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Design and Implementation of a Smart WBAN for Diabetes Management in Healthcare.

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Abstract

Wireless Body Area Network is one of network technology that have revolutionized the world of technology and to explain the importance of the networking major in the different majors, in this project we choose one of the important major in the l ife is the healthcare major. The Self-Management can not only make the treatment effective but also makes the treatment cost effective in case of chronic diseases like Diabetes and metabolic disorders [17]. The Internet of Things (IoTs) consists of many smart devices and components that communicate via their connection to the Internet, which is used to collect data with sensors that obtain personal health parameters. In this study we made a device that measures the level of blood sugar in the patient through acupuncture and send the result to apply in the phone via WIFI technology, through the application the patient can see the result of the examination saved or deleted and work alerts for important times such as sports time, food and medicine and the time of visiting the doctor also can save information about the drug used and the competent doctor, therefore the patient can manage the level of blood sugar easily and without complications.

1. Introduction:

The Internet, itself a significant component of the IoT, started out as part of DARPA (Defense Advanced Research Projects Agency) in 1962, and evolved into ARPANET in 1969. In the 1980s, commercial service providers began supporting public use of ARPANET, allowing it to evolve into our modern. Internet. Global Positioning Satellites (GPS) became a reality in early 1993, with the Department of Defense providing a stable, highly functional system of 24 satellites. This was quickly followed by privately owned, commercial satellites being placed in orbit. Satellites and landlines provide basic communications for much of the IoT. One additional and important component in developing a functional IoT was IPV6's remarkably intelligent decision to increase address space. Steve Leibson, of the Computer History Museum, states, "The address space expansion means that we could assign an IPV6 address to every atom on the surface of the earth, and still have enough addresses left to do another 100+ earths." Put another way, we are not going to run out of internet addresses anytime soon.[1] and [2]. By the year 2013, the Internet of Things had evolved into to a system using multiple technologies, ranging from the Internet to wireless communication and from micro-electromechanical systems (MEMS) to embedded systems. The traditional fields of automation (including the automation of buildings and homes), wireless sensor networks, GPS, control systems, and others, all support the IoT.

The IOT became part of our daily life and the use of this technology became necessary and effective in all fields, as well as in the field of medicine, bringing artificial intelligence a qualitative shift that affected the work of doctors became very easy to diagnose patients with the help of advanced modern medical machines, we have focused on diabetes patients and how technology helped them manage their sugar level we have made a sugar device that measures the level of blood sugar and linked it with application we have programmed to allow patients to follow up on their cases, determine treatment times, remind them of appointments and communicate with doctors.

2. Literature Background.

In 2019 according to international diabetes federation there is Approximately 463 million adults (20-79 years) were living with diabetes; by 2045 this will rise to 700 million, the proportion of people with type 2 diabetes is increasing in most countries, 79% of adults with diabetes were living in low- and middle-income countries, 1 in 5 of the people who are above 65 years old have diabetes, 1 in 2 (232 million) people with diabetes were undiagnosed, Diabetes caused 4.2 million deaths, More than 1.1 million children and adolescents are living with type 1 diabetes, More than 20 million live births (1 in 6 live births) are affected by diabetes during pregnancy, and 374 million people are at increased risk of developing type 2 diabetes [17].

health monitoring systems based on Internet-of-things (IoT) have been recently introduced to improve the quality of health care services. However, the number of advanced IoT-based continuous glucose monitoring systems is small and the existing systems have several limitations, in this project we focus on how we can make a device for diabetes without this limitation and have more features.

2.1. Type of Network

The network divided to two types from the connect way:

2.1.1. Wired Networking

Wired networking (networking cable) are networking hardware used to connect one network device to other network devices or to connect two or more computers to share printers, scanners etc. Different types of network cables, such as coaxial cable, optical fiber cable, and twisted pair cables, are used depending on the network's physical layer, topology, and size. The devices can be separated by a few meters (e.g. via Ethernet) or nearly unlimited distances (e.g. via the interconnections of the Internet)[2].

2.1.2. Wireless Networking

Wireless networks are networks that use radio waves to connect devices, without the necessity of using cables of any kind. Devices commonly used for wireless networking include portable computers, desktop computers, hand-held computers, Personal Digital Assistants (PDAs), cellular phones, pen-based computers, and pagers. Wireless networks work similar to wired networks however, wireless networks must convert information signals into a form suitable for transmission through the air medium[4].

2.2. Wireless Sensor Networks (WSNs)

A WSN is a wireless network that contains distributed independent sensor devices that are meant to monitor physical or environmental conditions. A WSN consists of a set of connected tiny sensor nodes, which communicate with each other and exchange information and data [5]. These nodes obtain information on the environment such as temperature, pressure, humidity or pollutant, and send this information to a base station. The latter sends the info to a wired network or activates an alarm or an action, depending on the type and magnitude of data monitored [6] and [17]. Typical applications include weather and forest monitoring, battlefield surveillance, physical monitoring of environmental conditions such as pressure, temperature, vibration, pollutants, or tracing human and animal movement in forests and borders. They use the same transmission medium (which is air) for wireless transmission as Wireless Local Area Networks (WLANs). For nodes in a Local Area Network (LAN) to communicate properly, standard access protocols like Institute of Electrical and Electronic Engineering (IEEE) 802.11 are available [30]. The importance of WSN makes it suitable for application in health, military, education, firefighting and prevention, and psychology. The survival rate in cardiac arrest in the first 720 s (12 min) is 48%– 75% as reported by the American Heart Association (AHA). A detailed description of the WSN application shown in Figure 2.1.

