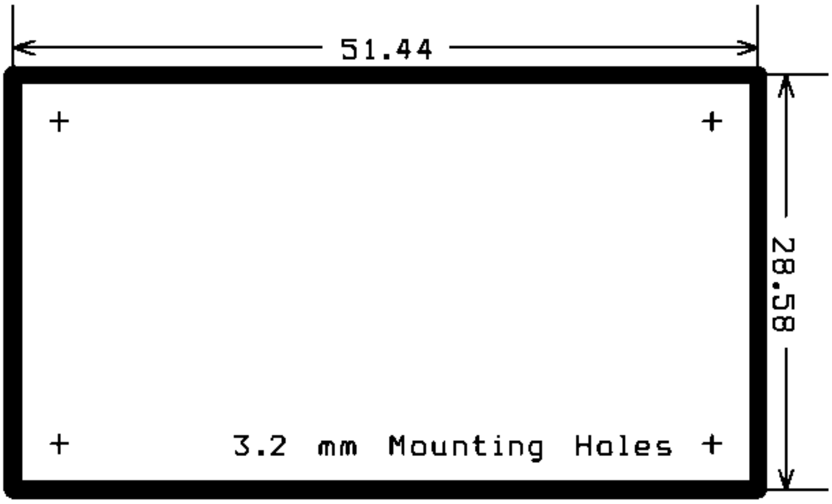


SIGNAL VIEW:

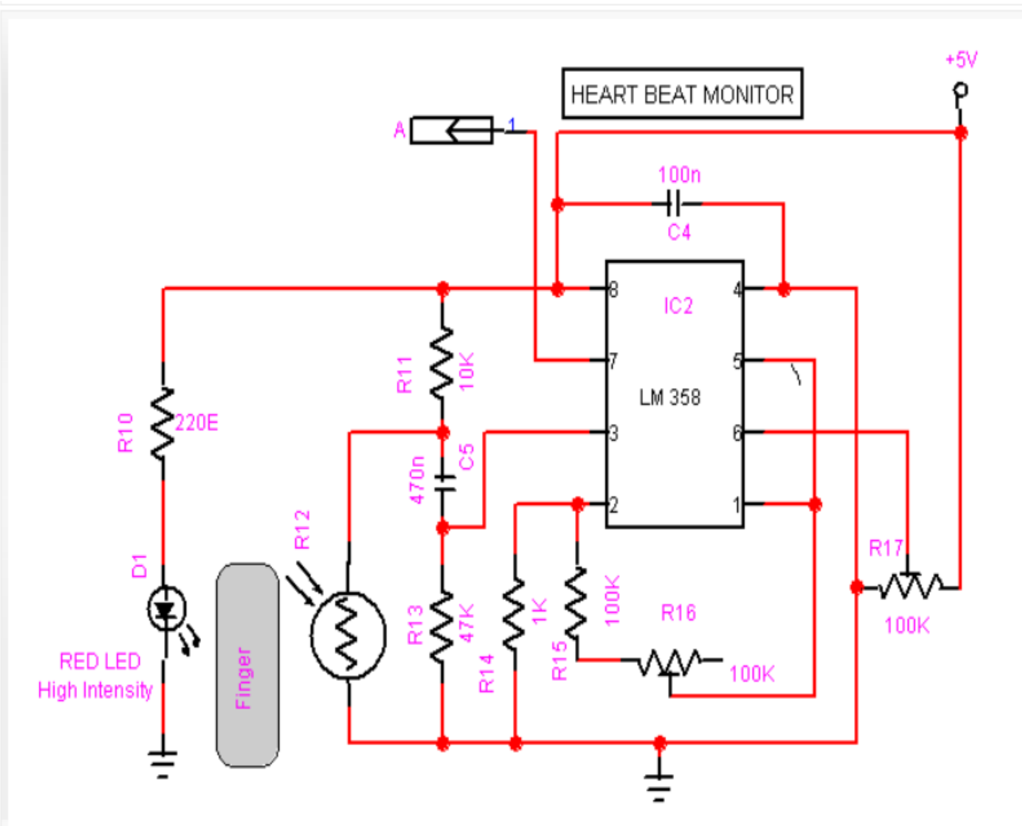
Below figure shows signal of heart beat and sensor signal output graph. actual heart beat received by detector (Yellow) and the trigger point of sensor (Red)after which the sensor outputs digital signal (Blue) at 5V level.

