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TELEHEALTH WIRELESS SYSTEMS: APPLICATIONS AND FUTURE PROSPECTS

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ABSTRACT

The application of wired and wireless systems in healthcare care delivery, have proved useful especially in the face of the dreaded COVID 19 pandemic. The paradigm shift from the usage of conventional computers to a more robust medical device is made possible through findings in telecommunication innovations. This paper builds the confidence of healthcare providers and telecommunication experts on tilting the spotlight to telehealth technologies, as the future of health care, globally. This technical paper also x-rays the immense benefits, demerits, applications and future prospects of telecommunication in health delivery. It also analyses DNA computing, as the future of telehealth .Millions of natural dormant supercomputers exist inside the human body in the form of DNA found in the human gene. To ignite these dormant biochips ,requires systemic design options (biosensors) that can only be offered by DNA computing technology. Those natural supercomputers can only be harnessed and allowed to communicate with external telehealth devices through DNA computing technology.

A call to prioritize the goal of researchers and other state actors in the laboratory,to find ways on how this telecommunication devices can be enhanced, to perform extraordinary operations,in tandem with biochips in the human body .Tele health systems can be designed to correct minor bio errors in the body just like a modern day auto diagnostic tool is designed to correct an auto error. The role of telecommunication technology in health care delivery cannot be overemphasized especially in the face of the ever increasing pandemic cases across the globe.

Keywords: Telehealth, DNA computing,COVID-19,Goppa code.

1. INTRODUCTION

Specifications for new forms of communication technology are constantly changing. Telecom companies have taken a more robust and holistic approach to health informatics, biomedical engineering, and illness diagnosis and treatment. The term "telehealth" describes a new medical practice made possible by technological developments. The phrase "telehealth" was created by merging the terms "tele" and "health." The term "tele" denotes "to" or "at" a distance, whereas "health" refers to the absence of disease, according to the Revised Oxford Dictionary of Contemporary English[1]. According to a survey conducted in 2013 on the improvement of relevant technologies in the health sector, the value of wired and wireless technologies was predicted to be over the US $ 250 billion in 2010. Many modern medical practices use wired and wireless technology, including in-depth imaging, in-vitro diagnosis, and in-vitro therapy. The rapid development of biomedical practice in health delivery is made possible by technological advancements in communication systems.

Thus, "telehealth" refers to electronic communication technologies for medical care, including diagnosis, monitoring, and treatment. This allows medical professionals to give treatment to patients without ever having to touch them. Data sharing between hospitals and clinics via an electronic network is used in various medical settings, including remote surgery robot control, distance education, and small seminars and meetings. Modifying a medical device's software and performing updates remotely. These examples only scratch the surface of how healthcare providers might utilise wired and wireless networks. There may be an online health conference with specialists and stakeholders discussing pressing health concerns. New healthcare technology has altered the traditional model of home care. E-mail, the internet, and smartphones are just a few examples of the ubiquitous technology that enables remote health monitoring in the modern day. Broadband connections, whether wired, wireless, or otherwise, allow the transmission of high-definition video and audio signals. Researchers predict that future iterations of telehealth tools will significantly advance remote sensing capabilities. Technological advancements will facilitate patient-provider communication in wireless connectivity and digital processing. Wearable metres and monitors will enable continuous monitoring and frequent testing to be feasible. Self-care in the medical realm is aided by telehealth technology, and already-established healthcare advocacy initiatives also benefit. A patient's vitals and responses to stimuli can be tracked using cameras and sensors. As a result, patients no longer need to physically attend the hospital because monitors can transmit various data to doctors from afar. People may use these technologies at home as reminders to take their prescriptions, check their blood pressure, get a physical, or schedule a follow-up visit.

Telehealth has become increasingly popular due to the public outcry and large push for social isolation in reaction to terrifying deadly illnesses like the Coronavirus.

As a result, on March 17, 2020, the Centers for Medicare & Medicaid Services (CMS) urged health care providers to use telemedicine as an alternate method of delivering treatment in basic, secondary, and tertiary hospitals throughout the globe in the face of the coronavirus. In addition to the advantages above, choosing telehealth as the primary method of health delivery[2] also has additional significant advantages. One or more of the benefits include:

A. Management of scarce resources:

In the face of dwindling economy around the globe, there have been hikes in transportation fare, lack of mobility. Most times the medical staff will be lodged in a hotel for days, at the expense of the patient. Moving a patient to meet a health personnel, involves a lot of financial commitment and logistic. Besides this, rolling plan of various nations has witnessed a tremendous decline in budgetary allocation in the health sector. Decreased funding can be addressed by use of telecommunication means to diagnose, treat and monitor patient. Thus the use of wired and wireless systems such as video conferencing tools will reduce the transportation and accommodation expenses**[3].**

B. Increase in banditry and terrorism.

The surge in criminality in recent times have made road, seaways and waterways to be a nightmare for travelers.Travellers are kidnapped on transit and are only released in exchange for ransom. Recently in Nigeria, over 150 passengers enroute the southern part of that country through a rail system were kidnapped and whisked away to unknown destination. Among the hostages were medical doctors and nurses who were on a medical assignment. Such negative occurrence could have been averted, if the medical personnel have used remote technology (wired and wireless devices) to reach their wider audience.