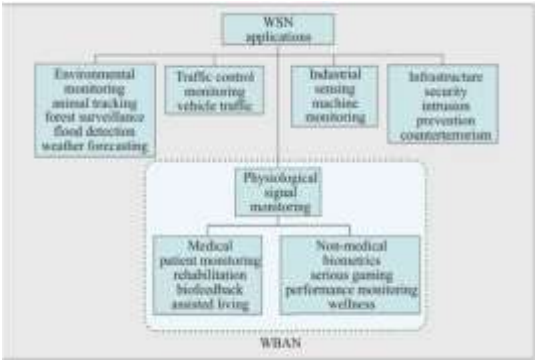

Figure 1 WSN applications[2]

There are several wireless sensor technologies, which are regarded as an offshoot of WSN, and the commonest is WBAN. WBANs, which are also referred to as Body Sensor Networks (BSNs) or Body Area Networks (BANs), are fashioned with thin, small lightweight sensors dispersed around, on, and in a human body to function as a monitoring device for the body and its immediate environment. WBAN functions as a monitoring, data detection and collection, and wireless data transfer system. Usually, PDA and smart mobile phones are used to transfer the data to the health professional through a main wireless system. The measured data are either processed or transferred in its raw state through a single gateway or multigateway. The sensor nodes are commonly made-up of sensing component, processing component, communicating component, and a power unit. Together they sense, collect, process, and transmit data

wirelessly to a central receiver. The following features are important for the most reliable and efficient sensor nodes: low cost, power efficient, wireless capabilities, multi-hop data routing, and decentralized processing [6]. The lifespan of sensor nodes is mostly affected by the quality and duration of the power source, that is, the battery. Previous studies have tried to increase the lifespan of sensor nodes by balancing or duty cycling the load among the sensor node. However, recent studies seek to prolong the node's lifespan by integrating renewable energy.

Deployment of sensor nodes is done in multitudes because of their low and small size. Although WBAN is referred to as an offshoot of WSN, there are several differences between these two systems, and these parameters of differences are presented in Figure 2.2. Energy efficiency and reliability are very important parameters in both systems. The other parameters are more important in WBAN than in WSN, for instance, maximum security is required in WBAN because of the sensitive nature of the data being transmitted [7].

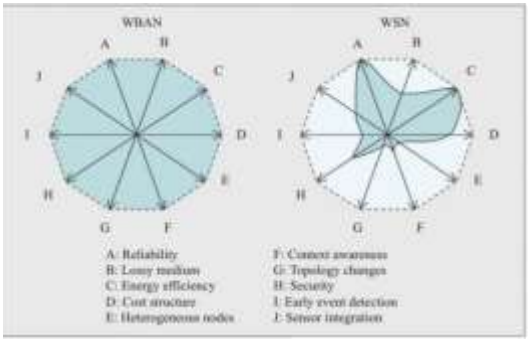

Figure 2 WBAN and WSN[2]

2.3. Wireless Body Area Network (WBAN)

WBAN was first presented in an article from 1996, but he named these body networks as the WPAN at the beginning. WBAN is seen as a valuable solution to monitor human body remotely and fluently. Many works have discussed WBAN definitions, architectures, applications, etc. because various current trends such as growing population have promoted the growth of WBAN. However, most of the existing works focus on theoretical performance enhancement. IEEE 802 has established a Task Group called IEEE 802.15.6 in November 2007 for the standardization of WBAN. The purpose of the group is to establish a communication standard optimized for low power high reliability application for BANS. We can find different annotations for WBAN like WBANS - Wireless Body Area Sensor Networks or WBSN Wearable Body Sensors Network.

2.3 Problem statement

In this study we will focus on making Smart device for Diabetics, and what are the requirements to implement this technology to link between device and program. And make the device send the result of the sugar level check to the application.

2.4 project objects

The objectives of this project are as follows:

1- Improving the lives of diabetics by monitoring their condition easily.
2- Facilitating the process of following up on diabetes patients by doctors.
3- Reminding the patient of what he needs in terms of medication, advice, and others.
4- The integration and use of modern technology and its developments in the medical field 5- Design Smart device and android application for Diabetics.

6- To learn about Artificial intelligence technology and its benefits.

2.5 Research questions

1- How can we Improve the lives of diabetics?
2- How can we facilitate the work of diabetes doctors?
3- What are the benefits of Artificial intelligence technology?
4- How can we integrate and use modern technology and its developments in the medical field?
5- How the Smart device technology works with Android program?
6- Why most of companies use this technology (Artificial intelligence technology)?

2.6. Diabetes

The epidemic nature of diabetes mellitus in different regions is reviewed. The Middle East and North Africa region has the highest prevalence of diabetes in adults (10.9%) whereas, the Western Pacific region has the highest number of adults diagnosed with diabetes and has countries with the highest prevalence of diabetes (37.5%). Different classes of diabetes mellitus, type 1, type 2, gestational diabetes and other types of diabetes mellitus [3]

2.6.1 Diabetes mellitus (DM)

commonly known as diabetes, is a group of metabolic disorders characterized by a high blood sugar level over a prolonged period of time. Symptoms often include frequent urination, increased thirst and increased appetite. If left untreated, diabetes can cause many complications. Acute complications can include diabetic ketoacidosis,

hyperosmolar hyperglycemic state, or death. Serious long-term complications include cardiovascular disease, stroke, chronic kidney disease, foot ulcers, damage to the nerves, damage to the eyes and cognitive impairment.

Diabetes is a number of diseases that involve problems with the hormone insulin. Normally, the pancreas (an organ behind the stomach) releases insulin to help your body store and use the sugar and fat from the food you eat. Diabetes can occur when the pancreas produces very little or no insulin, or when the body does not respond appropriately to insulin. As yet, there is no cure. People with diabetes need to manage their disease to stay healthy [3].

Diabetes is due to either the pancreas not producing enough insulin, or the cells of the body not responding properly to the insulin produced. There are three main types of diabetes mellitus [3]: Type 1 diabetes results from failure of the pancreas to produce enough insulin due to loss of beta cells. This form was previously referred to as "insulin-dependent diabetes mellitus" (IDDM) or "juvenile diabetes". The loss of beta cells is caused by an autoimmune response. The cause of this autoimmune response is unknown.

- Type 2 diabetes begins with insulin resistance, a condition in which cells fail to respond to insulin properly. As the disease progresses, a lack of insulin may also develop. This form was previously referred to as "non-insulin-dependent diabetes mellitus" (NIDDM) or "adult-onset diabetes". The most common cause is a combination of excessive body weight and insufficient exercise.
- Gestational diabetes is the third main form, and occurs when pregnant women without a previous history of diabetes develop high blood sugar levels.