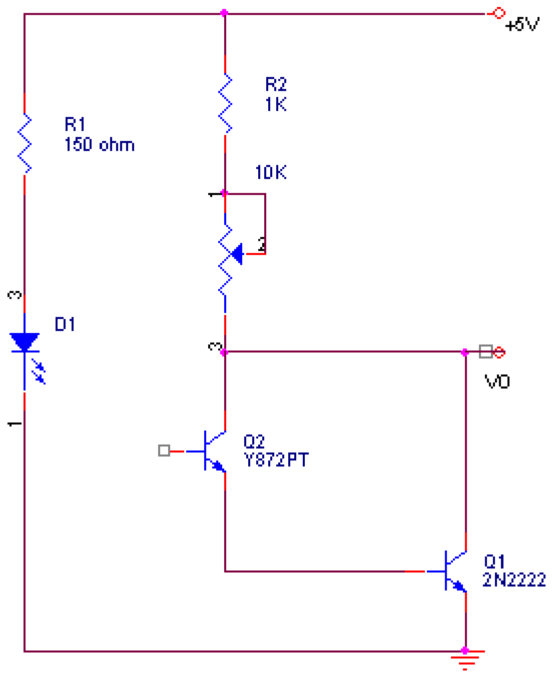
Below figure shows target pulse rates for people aged between 20 and 70. The target range is the pulse rate needed in order to provide suitable exercise for the heart. For a 25-year old, this range is about 140-170 beats per minute while for a 60-year old it is typically between 115 and 140 beats per minute.

Board Dimensions (mm):



4.6 CIRCUIT DIAGRAM:





Heart beat is sensed by using a high intensity type LED and LDR. The finger is placed between the LED and LDR. As Sensor a photo diode or a photo transistor can be used.

The skin may be illuminated with visible (red) using transmitted or reflected light for detection. The very small changes in reflectivity or in transmittance caused by the varying blood content of human tissue are almost invisible. Various noise sources may produce disturbance signals with amplitudes equal or even higher than the amplitude of the pulse signal. Valid pulse measurement therefore requires extensive preprocessing of the raw signal.

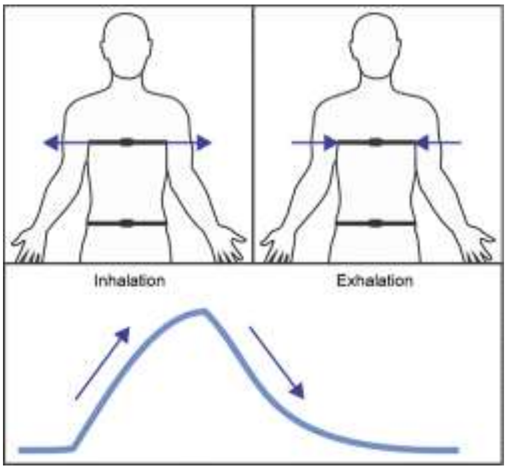
The new signal processing approach presented here combines analog and digital signal processing in a way that both parts can be kept simple but in combination are very effective in suppressing disturbance signals. The setup described here uses a red LED for transmitted light illumination and a LDR as detector. With only slight changes in the preamplifier circuit the same hardware and software could be used with other illumination and detection concepts. The detectors photo current (AC Part) is converted to voltage and amplified by an operational amplifier (LM358).

Output is given to another non-inverting input of the same LM358; here the second amplification is done. The value is preset in the inverting input, the amplified value is compared with preset value if any abnormal condition occurs it will generate an interrupt to the controller

RESPIRATORY SENSOR

The respiration sensor is a sensitive girth sensor worn using an easy fitting high durability woven elastic band fixed with a length adjustable webbing belt. It detects chest or abdominal expansion/contraction and outputs the respiration waveform.

Operating Principle:



A stretch sensitive device is strapped to the torso to measure the relative amount of expansion that occurs during respiration (breathing). As breathing in takes place the rib cage expands which stretches the device. When exhaling, the stretch relaxes and the sensor returns to its neutral position. The resulting waveform is displayed on the screen.

To monitor thoracic respiration (chest breathing), the strap is positioned to the upper aspect of the trunk. Position it on the lower aspect of the trunk to measure diaphragmatic respiration (stomach breathing).