C. Rising epidemic:

Long ago, a wise book predicted ": There will be enormous earthquakes, and in one location after another, food shortages and plague" (Luke 21:11). In this sense, pestilence refers to a very lethal epidemic disease[4]. Thus, it was predicted long ago that deadly illnesses would produce an unprecedented spike in global mortality rates.

According to the latest data from the World Health Organization (WHO), as of 5:03 pm CEST on August 17, 2022, a total of 589,680,368 confirmed cases of COVID-19 have been recorded, along with 6,436,519 fatalities. By August 9, 2022, a total of 12,355,390,461 doses of vaccine had been distributed[5]. This data from the WHO dashboard so supports the projected increase in mortality. Because of many illnesses' contagious nature, in-person treatment and diagnosis must be discouraged. In a recent analysis, UNDP estimated that as many as 180,000 healthcare personnel had lost their lives to COVID-19. The combined populations of Monaco (38,300), the Marshall Islands (55,500), and Nevis (52,823) don't even come close to this total. This suggests that the CORONA virus has killed off the whole population of three countries. The telehealth industry promotes isolation as a treatment because of telemedicine to prevent the transmission of sickness.

D. Care Giver connection:

Sick ones always require family members who will always be by their side, to answer questions from health workers and attend to their personal need. Since these care givers may be engaged in other secular setting, they can still use one stone to kill two birds. They can connect virtually in remote medical session or video conferencing from any part of the world and still give patient information, which may be required by the health personnel.

E. Holistic medical estimate

Telehealth offers a unique advantage to health care vendors, to check how their patients adapt to their immediate environment (home).Neurologist studies the immediate environment and suggests to the patient the best therapeutic approach to take. Also allergists use the surrounding of a patient to get an idea of a patient's allergic details.

F. Time:

Travel time is removed, since the health provider can attend to the need of the patient at the comfort of his home.

2.LIMITATIONS OF TELEHEALTH DEVICES

It is true that every area that has a merit must also have a demerit.Telehealth also has its limitations as discussed below;

Emergency situations may arise and which requires in person attention. Just like we may have Emergency situations in physical setting, they may also occur virtually. In such situations the health personnel may be handicapped to handle the emergent situation since the patient is far from him.Moreso ,telecommunication have created two distinct groups in the use of wired and wireless systems. The “digital natives” and the “digital immigrants”. The digital natives are the people mostly young ones ,who were born into the digital age and have inborn ability to operate telecommunication devices and software while digital immigrants are a set of people usually old people who have little or no experience in operating this electronic devices. Thus challenging situations may arise when a patient does not have the IT skills to handle these devices. Most times patients are old people, who may not have the requisite ability to follow through a remote session .Patient recovery is attributed to a close relationship between the health care provider and the patient. There is a weak bond of relationship when the two parties are far away.Telehealth does not guarantee that patient – provider attachment (PPA).For effective communication to take place, good internet connectivity, and broadband connection, broadband mobile communicating technology of 4G and 5 G improves the audio and video quality. Thus, data is required for an efficient broadband connectivity. Data comes with its cost and in most cases, huge amount of data is required in remote control, video conferencing and audio calls. A person, who designs, assembles or maintains a telehealth device maybe referred to as a telecommunication/biomedical/computer/electronic engineer. The kind of responsibility saddled on a telecommunication engineer requires that he or she develops the following skills:

The capacity to merge engineering and health (medicine): It is vital that professionals in this field imbibe the lessons about the medical field and combine same with engineering concept ,by imitating biological models aimed at their prototype.

The problem solving and decision making skills: Technocrats in this field must develop problem solving skills. In the course of his duty, a telecommunication engineer may encounter a challenge that is life threatening, thus his decisions must be reasonable and timely.
Design and innovation skills are also one of the cardinal skills which should be possessed by a telecommunication expert. It involves the skill of designing and creating innovative devices that contributes to the development of treatment methods.
Logical thinking skills are another vital skill that should be possessed by a telecommunication engineer. With these skills, he can develop and master critical