2.6.2 Signs and symptoms

Figure 3 Overview of the most significant symptoms of diabetes[8]

The classic symptoms of untreated diabetes are unintended weight loss, polyuria (increased urination), polydipsia (increased thirst), and polyphagia (increased hunger). Symptoms may develop rapidly (weeks or months) in type 1 diabetes, while they usually develop much more slowly and may be subtle or absent in type 2 diabetes.

Several other signs and symptoms can mark the onset of diabetes although they are not specific to the disease. In addition to the known ones above, they include blurred vision, headache, fatigue, slow healing of cuts, and itchy skin. Prolonged high blood glucose can cause glucose absorption in the lens of the eye, which leads to changes in its shape, resulting in vision changes. Long-term vision loss can also be caused by diabetic retinopathy. A number of skin rashes that can occur in diabetes are collectively known as diabetic dermadromes [9].

2.6.3 Diabetes Management

Diabetes management concentrates on keeping blood sugar levels as close to normal, without causing low blood sugar. This can usually be accomplished with dietary changes, exercise, weight loss, and use of appropriate medications (insulin, oral medications).

Learning about the disease and actively participating in the treatment is important, since complications are far less common and less severe in people who have well-managed blood sugar levels. Per the American College of Physicians, the goal of treatment is an HbA1C level of 7-8%. Attention is also paid to other health problems that may accelerate the negative effects of diabetes. These include smoking, high blood pressure, metabolic syndrome obesity, and lack of regular exercise. Specialized footwear is widely used to reduce the risk of ulcers in at-risk diabetic feet although evidence for the efficacy of this remains equivocal.

2.6.4 Self-management of diabetes and internet of things

Self-Management is an important part of Diabetes Management. The Self-Management can not only make the treatment effective but also makes the treatment cost effective in case of chronic diseases like Diabetes and metabolic disorders. With the advent of handheld diagnostic equipment and wearable technologies, the self-management has achieved new dimensions. The Internet of Things (IoT) concept plays a significant role in self-management in Diabetes Management. IoT uses sensors to assist diabetes management by monitoring blood pressure, glucose level, calorie intake and physical activity. This research proposes an intelligent service model for healthcare which gives an effective feedback to an individual in diabetes management. This model identifies the risk events beforehand and raises alarm for patient, family and healthcare team. [18]

3. The Internet of Things (IoT)

Refers to the use of intelligently connected devices and systems to leverage data gathered by embedded sensors and actuators in machines and other physical objects. IoT is expected to spread rapidly over the coming years and this convergence will unleash a new dimension of services that improve the quality of life of consumers and productivity of enterprises.

For consumers, the IoT has the potential to deliver solutions that dramatically improve energy efficiency, security, health, education and many other aspects of daily life. For enterprises, IoT can underpin solutions that improve decision-making and productivity in manufacturing, retail, agriculture and other sectors [2].

3.1. History of IoT?

The term "Internet of Things" (IoT) was first used in 1999 by British technology pioneer Kevin Ashton to describe a system in which objects in the physical world could be connected to the Internet by sensors.12 Ashton coined the term to illustrate the power of connecting Radio-Frequency Identification (RFID) tags13 used in corporate supply chains to the Internet in order to count and track goods without the need for human intervention. Today, the Internet of Things has become a popular term for describing scenarios in which Internet connectivity and computing capability extend to a variety of objects, devices, sensors, and everyday items [33].

While the term "Internet of Things" is relatively new, the concept of combining computers and networks to monitor and control devices has been around for decades. By the late 1970s, for example, systems for remotely monitoring meters on the electrical grid via telephone lines were already in commercial use [33]. In the 1990s, advances in wireless technology allowed "machine–to–machine" (M2M) enterprise and industrial solutions for equipment monitoring and operation to become widespread. Many of these early M2M solutions, however, were based on closed purpose–built networks and proprietary or industry– specific standards,15 rather than on Internet Protocol (IP)–based networks and Internet standards [33].

3.2 What is the IoT?

In a very short time, the Internet has dramatically changed how we work, live, play, and learn. Yet, we have barely scratched the surface. Using existing and new technologies, we are connecting the physical world to the Internet. It is by connecting the unconnected that we transition from the Internet to the Internet of Things (IoT).

IoT (Internet of Things) is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system [33].

IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment. They enhance data collection, automation, operations, and much more through smart devices and powerful enabling technology.

3.3 IoT − Key Features

The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use. A brief review of these features is given below [32] and [33]:

- **AI** − IoT essentially makes virtually anything "smart", meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. This can mean something as simple as enhancing your refrigerator and cabinets to detect when milk and your favorite cereal run low, and to then place an order with your preferred grocer.
- **Connectivity** − New enabling technologies for networking, and specifically IoT networking, mean networks are no longer exclusively tied to major providers. Networks can exist on a much smaller and cheaper scale while still being practical. IoT creates these small networks between its system devices.
- **Sensors** − IoT loses its distinction without sensors. They act as defining instruments which transform IoT from a standard passive network of devices into an active system capable of real-world integration.
- **Active Engagement** − Much of today's interaction with connected technology happens through passive engagement. IoT introduces a new paradigm for active content, product, or service engagement. • **Small Devices** − Devices, as predicted, have become smaller, cheaper, and more powerful over time. IoT exploits purpose-built small devices to deliver its precision, scalability, and versatility.

3.4 Internet of Things - Technology and Protocols

IoT primarily exploits standard protocols and networking technologies. However, the major enabling technologies and protocols of IoT are RFID, NFC, low-energy Bluetooth, low-energy wireless, lowenergy radio protocols, LTE-A, and WIFI-Direct. These technologies support the specific networking functionality needed in an IoT system in contrast

to a standard uniform network of common systems. **a) NFC and RFID**

RFID (radio-frequency identification) and NFC (near-field communication) provide simple, low energy, and versatile options for identity and access tokens, connection bootstrapping, and payments.