NODE MCU

Wi-Fi chips are a quite lesser in cost than compared to other contemporary chips which has in built MCU and TCP/IP layer. This is cheap cost, lesser power consumption than other controllers and reliable performance. Several automation systems in Electrical & medical make use of Node MCU Wi-fi Chips.

The proposed Surveillance and control system in this paper is divided into two categories, premise & one directional Though both the categories have same purpose but differ in the system design. One directional focus mainly on long distance control like traffic signals which works on LoRa through its Master Controller (Raspberry Pi). This pi has several input/output pins which are connected to devices. Further pi is connected to Cloud server to process the data and send information to end user in mobile or web application.

On premise uses Node MCU module to communicate to Master controller over the HTTP protocol through internet to detect the faulty devices in the system Fig-1: Node MCU Module the Node MCU as shown in Fig.1 has assimilated TCP/IP protocol that can give any microcontroller entrance to the Wi-Fi network that supports 2.4 GHz Wi-Fi (802.11 Wi-Fi standards).

Node MCU is capable of either connecting to an existing wireless connection or hosting an application over http protocol. Each Node MCU module comes preprogrammed with an AT command set firmware which means one can simply link this up to your device and get about like Wi-Fi shield.

ESP8266 Node MCU

Description

Node MCU is an open-source firmware and development kit that helps you to prototype or build IoT products. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The firmware uses the Lua scripting language. It is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266.

CU Definition

MCU stands for Micro Controller Unit - which really means it is a computer on a single chip. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. They are used to automate automobile engine control, implantable medical devices, remote controls, office machines, appliances, power tools, toys etc.

Lua Flash Store (LFS)

In September 2018 support for a Lua Flash Store (LFS) was introduced. LFS allows Lua code and its associated constant data to be executed directly out of flash-memory; just as the firmware itself is executed. This now enables Node MCU developers to create Lua applications with up to 256Kb Lua code and read-only constants executing out of flash. All of the RAM is available for read-write data!

Releases

This project uses two main branches, `release` and `dev`. `dev` is actively worked on and it's also where PRs should be created against. `release` thus can be considered "stable" even though there are no automated regression tests. The goal is to merge back to `release` roughly every 2 months. Depending on the current "heat" (issues, PRs) we accept changes to `dev` for 5-6 weeks and then hold back for 2-3 weeks before the next snap is completed.

A new tag is created every time `dev` is merged back to `release` branch. They are listed in the releases section on GitHub. Tag names follow the `<SDK-version>-release_yyyymmdd` pattern.

Up-To-Date Documentation

At the moment the only up-to-date documentation maintained by the current NodeMCU team is in English. It is part of the source code repository (`/docs` subfolder) and kept in sync with the code.

Next

WiFi (ESP8266WiFi library)

ESP8266WiFi library has been developed basing on ESP8266 SDK, using naming convention and overall functionality philosophy of the Arduino WiFi Shield library. Over time the wealth Wi-Fi features ported from ESP8266 SDK to this library outgrew the APIs of WiFi Shield library and it became apparent that we need to provide separate documentation on what is new and extra.

ESP8266WiFi library documentation

Ticker

Library for calling functions repeatedly with a certain period. Three examples included.

It is currently not recommended to do blocking IO operations (network, serial, file) from Ticker callback functions. Instead, set a flag inside the ticker callback and check for that flag inside the loop function.

Here is library to simplificate `Ticker` usage and avoid WDT reset: TickerScheduler

EEPROM

This is a bit different from standard EEPROM class. You need to call `EEPROM.begin(size)` before you start reading or writing, size being the number of bytes you want to use. Size can be anywhere between 4 and 4096 bytes.

`EEPROM.write` does not write to flash immediately, instead you must call `EEPROM.commit()` whenever you wish to save changes to flash. `EEPROM.end()` will also commit, and will release the RAM copy of EEPROM contents.

EEPROM library uses one sector of flash located just after the embedded filesystem.

Three examples included.

Note that the sector needs to be re-flashed every time the changed EEPROM data needs to be saved, thus will wear out the flash memory very quickly even if small amounts of data are written. Consider using one of the EEPROM libraries mentioned down below.