thinking skill in order to navigate recent innovations away from errors. The market is flooded with various telehealth devices and software whose mode of operation is dependent on electronic principles. Accordingly, medical devices can be classified into the following: diagnostic and therapeutic equipment; instruments and supplies; ancilliary equipment and special service devices. Over 95 percent of these divisions of medical devices are made up of either wired or wireless components or add-in. They include the following: mobile phones, thermometers, digital otoscopes, digital ultrasound, wireless scales, pulse oximeters, digital cameras, and medical watches. Others include software such as AnyDesk, team viewer and zoom. The new USB WIFI portable handheld color Doppler ultrasound linear/covex probe which will be discussed extensively in this paper, has unique feature embedded in it, which can be used on remote basis. It is most suitable for POCT, outpatient, emergency, ambulance, hospital ward inspection ,community clinical and outdoor inspect, anastecia, ICU, intervention tumor, catheter.Through the wifi+usb on the handheld ultrasound,a patient can transfer images of his internal organ to a doctor who is thousand miles away from him. The visual image is not limited to abdominal, lung, kidney, urology, obstetrics/gynecology, superficial, small parts,MSK, breast, thyroid and vascular. The patient can place the probe of the ultrasound, on the affected body part. Through internet connectivity, the doctor can monitor, scan the patient's body many miles away.

Telecommunication devices that are used in healthcare delivery are grouped basically into four based on their mode of operation and output

A. Visual telephony:

Video telephony consists of both wired and wireless systems for coding and decoding sound and visual signals by the health provider and the patient at different places at the same time. This form of communication is useful in attending to handicapped such as deaf and speech impared persons.

B. Real-time devices:

These are mostly wired devices that connect the user and the heath worker on real time bases. The health worker listens to the voice of the client, monitors his or her reactions. Example of such real time wireless devices is videoconferencing tools which have proved useful in areas of diagnoses, patient monitoring, counseling, interviews, training etc

C.Remote treatment:

This is basically the beauty of telecommunication devices which enables medical professionals to monitor a patient remotely, using different telecommunication systems. Usually the health worker has access to the body of the patient, when tranducers in the form of probe or sensors are attached to the part of the body under examination.A typical example is the use of AnyDesk application and handheld Doppler ultrasound to check any internal organ of the client.

D. Save and Send:

The patient takes the medical data at his/her location and forwards the images or biosignals and then transmits the data to medical personnel via the internet. Then the medical personnel now take a convenient time to access and analyse the data sent by the patient.

The ingenuity of telehealth is applied in various medical fields which can be categorized into telenursing, telepharmacy, telesurgery, teleophthalmology, teledermatology, teleradiology and telenutrition.

3.TELEHEALTH APPLICATIONS

Cloud Computing is a unique bank that offers a wide range security, reliability, confidentiality and adaptability of digital storage facility. Thus, in the event of loss of patient's data, it can still be retrieved through cloud computing**[6].** Cloud computing is a panacea, that intertwines powerful computing with multifaceted healthcare information. Mobile devices accept signals from the individuals body and perform preliminary digital diagnostic task, then the huge complex task are processed on cloud servers ,which are more secured and easily accessible .Cloud computing has a unique feature called cloudlets technology , which is a connects mobile devices(computers, android phoes,medical watches,laptops,tablets) and remote cloud servers ,by enhancing work allocation, computing resources and the man time spent in retrieval, processing of data.

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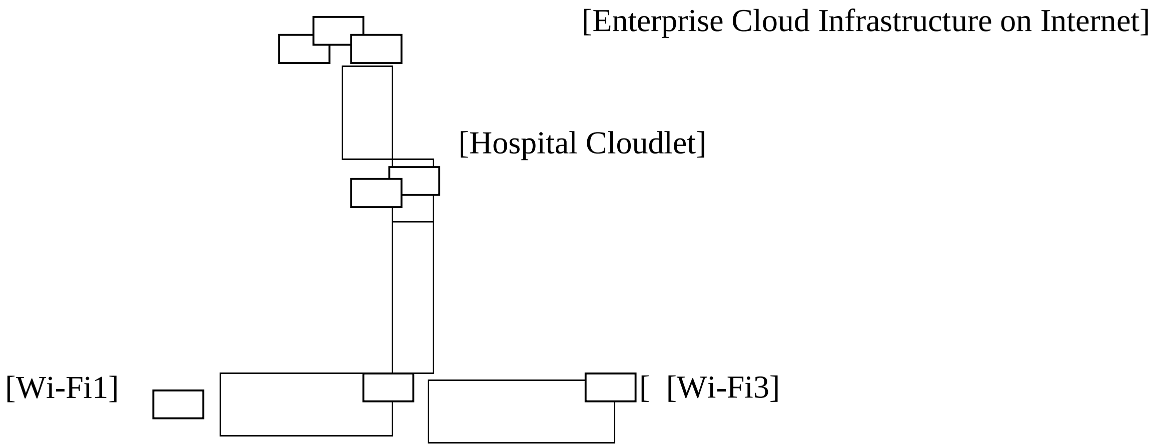

Cloudlet telecommunication technology

Telehealth software operates on the principle of enormous computing and signals, in addition to non –static data in a health facility. Mobile cloud offers the vital electronic resources, at the convenience of the user and the healthcare provider, through cloudlet technology. Cloud computing also offers data management architectural platform, for smooth operation of telehealth software thereby reducing financial restraints and increasing system functionality. Cloud computing has immensely contributed to heath informatics and disease surveillance and control , by empowering health policy makers, with database required to carry out real –time data constraint. International organizations such as WHO leverage on cloud computing, to gather data about sensitive data such as mortality rate (birth and death) on a global scale.