- RFID technology employs 2-way radio transmitter-receivers to identify and track tags associated with objects.
- NFC consists of communication protocols for electronic devices, typically a mobile device and a standard device.

b) Low-Energy Bluetooth

This technology supports the low-power, long-use need of IoT function while exploiting a standard technology with native support across systems.

c) Low-Energy Wireless

This technology replaces the most power-hungry aspect of an IoT system. Though sensors and other elements can power down over long periods, communication links (i.e., wireless) must remain in listening mode. Low-energy wireless not only reduces consumption, but also extends the life of the device through less use.

d) Radio Protocols

ZigBee, Z-Wave, and Thread are radio protocols for creating low-rate private area networks. These technologies are low-power, but offer high throughput unlike many similar options. This increases the power of small local device networks without the typical costs.

e) LTE-A

LTE-A, or LTE Advanced, delivers an important upgrade to LTE technology by increasing not only its coverage, but also reducing its latency and raising its throughput. It gives IoT a tremendous power through expanding its range, with its most significant applications being vehicle, UAV, and similar communication.

f) WIFI-Direct

WIFI-Direct eliminates the need for an access point. It allows P2P (peer-to-peer) connections with the speed of WIFI, but with lower latency. WIFI-Direct eliminates an element of a network that often bogs it down, and it does not compromise on speed or throughput.

3.5 Internet of Things - Common Uses

IoT has applications across all industries and markets. It spans user groups from those who want to reduce energy use in their home to large organizations who want to streamline their operations. It proves not just useful, but nearly critical in many industries as technology advances and we move towards the advanced automation imagined in the distant future [32] and [33].

a) Engineering, Industry, and Infrastructure

b) Government and Safety

c) Home and Office

d) Health and Medicine

IoT pushes us towards our imagined future of medicine which exploits a highly integrated network of sophisticated medical devices. Today, IoT can dramatically enhance medical research, devices, care, and emergency care. The integration of all elements provides more accuracy, more attention to detail, faster reactions to events, and constant improvement while reducing the typical overhead of medical research and organizations.

3.6 IoT - Building/Housing Applications

IoT applied to buildings and various structures allows us to automate routine residential and commercial tasks and needs in a way that dramatically improves living and working environments. This, as seen with manufacturing and energy applications, reduces costs, enhances safety, improves individual productivity, and enhances quality of life [32].

a) Environment and Conditioning

One of the greatest challenges in the engineering of buildings remains management of environment and conditions due to many factors at work. These factors include building materials, climate, building use, and more. Managing energy costs receives the most attention, but conditioning also impacts the durability and state of the structure.

IoT aids in improving structure design and managing existing structures through more accurate and complete data on buildings. It provides important engineering information such as how well a material performs as insulation in a particular design and environment.

b) Health and Safety

Buildings, even when constructed with care, can suffer from certain health and safety issues. These issues include poor performing materials, flaws that leave the building vulnerable to extreme weather, poor foundations, and more.

Current solutions lack the sophistication needed to detect minor issues before they become major issues, or emergencies. IoT offers a more reliable and complete solution by observing issues in a finegrained way to control dangers and aid in preventing them; for example, it can measure changes in a system's state impacting fire safety rather than simply detecting smoke.

c) Productivity and Quality of Life

Beyond safety or energy concerns, most people desire certain comforts from housing or commercial spaces like specific lighting and temperature. IoT enhances these comforts by allowing faster and easier customizing.

Adjustments also apply to the area of productivity. They personalize spaces to create an optimized environment such as a smart office or kitchen prepared for a specific individual.

3.7 Internet of Things - Consumer Applications

Consumers benefit personally and professionally from the optimization and data analysis of IoT. IoT technology behaves like a team of personal assistants, advisors, and security. It enhances the way we live, work, and play.

a) Home

IoT takes the place of a full staff:

- **Butler** − IoT waits for you to return home, and ensures your home remains fully prepared. It monitors your supplies, family, and the state of your home. It takes actions to resolve any issues that appear.
- **Chef** − An IoT kitchen prepares meals or simply aids you in preparing them.
- **Nanny** − IoT can somewhat act as a guardian by controlling access, providing supplies, and alerting the proper individuals in an emergency.
- **Gardner** − The same IoT systems of a farm easily work for home landscaping.
- **Repairman** − Smart systems perform key maintenance and repairs, and also request them.
- **Security Guard** − IoT watches over you 24/7. It can observe suspicious individuals' miles away, and recognize the potential of minor equipment problems to become disasters well before they do.

b) Work

A smart office or other workspace combines customization of the work environment with smart tools. IoT learns about you, your job, and the way you work to deliver an optimized environment. This results in practical accommodations like adjusting the room temperature, but also more advanced benefits like modifying your schedule and the tools you use to increase your output and reduce your work time. IoT acts as a manager and consultant capable of seeing what you cannot.

c) Entertainment

IoT learns as much about you personally as it does professionally. This enables the technology to support leisure:

- **Culture and Night Life** − IoT can analyze your real-world activities and response to guide you in finding more of the things and places you enjoy such as recommending restaurants and events based on your preferences and experiences.
- **Vacations** − Planning and saving for vacations proves difficult for some, and many utilize agencies, which can be replaced by IoT.
- **Products and Services** − IoT offers better analysis of the products you like and need than current analytics based on its deeper access. It integrates with key information like your finances to recommend great solutions.

3.8 Internet of Things – Security

Every connected device creates opportunities for attackers. These vulnerabilities are broad, even for a single small device. The risks posed include data transfer, device access, malfunctioning devices, and always-on/always-connected devices. The main challenges in security remain the security limitations associated with producing low-cost devices, and the growing number of devices which creates more opportunities for attacks [29] , [30], [31], [32] and [33].

Security Spectrum

The definition of a secured device spans from the simplest measures to sophisticated designs. Security should be thought of as a spectrum of vulnerability which changes over time as threats evolve.

Security must be assessed based on user needs and implementation. Users must recognize the impact of security measures because poorly designed security creates more problems than it solves.