I2C (Wire library)

Wire library currently supports master mode up to approximately 450KHz. Before using I2C, pins for SDA and SCL need to be set by calling `Wire.begin(int sda, int scl)`, i.e. `Wire.begin(0, 2)` on ESP-01, else they default to pins 4(SDA) and 5(SCL).

SPI

SPI library supports the entire Arduino SPI API including transactions, including setting phase (CPHA). Setting the Clock polarity (CPOL) is not supported, yet (SPI_MODE2 and SPI_MODE3 not working).

CD: Liquid Crystal Display (LCD) consists of rod-shaped tiny molecules sandwiched between a flat piece of glass and an opaque substrate. These rod-shaped molecules in between the plates align into two different physical positions based on the electric charge applied to them. When electric charge is applied they align to block the light entering through them, where as when no-charge is applied they become transparent.Light passing through makes the desired images appear. This is the basic concept behind LCD displays. LCDs are most commonly used because of their advantages over other display technologies. They are thin and flat and consume very small amount of power compared to LED displays and cathode ray tubes (CRTs). LCD Technologies and types: Some of the LCD technologies are,Blue Mode STN - This is the basic LCD, which needs lot of improvement on contrast ratio and viewing angle.FSTN (Film STN) - Comes with an additional linearization film to offer better contrast. CSTN (colour STN) - Layers of color filters are added to create up to 65,000 colors. DSTN (Double STN) - Improves contrast and eliminates any other colors appearing on the screen.

Types based on displayed data:

1. Segment LCD: Displays numbers, letters and fixed symbols and were used in old style industrial panel display and such standard where we need to display fixed number of characters.

2. Graphical LCD: Instead of segments it has pixels in rows and columns. By energizing set of pixels any character can be displayed.

3. Color LCD displays: Are of type passive matrix and Thin film transistor/ active matrix.

Two types of color displays: Passive Matrix:

Row & Column approach Apply small bias to perpendicular lines of electrodes Bias strong enough to darken bit at line intersection · Multiplexed addressing scheme Advantages: Simple to implement Disadvantages: Can cause distortion Active Matrix · Each cell has its own thin-film transistor (TFT). ·Addressed independently from behind LCD. · Direct addressing scheme Advantages: Sharp display, better viewing angle, 40:1 contrast Disadvantages: Need better backlight, complex hardware Recent passive-matrix displays using new CSTN and DSTN technologies produce sharp colors rivaling active-matrix displays. **LCD Module Backlighting**:

LCDs unlike LEDS do not produce light, they need some external light source to view. So most of the latest LCD screens used in notebook computers use a light source. They use CFT or EL Panel or in recent times white LED as source of light fixed in the background of LCD. LED lamp is a better choice over CFT and EL due to its ability to offer variety of colors, intensity, long life (>100K Hrs), wide temperature range, and low voltage operation. Electroluminescent/EL Panel: The EL backlight consumes less power but require high voltage (120VAC @ 400Hz Typically). EL panel is also not long lasting and is sensitive to wider operating temperature range.Cold Cathode Florescent Lamp: This backlight is most popular and is suitable for large sized LCD displays. CFT has same drawbacks of EL panel i.e. short life span and limited temperature range, and need high voltage to operate (>300VAC @ 30-80KHz) and is also prone to vibrations.

Different viewing modes: Reflective: In the reflective mode LCDs use ambient light to illuminate the display making them more suitable for outdoor use. Transmissive: Transmissive mode will depend on internal backlight and is only viewable in indoors. Transflective: Transflective mode LCDs employ both Reflective and Transmissive types and switch based on the availability of ambient light.

Special characteristics of LCDs:

Liquid Crystals are very sensitive to constant electric fields. Only AC-voltages should be applied as DC voltages can cause an electrochemical reaction, which destroys the liquid crystals irreversibly.

Temperature dependent and in a very cold or hot environment LCD may not work correctly. This is a reversible effect. Some displays need temperature compensation circuits to automatically adjust the applied LC voltage.

Key specifications of LCD display:

Important factors to consider when evaluating an LCD monitor:

1. Resolution: The horizontal and vertical size measured by number of pixels (e.g., 1024x768).
2. Dot pitch: The distance between the centers of two adjacent pixels. Smaller dot pitch indicates sharper image.