Integrating Cloud computing architecture with hospital administrative data platforms, assists in accessible complex integrated analyses, thereby ensuring judicious use of resources, reducing admistrative bottleneck and enhancing the accuracy of medical records. Cloud computing support system, assists in up-to-date algorithm and already existing online platforms for a well structured robust telehealth experience.Advances in cloud computing (telecommunication) have transformed the existing landmark in healthcare practice.

A practical example of immense benefit of cloud computing is the zenysis platform,which articulates advanced analytical systems and big data .Zenysis is applied in therapeutic algorithm, health promotion evaluation, survilance data , patient EMR data, and medical diagnoses.

WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
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Telehealth software

Telecommunication and software engineers have developed computer applications that are significant in medical field. The rising trend in disease outbreak has led state actors to adopt need assessment initiatives, geared towards ameliorating the endemic and pandemic. Medical software are not limited to Any Desk and teamviewer.Software for health vendors using electronic components like wired or wireless means ,to encode and decode information between health providers and agencies both in accessible and non-accessible areas and to exchange data on how to eliminate or reduce infectious disease. We also have software that monitors a patient's movement in line with geologically based features. Virtual chat bots that engage and monitor COVID- 19 patients virtually. The recent development of a robot nurse that attends to aged ones in old people home attest to the fact that software are really defining health delivery. The operation of the robot nurse is based on the principle of programs that have been intertwined in the hardware that makes up the robot. Robotic telehealth software with add-in component such as cameras, which are conveyed to quarantine locations for patient monitoring .Virtual doctor software which requires that a patient responds to a directed question about inherent signs in the body and the patient, is directed on what to do in order to get well**[7].**

Teledietitics

Telecommunication plays a significant role in patient nutrition matters ,by the use of video conferencing on interactions between a nutritionist and a client. The client through a teledietics platform, uploads important data which the nutritionist analyses. Then the nutritionist reaches a professional conclusion on the patient and follows through on the client improvement level. Also remote sensing activities on both parties are possible through this videoconferencing platform.Teledietics have been immensely supportive during the severe attack of COVID -19.In the face of rising causalities from the dreaded disease, health personnel kept safe by reaching out to the elderly ones on nutrition matters through telecommunication tools.

Telenursing

This is the means whereby telecommunication is used to provide nursing services, with a huge distance existing between the nurse and the patient. Also in this group are robotic nurses that were developed in Japan recently, which renders services that human nurses can provide. This humanoid as they are called have been programmed to walk, talk and behave like nurses.Telenursing serve various purposes ranging from saving time spent in travelling to meet a patient, remedy to inadequate nurses and helps to decongest the hospitals of patient. A typical example of telenursing is the Google glass breastfeeding software which empowers nursing mothers to take care of their babies professionally by following and watching about emerging issues in breastfeeding, reach out to pediatrician through a secure goggle handout who can also monitor the nursing mother through a camera. This giant move have really reduced the cost of healthcare and wider coverage of locations (overpopulated, low populated area, rural and urban setting)

Telepharmacy

This is another emerging field where telecommunication is used to convey drugs to patients in a given area which cannot be easily accessed by a pharmacist. The activities that are grouped under this branch of telehealth include drug therapy surveilance, client counseling and guidance, refiil authorization for prescription of drugs, evaluation of drug formula compliance through videoconferencing .Telepharmacy also covers remote dispensing of medications by system driven packaging and labeling devices .

Teleophthalmology

This is the use of wired or wireless software enabled devices to effect eye care solutions .Modern ophthalmology practice involves remote care and diagnoses ,diagnoses and evaluation and distance learning. For instance in far away Mizoram, India, a province in India with poor road network, teleophthalmologist provided services to more than 10,000 people via telecommunication devices. These clients were diagnosed by local ophthalmic assistants but complex medical attention was done on appointment basis after the electronic images were virtually viewed by optometrist in another location. Thus the travel time was reduced from an average five trips to only one that was required ,for the complex medical attention.Teleophthamology also offers a patient the advantage to complete a virtual examination .Consultations over a given distance using telecommunication means have been noted to improve service delivery, accessibility of professional attention, and overall feedback mechanism from the patient.