Challenges

Beyond costs and the ubiquity of devices, other security issues plague IoT:

- **Unpredictable Behavior** − The sheer volume of deployed devices and their long list of enabling technologies means their behavior in the field can be unpredictable. A specific system may be well designed and within administration control, but there are no guarantees about how it will interact with others.
- **Device Similarity** − IoT devices are fairly uniform. They utilize the same connection technology and components. If one system or device suffers from a vulnerability, many more have the same issue.
- **Problematic Deployment** − One of the main goals of IoT remains to place advanced networks and analytics where they previously could not go. Unfortunately, this creates the problem of physically securing the devices in these strange or easily accessed places.

- **Long Device Life and Expired Support** − One of the benefits of IoT devices is longevity, however, that long life also means they may outlive their device support. Compare this to traditional systems which typically have support and upgrades long after many have stopped using them. Orphaned devices and abandonware lack the same security hardening of other systems due to the evolution of technology over time.
- **No Upgrade Support** − Many IoT devices, like many mobile and small devices, are not designed to allow upgrades or any modifications. Others offer inconvenient upgrades, which many owners ignore, or fail to notice.
- **Poor or No Transparency** − Many IoT devices fail to provide transparency with regard to their functionality. Users cannot observe or access their processes, and are left to assume how devices behave. They have no control over unwanted functions or data collection; furthermore, when a manufacturer updates the device, it may bring more unwanted functions.
- **No Alerts** − Another goal of IoT remains to provide its incredible functionality without being obtrusive. This introduces the problem of user awareness. Users do not monitor the devices or know when something goes wrong. Security breaches can persist over long periods without detection.

At the end The Internet of Things promises to deliver a step change in individuals' quality of life and enterprises' productivity. Through a widely distributed, locally intelligent network of smart devices, the IoT has the potential to enable extensions and enhancements to fundamental services in transportation, logistics, security, utilities, education, healthcare and other areas, while providing a new ecosystem for application development.

A concerted effort is required to move the industry beyond the early stages of market development towards maturity, driven by common understanding of the distinct nature of the opportunity. This market has distinct characteristics in the areas of service distribution, business and charging models, capabilities required to deliver IoT services, and the differing demands these services will place on mobile networks.

3.9 Internet of Things - Health and Medicine

IoT pushes us towards our imagined future of medicine which exploits a highly integrated network of sophisticated medical devices. Today, IoT can dramatically enhance medical research, devices, care, and emergency care. The integration of all elements provides more accuracy, more attention to detail, faster reactions to events, and constant improvement while reducing the typical overhead of medical research and organizations [33].

From this point on, there are many medical devices that solve many medical problems and help patients such as diabetics. There are many technologies that help diabetics to better control their disease, such as an artificial pancreas as well as blood glucose screening machines.

4. Diabetes device

The diabetes device checks the patient's blood sugar level after inserting the chip, putting blood into it, and then sending the result to the mobile app.

4.1 Hardware used in the first device:

- Arduino UNO
- GSM sensor
- IC
- LDE
- Resistors
- Capacitors
- Glucose sensor
- Chip sensor
- Switch
- battery

4.1.1 Arduino UNO

Figure 4 Arduino UNO

Arduino UNO is based on an ATmega328P microcontroller. It is easy to use comparing to other boards, such as the Arduino Mega board, etc. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack and an ICSP (In-Circuit Serial Programming) header.[1] It is the most used of standard form from the list of all available Arduino Boards. It is also recommended for beginners as it is easy to use. Arduino Uno is a microcontroller board developed by Arduino.cc which is an

open-source electronics platform mainly based on AVR microcontroller Atmega328. First Arduino project was started in Interaction Design Institute Ivrea in 2003 by David Cuartielles and Massimo Banzi with the intention of providing a cheap and flexible way to students and professional for controlling a number of devices in the real world. The current version of Arduino Uno comes with USB interface, 6 analog input pins, 14 I/O digital ports that are used to connect with external electronic circuits. Out of 14 I/O ports, 6 pins can be used for PWM output. It allows the designers to control and sense the external electronic devices in the real world [33].

LCD:

Figure 5 LCD

TL084 Op amp is very similar to the LM324 Op-Amp, they both have four Op-Amps inside them and have the exact same pinouts. The TL084 however is not meant for common 5V operation as it requires a minimum of 7V to operate. So Unlike LM324 or other op-amps, if you are using the Op-Amp in single supply mode, make sure you provide a minimum of 7V for the Op-Amp to function normally.

4.1.Parts of the diabetes device:

- ESP8266
- Capacitors
- resistance
- battery
- IC
- Glucose sensor
- Switch

ESP8266:

Figure 6 ESP8266

A microcontroller has the ability to perform activities related to WIFI and thus is widely used as a WIFI unit The ESP8266 is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability, produced by Espressif Systems in Shanghai. The chip first came to the attention of Western makers in August 2014 with the ESP-01 module, made by a third-party manufacturer Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at first there was almost no English-language documentation on the chip and the commands it accepted The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, the chip, and the software on it, as well as to translate the Chinese documentation The ESP8285 is an ESP8266 with 1 MiB of built-in flash, allowing the building of single-chip devices capable of connecting to Wi-Fi.

4.2 Programming types with: ESP8266:

1. **Using AT commands.**
2. **Use the Arduino IDE.**

The "standard" version has 2 digital pins that can be used for input or output. Eg: to drive LED's or relays. These pins can also be used for PWM. Other versions have more pins exposed. For example, the ESP-12, which is a good option if you need more pins. Either way the programming is still the same.

Analog input is also available on the ESP8266 chip (ADC/TOUT) but it's not wired up on the ESP-01. It can be combined with an Arduino or it can be programmed to work on its own. There are various tools and development environments (IDE's) to program it.

• **Breadboard Power Supply**

A good power supply seems to be a crucial aspect for the ESP8266. A breadboard power supply is really useful, especially when you're dealing with mixed voltages. The one shown here supplies 3.3V and 5.5V and plugs right into your breadboard. I should have got one a long time ago! The ESP8266 can chew a lot of mA (>300mA at times). If your ESP reboots or seems unreliable then you need a separate power supply for the ESP (keep a common ground though). Also connect a capacitor across 3.3V and ground to minimize spikes and to provide a small reservoir of power.