3.Viewable size: The diagonal size of the LCD display panel.
4. Response time: The minimum time LCD takes to change a pixel's color or brightness.
5. Refresh rate: The rate at which the data is loaded in the monitor measured with the unit of number of times per second. Higher the refresh rate lesser is the flickering.
6.Matrix Type: Active TFT or Passive.

7. Viewing angle: The angle from which the user can view the image on the display clearly.

8. Color support: The types and number of colors supported by the LCD (known as color gamut).

9. Brightness: The amount of light emitted from the display (known as luminance).

10. Contrast ratio: The ratio of the intensity of the brightest bright to the darkest dark.
11. Aspect ratio: The ratio of the width to the height (for example, 4:3, 5:4, 16:9 or 16:10).
12. Gamma correction: It is the name of a nonlinear operation used to code and decode luminance or tristimulus values in video or still image systems

PCB DESIGN

A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or signal traces etched from copper sheets laminated onto a non-conductive substrate. It is also referred to as printed wiring board (PWB) or etched wiring board. A PCB populated with electronic components is a printed circuit assembly (PCA), also known as a printed circuit board assembly or PCB Assembly (PCBA). Printed circuit boards are used in virtually all but the simplest commercially produced electronic devices.

PCBs are inexpensive, and can be highly reliable. They require much more layout effort and higher initial cost than either wire wrap or point-to-point construction, but are much cheaper and faster for high-volume production; the production and soldering of PCBs can be done by automated equipment. Much of the electronics industry's PCB design, assembly, and quality control needs are set by standards that are published by the IPC organization.

MATERIALS:

Conducting layers are typically made of thin copper foil. Insulating layers dielectric are typically laminated together with epoxy resin prepreg. The board is typically coated with a solder mask that is green in color. Other colors that are normally available are blue, black, white and red. There are quite a few different dielectrics that can be chosen to provide different insulating values depending on the requirements of the circuit. Some of these dielectrics are polytetrafluoroethylene (Teflon), FR-4, FR-1, CEM-1 or CEM-3.

Well known prepare materials used in the PCB industry are FR-2 (Phenolic cotton paper), FR-3 (Cotton paper and epoxy), FR-4 (Woven glass and epoxy), FR-5 (Woven glass and epoxy), FR-6 (Matte glass and polyester), G-10 (Woven glass and epoxy), CEM-1 (Cotton paper and epoxy), CEM-2 (Cotton paper and epoxy), CEM-3 (Woven glass and epoxy), CEM-4 (Woven glass and epoxy), CEM-5 (Woven glass and polyester). Thermal expansion is an important consideration especially with ball grid array (BGA) and naked die technologies, and glass fiber offers the best dimensional stability.

FR-4 is by far the most common material used today. The board with copper on it is called "copper-clad laminate".

Copper foil thickness can be specified in ounces per square foot or micrometers. One ounce per square foot is 1.344 mils or 34 micrometers.

PATTERNING (ETCHING):

The vast majority of printed circuit boards are made by bonding a layer of copper over the entire substrate, sometimes on both sides, (creating a "blank PCB") then removing unwanted copper after applying a temporary mask (e.g., by etching), leaving only the desired copper traces. A few PCBs are made by adding traces to the bare substrate (or a substrate with a very thin layer of copper) usually by a complex process of multiple electroplating steps. The PCB manufacturing method primarily depends on whether it is for production volume or sample/prototype quantities. Double-sided boards or multi-layer boards use plated-through holes, called via to connect traces on either side of the substrate.

CHEMICAL ETCHING:

Chemical etching is done with ferric chloride, ammonium persulfate, or sometimes hydrochloric acid. For PTH (plated-through holes), additional steps of electroless deposition are done after the holes are drilled, then copper is electroplated to build up the thickness, the boards are screened, and plated with tin/lead. The tin/lead becomes the resist leaving the bare copper to be etched away.

The simplest method, used for small scale production and often by hobbyists, is immersion etching, in which the board is submerged in etching solution such as ferric chloride. Compared with methods used for mass production, the etching time is long. Heat and agitation can be applied to the bath to speed the etching rate. In bubble etching, air is passed through the etchant bath to agitate the solution and speed up etching.