Telepathology

It is the system of carrying out pathological processes over a given distance through telecommunication means. Telecommunication assists in the transmission of visual pathological data over a long distance for health promotion or disease diagnoses. The

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procedure is in the form of a pathologist selecting a visual picture for diagnostic and analytic purposes.

Teleradiology

This is a means of sending radiographic images such as the X-rays or MG from the location of a client to that of the healthcare provider through a wired or wireless technological device. To make this possible, three telecommunication devices are needed: Station 1(sender, transmission network and station 2(recipient) ,The two stations must be connected via an internet based network with a strong broadband width. Station 2 which receives the encoded signals must have a high-quality monitor, which must be tested before for functionality before real time activities. Besides that station 2 may have a peripheral device in form of wired or wireless printer, so that the picture can be painted for future use. High-speed broadband based internet such as the newest 5G have enhanced the operation of teleradiology.

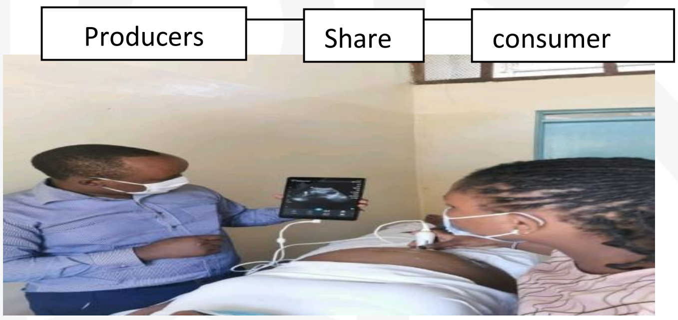
Telepsychiatry

This entails a platform that gives a wide range of opportunities to a health care provider and a client. Such opportunities include therapy management, clinical programs, and monitoring diagnoses and follow up. Real time telepsychiatrry, has enhanced the conventional means of treating mental illness practiced many years ago. Research of telecommunication gadgets for patients staying in inaccessible areas such as war torn areas, shows that virtual treatment of depression and traumatic stress , far more outweighs the in person means of attending to client with such problems**[8].**

Technical research question

What is the system design flow of wired and wireless system (telehealth devices) and how can it be improved with bio chips(DNA computing)?This question is discussed in the method segment of this paper