• **Integrated Circuit (IC):**

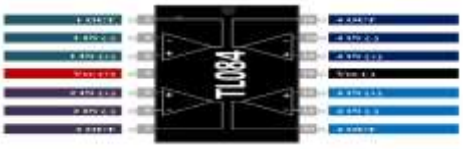

Figure 7 IC

The TL084 is a Quad Package Operational Amplifier, meaning it has four Op-Amps inside it and each Op-Amp can be used independently.

The main distinguishing feature of the TL084 Op-Amp is that they incorporate high-voltage JFET and bipolar transistors which helps the transistor to have very high input impedance and low bias current. Also, this Op-Amp has low noise and harmonic distortion making it an ideal choice for audio preamplifiers. So, if you are looking for an Op-Amp IC with Quad package and JFET driven then this IC might be the right choice.

Op-Amp Design Considerations

The Op-Amps as we know are the work horse for most electronics circuit designs. There is a plethora of application circuits for Op-Amp each having its characteristics and significance in its own way. But every Op-Amp design will have some common design considerations or tips which are common among them and we will discuss the same further.

Inputs:The input stage of an Op-Amp is mostly complex since it involves many stages. The Input common-mode range value must be considered while supplying voltage signals because the input voltage should never exceed the rail voltage else it will create a latchup condition which in return will create a short circuit of the supply voltage and thus damaging the circuit permanently.

Output: The TL084 is not a rail-to-rail Op-Amp hence the output voltage will not reach the maximum positive or maximum negative voltage when saturated. It will always be ~2V less than the supply voltage, this voltage drop occurs because of the Vce voltage drop of the transistors present inside the Op-Amp. Also remember that a saturated Op-Amp will comparatively draw more current and thus results in power loss.

Gain/Feedback: Op-Amps are known for their very large Open-Loop Gain, but sadly this gain is accompanied by noise hence most of the circuits are designed using Closed-Loop. A Closed-Loop system provides feedback to the input this limiting the gain value of the Op-Amp and the noise associated with it. A Negative feedback is commonly preferred, since it has predictable behaviors and stable operation.

Terminating Unused Op-Amp pins

Here the Op-Amp is operating between the voltage range Vdd and Vss. To terminate the Op-Amp the Inverting pin of the Op-Amp is connected to the Output pin and the Non-Inverting pin is provided with a constant voltage source. This constant voltage could be of any value but must be within the limits of supply voltage (Common mode Voltage Range). Hence it is not mandatory to have these two resistors since any available voltage of that particular range from the circuit can be used to terminate the NonInverting pin of the Op-Amp.

Applications

- Circuit requiring high input impedance
- Amplifier Circuits
- Buffer application
- Audio pre-amplification
- Multi-stage Voltage generators
- Audio/noise filter circuits

5. The part of Application

The application is designed to display examination results and manage a patient's routine. A number of tools have been used that will be explained in this section.

5.1 Android

Android is an open source and Linux-based operating system for mobile devices such as smartphones and tablet computers. Android was developed by the Open Handset Alliance, led by Google, and other companies. This tutorial will teach you basic Android programming and will also take you through some advance concepts related to Android application development [2] and [33].

5.2 What is API level?

Level is an integer value that uniquely identifies the framework API revision offered by a version of the Android platform [19]

Figure 8 android architecture [19]

6. The previous study

6.1 Study (1)

- **Title**: Detection of Levels of Blood Sugar Using Simple IoT Based Breath Analysis
- **Date**: 8, August 2020

- **Publisher:** Dr. Khalid Nazim Abdul Sattar, Dr. Mohammad Mahmood Otoo , Dr. Mutasim Al Sadig, Dr. Nandini
- **Conference Location:** Saudi Arabia
- **The aim of the study**

Objectives of the proposed work: 1. In this designed system, an Arduino UNO has been used to analyze and compute the patient health. 2. Use of smart devices to collect sugar level, temperature and humidity that will aid in evaluation of the health condition of the patient. 3. The diagnosed results are displayed on the android device used. 4. The results generated are stored onto the database for future references and are accessible from any location in case of emergency without minimal delay.

- **Study Hypotheses:**

The intention of the proposed system is to design a device based on IoT which provides a non-invasive technique to measure blood sugar level. It has been established that the level of ketone in the breath is directly linked to the sugar level of a person. For this purpose, the device collects the sample of the breath when the patient blows into the mouthpiece and senses the level of ketone in addition to the temperature and humidity levels of the breath. The design of system as , involves displaying the reading on the builtin LCD screen and in the Android mobile application which also provides for graphical representation of sensitivity characteristics of each of the fields mentioned.

a) **Breath analyzer:** A component which consists of the Figaro TGS sensor used to collect the breath sample for analysis.

b) **ThingSpeak:** A service that supports IoT applications and allow the users to analyze and visualize uploaded data using Matlab.

c) **Android Application:** An app that enables the patients/ doctors who have smartphones to view readings of the sensor and maintain a record of the same.

d) **Web page:** This displays the readings of the sensor to the patients and doctors who do not have access to smartphones or for those who do not wish to install the application.

- **The Results:**

Here, the results that are obtained after execution of the various algorithms and software are subject to analysis. This is further used in drawing conclusions related to the various parameters of the system like accuracy, complexity, usability, etc. The results which are obtained help the user in understanding the true purpose of the system and the need for its implementation.

Web page interfaces as shown in Fig 14 and Fig 15, provide necessary details to the users regarding information on Diabetes and its implications.