Splash etching uses a motor-driven paddle to splash boards with etchant; the process has become commercially obsolete since it is not as fast as spray etching. In spray etching, the etchant solution is distributed over the boards by nozzles, and recirculated by pumps. Adjustment of the nozzle pattern, flow rate, temperature, and etchant composition give predictable control of etching rates and high production rates.

As more copper is consumed from the boards, the etchant becomes saturated and less effective; different etchants have different capacities for copper, with some as high as 150 grams of copper per litre of solution. In commercial use, etchants can be regenerated to restore their activity, and the dissolved copper recovered and sold. Small-scale etching requires attention to disposal of used etchant, which is corrosive and toxic due to its metal content.

The etchant removes copper on all surfaces exposed by the resist. "Undercut" occurs when etchant attacks the thin edge of copper under the resist; this can reduce conductor widths and cause open-circuits. Careful control of etch time is required to prevent undercut. Where metallic plating is used as a resist, it can "overhang" which can cause short-circuits between adjacent traces when closely spaced. Overhang can be removed by wire-brushing the board after etching

DRILLING:

Holes through a PCB are typically drilled with small-diameter drill bits made of solid coated tungsten carbide. Coated tungsten carbide is recommended since many board materials are very abrasive and drilling must be high RPM and high feed to be cost effective. Drill bits must also remain sharp to not mar or tear the traces.

Drilling with high-speed-steel is simply not feasible since the drill bits will dull quickly and thus tear the copper and ruin the boards. The drilling is performed by automated drilling machines with placement controlled by a drill tape or drill file. These computer-generated files are also called numerically controlled drill (NCD) files or "Excellon files". The drill file describes the location and size of each drilled hole. These holes are often filled with annular rings (hollow rivets) to create vias. Vias allow the electrical and thermal connection of conductors on opposite sides of the PCB.

When very small vias are required, drilling with mechanical bits is costly because of high rates of wear and breakage. In this case, the vias may be evaporated by lasers. Laser-drilled vias typically have an inferior surface finish inside the hole. These holes are called micro vias.

It is also possible with controlled-depth drilling, laser drilling, or by pre-drilling the individual sheets of the PCB before lamination, to produce holes that connect only some of the copper layers, rather than passing through the entire board. These holes are called blind vias when they connect an internal copper layer to an outer layer, or buried vias when they connect two or more internal copper layers and no outer layers.

The walls of the holes, for boards with 2 or more layers, are made conductive then plated with copper to form plated-through holes that electrically connect the conducting layers of the PCB. For multilayer boards, those with 4 layers or more, drilling typically produces a smear of the high temperature decomposition products of bonding agent in the laminate system. Before the holes can be plated through, this smear must be removed by a chemical de-smear process, or by plasma-etch. Removing (etching back) the smear also reveals the interior conductors as well.

Grounding rows and reading columns

To detect a pressed key, the microcontroller grounds all rows by providing 0 to the output latch, and then it reads the columns. If the data read from the columns is D3-D0=1111, no key has been pressed and the process continues until a key press is detected. However, if one of the column bits has a zero, this means that a key press has occurred. For example, if D3-D0=1101, this means that a key in the D1 column has been pressed. After a key press is detected, the microcontroller will go through the process of identifying the key. Starting with the top row, the microcontroller grounds it by providing a low to row D0 only; then it reads the columns. If the data read is all1s, no key in that row is activated and the process is moved to the next row. It grounds the next row, reads the columns, and checks for any zero. This process continues until the row is identified. After identification of the row in which the key has been pressed, the next task is to find out which column the pressed key belongs to. This should be easy since the microcontroller knows at any time which row and column are being accessed.
In the program, it is assumed that P1 and P2 are initialized as output and input, respectively. Program13.1 goes through the following four major stages:

1) To make sure that the preceding key has been released, 0s are output to all rows at once, and the columns are read and checked repeatedly until all the columns are high. When all columns are found to be high, the program waits for a short amount of time before it goes to the next stage of waiting for a key to be pressed.