4. METHODS

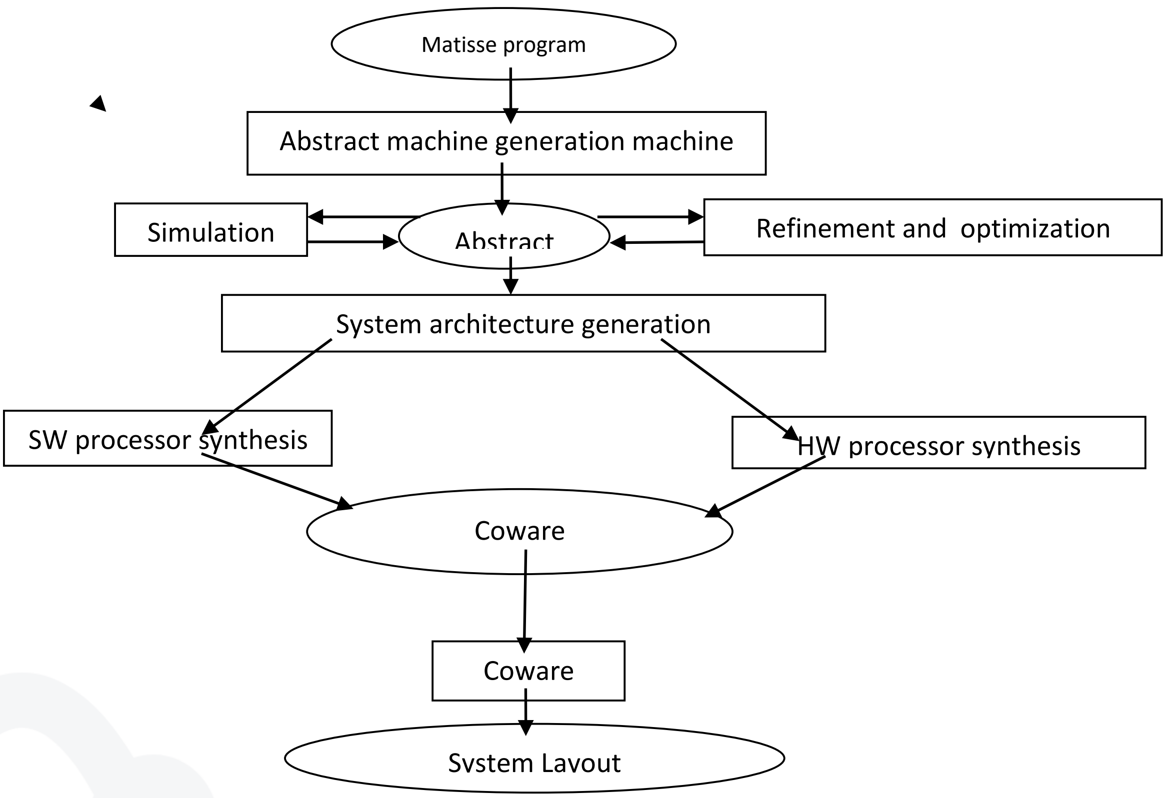


The impact of telecommunication in health sector can be demonstrated with the new USB WIFI Portable Handheld Color Doppler Ultrasound Linear/Convex Probe. This is an Innovative design in 2020, both with USB and WIFI connect to Tablet, which is a prototype of a wired and wireless form of telehealth device. The smallest color Ultrasound probe, most suitable for POCT, emergency, ambulance, hospital ward inspection, community clinical and outdoor inspect, anesthesia, ICU, intervention tumor, catheter. It provides a visual image during any clinical procedures. Some of the outstanding features of this telecommunication masterpiece are highlighted below: WiFi + USB Connection for more stable transmission. Built-in battery, when connected to WiFi, it can be charged while working. It can be integrated into other medical devices.Model: U5C.,Scan Mode: B, B/M, B+Color, B+PDI, B+Pw.,Frequency: 3.5/5.0MHz .WiFi type: 80.11n/2.4G/5G. USB type: Type CImage/Video. Storage: Storage on the Tablet PC. Power: Built-in Lithium battery, Replaceable.Battery Working Time: Average of 4 hours, according to scan Mode. Working System: Android/iOs/Windows**[9].**

System design flow of conventional systems

A framework to assess options and limit the cost of backtracking from bad choices is essential for any systematic approach to designing a system consisting of parallel processes accessing common data. Matisse is widely used as the standard for electrical design flows. Data types are used in the Matisse model to define the framework of the system. Matisse may be thought of as a system of interconnected, virtual processing items that communicate with one another, and this internal representation is what makes up the abstract machine. An abstract machine is generated as part of the process from the original Matisse program, which is utilised as an internal representation throughout the system design cycle. This abstract machine allows for the exploration of designer-independent, time-efficient system design [10].

A Model of the System: The Matisse model is a simplified version of the concept underpinning compositional C++(C++), and it fulfils the requirements described below. C+++ is an extension of C++ designed for describing concurrent applications that will execute on a cluster of computers using an advanced operating system (OS)[11]. On the other hand, Matisse is designed to describe concurrent processes that will execute on a combination of embedded software and hardware processors via an ultra-light operating system. The Matisse model views a system as a collection of independently running data-accessing tasks. Matisse tasks are only created once, at system startup, and then run in parallel.



5.DNA CONSTRUCTION AND INTEGRATION IN CONVENTIONAL SYSTEM MODEL

In Various DNA Code Constructions, we discuss some code design considerations and offer some building examples relevant to DNA computing. Our primary attention is on cyclic code constructs because of the ease with which they can be tested for secondary structure development and the reduced complexity with which DNA sequence synthesis can be accomplished. DNA codes benefit from a large minimum Hamming distance, a large minimum reverse-complement distance, a constant GC-content, and the introduced shift properties[12]. The codes discussed here are intended to have many of these features. There is a great deal of leeway in the code constructions that may be used, so we pick a couple that are easy to describe and provide sufficiently big codes. Limitations in checking for secondary structure in the code design lead to sub-optimal codes for the code word cardinality criterion[13].

5.DNA Codes Derived from Extended Goppa Codes That Are Cyclically Reversible

Based on extended Goppa codes over a finite field, we will explore a more general technique that enables the development of vast families of DNA codes with a

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guaranteed minimum and minimal reverse-complement distance GF(2^2) [28]. Remember that a C-code is considered reversible if and only if $c \in C$ implies that $c^R \in C$. If the generating polynomial of a cyclic code is g(z) is self-reciprocal, i.e., $z^{\deg(g(z))}g(z^{-1}) = \pm g(z)$**[14].** Given an [n, k, d] reversible cyclic code, C, over GF(2^2) Code C, derived by removing all the reversible codewords, is the shortest possible code, with the least distance d. (i.e., codewords c such that $c^R = c$), and then picking a random codeword from the remaining half in such a way that no codeword and its antonym are picked at the same time. Cb is a nonlinear code with r nonzero bits if and only if C has r self-reversible codewords (4k − r)/2 codewords of length n, and furthermore, $d_H(C) \geq d$ and $d^R{}_H(C) \geq d$. The value of r can be determined easily**[15].**

Theorem 1: There exists q in every k-dimensional reversible cyclic code over GF(q) [k/2] Codes that can be deciphered by themselves.