6.2 Study (2)

- **Title**: IoT-based continuous glucose monitoring system: A feasibility study
- **Date**: 2017
- **Publisher:** Elsevier B.V • **The aim of the study:**

a) proposing continuous glucose monitoring IoT-based system

b) designing an energy efficient sensor device using nRF protocol

c) designing an energy harvesting unit for the sensor device to extend the sensor device's battery life

- **Study Hypotheses:**

the number of advanced IoT-based continuous glucose monitoring systems is small and the existing systems have several limitations. In this paper we study feasibility of invasive and continuous glucose monitoring (CGM) system utilizing IoT based approach. We designed an IoT-based system architecture from a sensor device to a back-end system for presenting real-time glucose, body temperature and contextual data (i.e. environmental temperature) in graphical and human-readable forms to end-users such as

patients and doctors. In addition, nRF communication protocol is customized for suiting to the glucose monitoring system and achieving a high level of energy efficiency. Furthermore, we investigate energy consumption of the sensor device and design energy harvesting units for the device. Finally, the work provides many advanced services at a gateway level such as a push notification service for notifying patient and doctors in case of abnormal situations (i.e. too low or too high glucose level). The results show that our system is able to achieve continuous glucose monitoring remotely in real-time. In addition, the results reveal that a high level of energy efficiency can be achieved by applying the customized nRF component, the power management unit and the energy harvesting unit altogether in the sensor device.

6.2.1 Ethical, social and cultural viability (Cultural Feasibility): The system sugar + It combines two great sciences medicine, computer and networks science, all of which Greatest the moral and social aspect, especially the science of medicine, he is aware of a sensitive depends upon the lives of human beings and error in which a murderer, it is computer's ethics to keep the programmer or engineer on the privacy and information of customers and users of its program.

On the program sugar +The high degree of privacy for user's data provides a particularly sick of them, the program sugar +It isn't goal in collecting patient data is to provide medical statistics ,as data collection is not an end in itself, but rather a way to collect medical information to help the patient follow himself ,and to help medicine and medical statistics in tracking and eliminating diseases

6.2.2 Final Result

We conclude that diabetes is capable of recovery, and it is necessary to follow the patient's condition constantly and communicate with the doctor who is following up and work with his advice when diabetes rises. There are several things that help reduce it, such as boiled mint leaves, boiled fenugreek and other things, as well as practicing walking and when diabetes is lower than the normal range. Eat fruits or naturally sweetened food without artificial sugars, and be careful not to eat artificial sugars, as they have serious complications for diabetic patients due to the high level of glucose at once, which causes damage and complications. Diabetics needs to be monitored and examined periodically, but it is not daily, and also must be accurate in the dates of food and medication, and attention must be paid to a healthy lifestyle.

We concluded the following when following diabetes patient's health status in terms of food and medicine, and in terms of doing diets and exercises. They are rated that their condition is excellent, very good and in improvement, and they may recover from diabetes completely especially when doing a diet and exercising. As for those who neglect the follow-up their health conditions, their conditions gradually deteriorate and are classified as good or weak. This neglect may be due to several difficulties faced by the diabetic that he may have little knowledge of this disease and does not know what to avoid, which is useful and what is harmful is also tolerated by visiting doctors. Therefore, he does not care about making a diet or exercising without being interested in taking medicine. Also, one of the difficulties is that the bad Set up a home glucose test, so some devices may show different readings, and this causes wrong doses of medication, too, and may not be interested in following up on the daily test results.

7. How the first devise work:

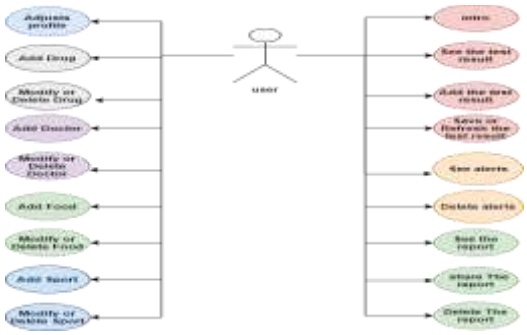

Diagram 10 Use case Diagram

The slide absorbs a certain amount of blood

- The process of oxidation of glucose and its conversion to glucose acid occurs
- Determining the level of sugar in the blood through the glucose sensor by passing an electric current
- Arduino receives the results of the examination and processing
- Arduino sends the result to the LDE and the GSM
- LDE is showing the result
- GSM sends the result to the phone number
- phone receives its message
- phone sends the message to the application

8. Arduino programming:

The Arduino IDE is the tool used to write code in the Arduino language and then convert it into an executable formula that can be placed on the microcontroller, he boards, the Arduino

development environment is characterized by simplicity and ease of handling, as it is almost without any complications
After completing the installation of the Arduino IDE, we do the deification steps to connect the Arduino to the computer:

1) connect the Arduino board to the cable.
2) Insert the other end of the USB slot into the computer and wait for a while for it to appear
3) A message stating that a computer recognized its Arduino board after its identification.
4) Arduino comes time to start working on the development environment

8.1 Arduino UNO

The Arduino has been programmed so that any data made by the device is sent to the Arduino
And then the Arduino send this data to the LDE and then sends it a text message via a GSM
Arduino UNO is based on an ATmega328P microcontroller. It is easy to use comparing to other boards, such as the Arduino Mega board, etc. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack and an ICSP (In-Circuit Serial Programming) header.
It is the most used of standard form from the list of all available Arduino Boards. It is also recommended for beginners as it is easy to use.
After the test results are calculated and sent to the Arduino
The Arduino is sending it to the LDE
The benefit of this LED is to reduce the number of ports to 4, after it was 16 implemented, as is clear in the figure

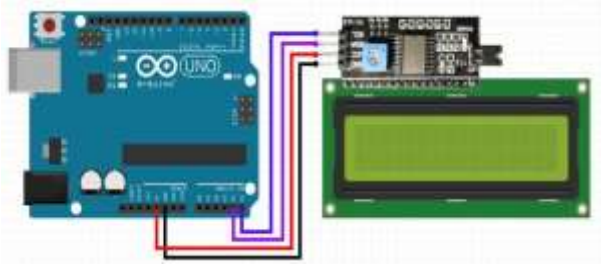

Figure 11 Arduino UNO with LCD

9. How the second device works

- The card absorbs a certain amount of blood
- The device sends and receives automatically and continuously Signs to monitor the variables to know whether the blood has been Placed or not
- Pass an electricity from one point and receives it from another Point to perform the calculation process
- When the blood reaches the tube, the voltage is increased at the Analog, the device makes sure that the blood has arrived and after That the timer is started
- The glucose oxidation occurs in the blood and it turns into glucose oxide and it becomes a conductor to the current
- You wait for a specific period of time, up to five seconds, and the Interaction reaches a certain limit within a certain time
- The interaction is carried out at a reverse way, meaning that the higher the glucose is the higher current, and the lower the glucose is the lower the current
- The amount of current that passed through the blood is calculated at a time of not more than five seconds
- The voltage is converted into a number and an understood reading