2) To see if any key is pressed, the columns are scanned over and over in an infinite loop until one of them has a 0 on it. Remember that the output latches connected to rows still have their initial zeros (provided in stage 1), making them grounded. After the key press detection, it waits 20ms for the bounce and then scans the columns again. This serves two functions: (a) it ensures that the first key press detection was not an erroneous one due to

spike noise, and(b) the 20ms delay prevents the same key press from being interpreted as a multiple key press. If after the 20-ms delay the key is still pressed, it goes to the next stage to detect which row it belongs to; otherwise, it goes back into the loop to detect a real key press

3) To detect which row the key press belongs to, it grounds one row at a time, reading the columns each time. If it finds that all columns are high, this means that the key press cannot belong to that row; therefore, it grounds the next row and continues until it finds the row the key press belongs to. Upon finding the row that the key press belongs to, it sets up the starting address for the look-up table holding the scan codes (or the ASCII value) for that row and goes to the next stage to identify the key.

4) To identify the key press, it rotates the column bits, one bit at a time, into the carry flag and checks to see if it is low. Upon finding the zero, it pulls out the ASCII code for that key from the look-up table; Otherwise, it increments the pointer to point to the next element of the look-up table.

SOFTWARE DESCRIPTION

Arduino Description

Arduino is an open-source electronics platform that provides a wide range of microcontrollers and development boards. While Arduino itself does not specifically cater to non-invasive glucose monitoring devices, it can be utilized as a part of the overall system design. Non-invasive glucose monitoring devices aim to measure blood glucose levels without the need for traditional finger pricks or invasive methods. These devices typically utilize different technologies such as spectroscopy, impedance measurement, or optical sensors to indirectly measure glucose levels.

When incorporating Arduino into a non-invasive glucose monitoring device, it can serve as the main controller or a component within the system. Arduino boards provide a convenient and flexible platform for interfacing with sensors, processing data, and communicating with other devices.

1. Install Arduino IDE:

Start by downloading and installing the Arduino IDE from the official Arduino website (https://www.arduino.cc/). Follow the instructions provided for your operating system.

2. Arduino Board Selection:

Depending on the specific hardware you are using for your non-invasive glucose monitoring device, select the appropriate Arduino board from the "Tools" menu in the Arduino IDE. Popular options include Arduino Uno, Arduino Nano, or Arduino Mega.

3. Library Installation:

Check if there are any libraries available that provide functionalities related to glucose monitoring. Libraries are pre-written code that can be added to your Arduino project to simplify complex tasks. You can find libraries on the Arduino Library Manager or by searching online. Make sure to follow the library's documentation for installation instructions.

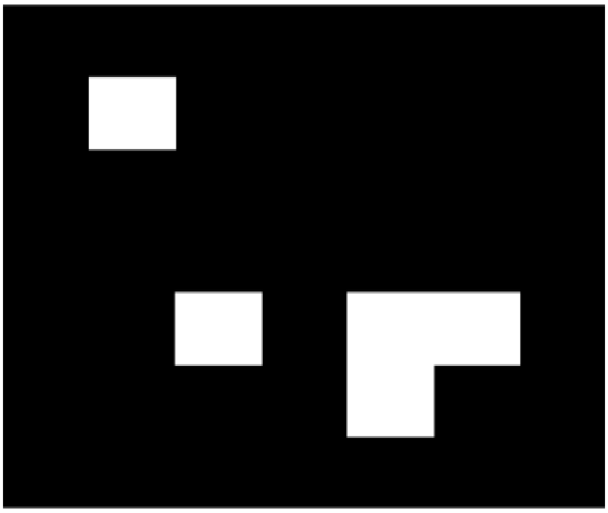
Code Development: Use the Arduino IDE's built-in code editor to write your program. You can start with the basic functions for reading data from sensors or any other required components. Consult the documentation of your glucose monitoring device to understand how to interact with it via Arduino.

4. Upload and Debug:

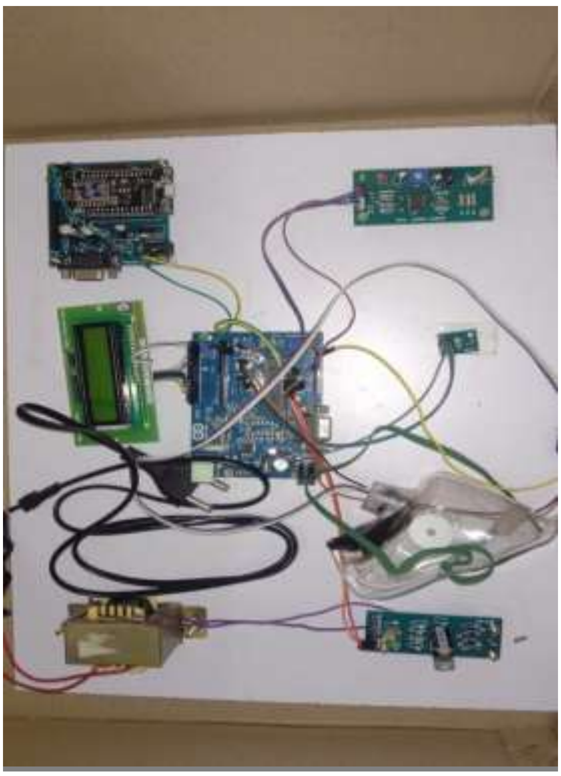
Once your code is ready, connect your Arduino board to your computer using a USB cable.