Proof. This polynomial a(z) = a0 + a1z +... an1z n1 is self-reciprocal if and only if the codeword a = a0a1... an1 is reversible. Let g(z) be the code's generator polynomial, with the property that a(z) = ia(z)g(z) for every polynomial ia(z) with degree no greater than k 1. Self-reciprocity between g(z) and a(z) implies that ia(z) is self-reciprocal (z). Thus, there are exactly q[k2/2] possible values for the coefficients of the dk/2e least-order terms z I I = 0, 1,..., dk/2e 1. This means that the value of ia(z) is defined uniquely by these terms. ut 14 By associating GF(22) with the DNA alphabet Q = A, C, G, T,' it is possible to view the code C described above as a DNA code. Let D be the code derived from C by replacing the first bn/2c symbols of c with their Watson-Crick complements for each c C. D and Cb both have the same number of codewords, and dH(D) is smaller than d. Moreover, it is simple to demonstrate that if n is even, then d RC H (D) = d R H(Cb), however if n is odd, then d RC H (D) may be one less than d R H(Cb) (Cb). The equation d R C H (D) d1[16] holds true in any circumstance. We apply the above technique to a family of reversible, cyclic extended Goppa codes. Initially, we think back to what a Goppa code is and how it's defined. Let L = 1,..., n GF(q m), where q is a power of a prime and m, n is a multiple of Z+. To illustrate, consider the polynomial g(z) of degree n over GF(q m) which does not have a root in L. All words (c1,..., cn), ci GF(q), where Pn i=1 ci zi 0 mod g, make up the Goppa code, (L) (z). (L) is a code with dimensions between k and n, minimum distance between d and m, and length n [17]. The foregoing definition of a polynomial yields the term "Goppa polynomial," which is shorthand for the polynomial g(z). Codes called Goppa codes will be considered, which are based on Goppa polynomials of the type g(z) = [(z 1)(z 2)]a, where an is an integer. There are two possible sets of coordinates L for the roots 1, 2: I L = GF(q m), with 1, 2 GF(q m) such that 2 = qm 1, 1 = qm 2, and n = q m; and (ii) L = GF(q m), with 1, 2 GF(q 2m) such By adding a global parity check to (L), it was proved that the extended Goppa codes generated in the aforementioned circumstances are reversible and cyclic [18]. This holds for any choice of g(z) and any ordering of the location set L fulfilling I + n+1i = 1 + 2. Although the length of the extended code is still a multiple of (L), the smallest possible separation between any two points is now at least 2a + 2. By using the DNA code construction to this type of family of extended Goppa codes over GF(4), we are able to prove the following theorem. There are cyclic DNA codes D for any positive integers a and m such that dH(D) 2a + 2 and d RC H(D) 2a + 1, with the following parameters: I length n = 4m +1, and number of codewords M 1 2 (42 2m2ma4 2 2m1ma); (ii) length n = 4m 1, and number of codewords Let L = GF(22), where q = 22 and m = 1, and where the primitive elements of GF are 1 = and 2 = 4. (24). Since a = 1, we define the Goppa polynomial as g(z) = (z 1)(z 2) [19]. With these values, we obtain a code of length 5, dimension 2, and minimum distance 4. This code is an extended Goppa code over GF(22). We list the GF(22) elements as 0, 1,, 1 +, and we specify that 0 is G, 1 is C, is T, and 1 + is A. The DNA code D created 15 as described in this section consists of the six codewords CGTTC, CAAAT, CTCCA, GCCTT, GGAGA, and ACTAA, and has dH(D) = d R H(D) = 4 and d RC H (D) = 3.

7.RESEARCH WORK ON HOW TO ENHANCE TELEHEALTH DEVICES

This research presents an innovative approach to enhancing the real-time performance of such communication networks. DNA computing, when used to develop telehealth technologies, can help attain this objective.

DNA computing is a branch of electrical engineering that proposes replacing silicon chips with biochips to perform logical and arithmetic operations utilizing the molecular characteristics of DNA. Information critical to an organism's continued existence is kept in the DNA of each of its cells. Each cell has nucleic acids (deoxyribonucleic acids) that are responsible for storing the genetic information of that cell (DNA). DNA molecules consist of millions of paired nucleotides, which coil into long, helical structures[20]. The nucleotide consists of four nitrogen bases, a five-carbon sugar, and a phosphate group. The nitrogen bases (adenine, thymine, guanine, and cytosine) receive the genetic instructions, while the other bases are responsible for the structural integrity of the molecule. According to the base-pairing rule, which links the strands together, T pairs with A and C pairs with G. The order in which these nucleotides appear is critical since it defines how important particular genes are. Because of this, difficult mathematical equations and issues can be solved quickly in the future using parallel computation.