9.1 Work Method of the device programmatically:

- The reading will be saved after it was returned into an understood number
- This reading is sent to the connected phone at that time
- In the event that there is no connected phone, the device will show signs that are understood by the user in order to explain the condition or the sugar level to him, and these signs are:
    1. Blue: Sugar level is low
    2. Green: natural
    3. Yellow: higher than normal little
    4. Red: Very high

9.2 Work of each part in the device:

Card:

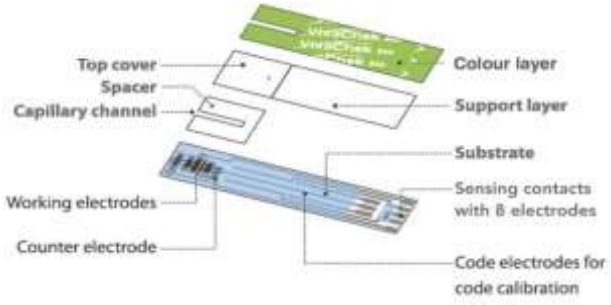

Figure 12 Card components

It is divided in to three poles:

1. Reference
2. Connector
3. Working

When a quantity of blood is placed in the strip, the first electrode (Reverence) contacts the second electrode

(Connector), and after the contact, the electrode (Connector) pumps electricity of 2.5 volts, glucose reacts with glucose oxide, producing glucose acid, after which the glucose turns into glucose acetate and interacts directly with The peroxidase from this reaction produces an electric current, but we cannot measure this current because it will be very weak, so we use the current amplifier (IC), which has made the current magnification and amplification, so the current is enlarged by 100 times and after that the measurement is done and the calculated reading is greater than the 2.5.

Sensor:

Figure 13 Where to place the card

A conductor with a resistance of the value of ohms, we connect the positive and negative wire if the signal = (1) the chip is present and the signal (0) the chip is not present Red: Very high

9.2 Practical part

This part contains the form of the device and the final application as well as a practical application of the device and application .

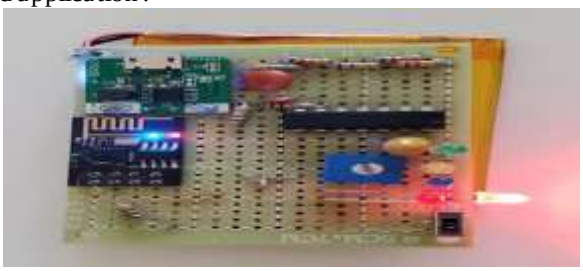

Figure 14 Final device shape

The device is currently not connected to any cellphone.

Figure 15 Connect the app to the device network

We connect the application to the device network so it shows us in the application that it has been successfully connected and lights the blue LED in the device.

Figure 16 Device connect with the cellphone and Sugar check chip

When the app connects with the mobile phone and the sugar check chip, the yellow LED lights up and a notice appears on the phone app that the sugar chip has been successfully installed waiting for blood.

Figure 17 The blood was put in the examination chip

When the blood is placed in the examination slide the device waits several seconds to receive the result and a message appears in the interface of the application that the blood has been placed and the result will appear within moments.

Figure 18 Result appears in the app

After the device analyzes the result and passes several processes the device sends the result to the application and appears on the main page of the application

Figure 19 Install a chip used by

When you enter a previously used chip, the device sends a wrong message to the application, and the message appears in the interface of the application

10. Conclusion.

In this study we implemented one of the new sections of networking major it's Wireless Body Area Network. WBAN is the future of saving the human life, it's help to monitor the physiology signal to develop human life. In this study we

explained one of the applications that used in it this technology. We implemented the study to the diabetes disease patients from period 01/02/2022 to 30/07/2022 in constant study explain this technology, developed from any technology and its devices ,application, layers ,relationship with IOT, how can it help in the healthcare system and the important applications healthcare the WBAN technology help in it. Explain how this technology help to rescued the patients as soon as possible so this will reduce the death rate and explain how the networking major has strong relationships with other majors and help to facilitate them. Also explain how we implement this technology by making system sends SMS and detected the location.

11. Suggestions.

For improving the network of sugar+ the searchers suggest the following:

1. Making sure of the quality of the test devices and we suggest to be all convenient and sophisticated.
2. Implement new technologies in IOT smart devices etc.
3. The programmer of IOT, smart devices, network should be having experience.
4. collected must information about IOT, smart devices, programming, network especially in connectivity.

12. Recommendation.

The need for more sophisticated networking is evident, and the purpose of IOT smart devices, programming and network especially in connectivity are clear. So how can you best prepare for the transition to this dynamic approach? The key to successful adoption is to find an integrator who can guide yourself with your program and help navigate its complexities. The recommendations below can help you identify the right adoption strategy as well as the best partner to meet your project's unique needs.

1. **Determine how your network could benefit from IOT adoption.** Identify where in your organization IOT would be most beneficial. And remember, this is not a one size fits-all solution. Carefully consider the how, when, and where IOT complements your organization.
2. **Assess your organization's risk tolerance and adaptability**

To successfully implement IOT, first identify the balance of risk versus reward that your organization is ready to accept.

3. **Assess a range of provider options and vendor solutions** IOT is so new that it is considered to be a disruptive technology. Many startups are entering the burgeoning marketplace, as well as novel offers by more well established, traditional providers. Plan wisely, and identify the options that are best aligned with your specific needs. Find out what is most compelling about the solutions offered, and then assess the respective IOT within a test lab or pilot program before committing completely.
4. **Prepare your leadership and staff for the changes smart devices will bring smart devices** will lead to significant changes to networking in general—along with the additional skill sets required for the environment, there will be opportunities for network engineers to participate in new areas, and at different levels, compared to what they have done in the past.

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