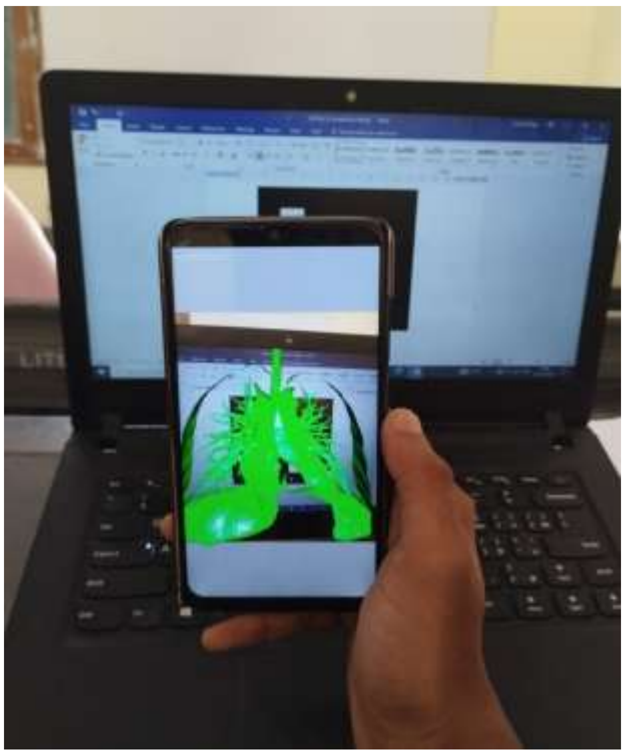
Select the correct board and port from the "Tools" menu in the Arduino IDE. Then, click the "Upload" button to compile and upload your code to the Arduino board. Use the serial monitor to debug and view any output or error messages from your device.

5.3 SCREENSHOT



3. RESULT AND DISCUSSION





The results of a immersive health data monitoring in VR using a multiple type of sensors can vary depending on the specific implementation and the accuracy of the sensor used. However, in an ideal scenario, the system would be able to accurately measure and display the heart rate, Spo2 rate, temperature, respiration rate of an individual in real time. The non-invasive nature of the sensor makes it more comfortable and convenient for patients.

By monitoring heart rate and respiratory rate, healthcare professionals and care givers can gain valuable insights into a patient's respiratory health. Changes in respiratory rate can indicate respiratory distress, respiratory diseases, or the effectiveness of respiratory treatments.

Monitoring respiratory rate can also be crucial in detecting abnormalities, such as irregular breathing patterns or apnea, which may requireimmediate medical attention. The data obtained from the non-invasive sensor canbe recorded and analyzed over time to identify patterns or trends in respiratoryrate. This longitudinal monitoring can provide valuable information for medical professionals to make informed decisions about patient care, adjust treatmentplans, or evaluate the effectiveness of interventions.

CONCLUSION

The proposed technology allows a physician to visualize the inside of the patient’s body and to interact with the 3D body in a hands-free operation. The CT and MRI datasets for the patient are viewed, read and defined concurrently during surgery in the operation room. This project has described a kit that can conveniently measure the health data in any environment. Base on that, it was able to make accurate measurements by sharing measurement, communication and roles and maximizing the efficiency of battery consumption. We also describe an algorithm that can monitor and analyze biological signals simultaneously with real-time measurements and identify risk situations. When a dangerous situation occurs, Kit send the message the danger situation to smartphones so that wearer and his/her caregiver can be alerted. It shows that accurate measurements can be made in actual environments.

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