The DNA replication process is self-sufficient, meaning it can complete the computation with significantly less hardware than conventional computers. It takes a creative mind with a firm grasp of both biology and electronics to build a dependable algorithm that can be carried out in DNA[21]. Instead of using binary digits as older computers do, data will be stored in bases T, G, and C. Synthesized DNA sequences can be utilized in place of natural ones as inputs to algorithms. DNA computing, often known as "wet" or "molecular" computing, uses the reaction of DNA molecules to perform the computation. DNA computing is the latest innovation in bioinformatics. We use the term "bioinformatics" to refer to the computational study of molecular biology and genetics. Computers store and analyze data, most often nucleotide sequence data for studying regulatory regions of genes and amino acid sequence data for studying functional domains of proteins. Gene sequence comparisons are utilized to get insight into divisive medical areas like gene editing. Single-or double-stranded DNA is a polymer of building blocks called nucleotides. A nucleotide consists of a nitrogenous base, a sugar with five carbons, and a phosphate group. Phosphate is attached to carbon five and then carbon three. Because of this, the DNA strand can be oriented in a particular way[22].

More research into DNA hybridization computing circuits is required.

This requires input components to work together with billions of nanoscale DNA gates to generate signals. Numerous DNA motifs have been used in numerous proposed designs for logic gates and Boolean circuits. The Rochester team's DNA logic gates are a stepping stone toward developing a biological computer with the functionality of a modern personal computer. DNA logic gates replace electrical signals with genetic information to perform logical computations. They take in segments of DNA, dissect them, and then produce a coherent whole. The genetic "and gate" combines two DNA inputs into a single molecule with a closed loop at both ends[23]. Combined with DNA microchips, these logic gates may pave the way for significant progress in DNA computing. Therefore, molecular diffusion or interaction can power localized hybridization circuits based on a solution. Therefore, DNA strands can be used in conjunction with telehealth devices to facilitate disease modelling and treatment.

With the advent of the digital age and its attendant proliferation of communication devices, silicon electronic part production and photolithographic techniques have declined and have become prohibitively expensive. On the other hand, molecular computation does not have any of these restrictions. DNA computing also holds great promise for enhancing the efficiency with which biological signals can be decoded and interpreted. Traditional communication technologies are limited in their ability to decode signals from complex systems like living cells. For example, the USB digital handheld ultrasound displays images of internal body organs on the monitor as the probe moves over the body's surface. Still, it can't treat all medical conditions with electrical impulses. A mobile laptop can be compared to medical diagnostic equipment (modern digital cars). An error code will appear on the screen when a problem arises in a modern digital vehicle. A mechanic will use a diagnostic scanner to determine what's wrong with an electronic car. With the car already running, the mechanic hooks up the diagnostic tool to the 16-pin connector under the steering wheel and starts the engine to read and diagnose the technical problem. The diagnostic device can receive signals from the ECM's sensors. Notably, the diagnostic tool has improved systems that detect technical faults and clear such errors [24], so it can fix most technical issues with the mobile laptop right away.

These capabilities inherent in a vehicle diagnostic tool ,are not found in human electronic diagnostic tools ,because the probes are not empowered to treat some ailment, just like the auto diagnostic tool can clear a technical fault. To fill this missing gap in telehealth devices, this paper tries to reawaken the minds of electronic and telecommunication engineers on the need to understudy the concept of DNA computing.DNA and nucleic acids have tremendous benefits to offer to wired and wireless diagnostic devices as stated below

A. They accommodate a huge array of electronic operations through familiar enzymatic reactions for manipulation of body cells.

B. Varied methods like FRET,AFM imaging and plasmonics, are inherent quantifying DNA nanostructure.

C. It allows for specific and controllable biological environment.

D. Their structures are much more determined, when compared to proteins

E. They convey information encoded in cell sequences.

F. Alteration can be made to living cells through well connected electronic components.

G. DNA computing solves complex problems (massive parallel processing) which is in contrast to conventional systems that solve problems in a step by step manner or sequentially.

H. DNA computation evolved as a hard task that needs assessment by biomedical engineers but has since had immense benefit to telehealth.DNA devices is exceptionally needed as biosensors for molecular detection, cell alteration, structure determination, and as a means for drug delivery. Communication between living cells and a telecommunication system can be faster and efficient for curing diseases; if DNA computing is well structured during the design of such systems.DNA can be engaged in carrying out complex nanofabrication sequences. Lattices and non-periodic structures such as smiley face have been designed through the concept of DNA computing. Thus structures in form of scaffolds are used to place gates, transistors at exact point. Programmable self-assembly of DNA supports bio-chemical circuits that can carry out the synthesis and alteration of cell structure**[25].**

8. RESULTS

DNA computing ideas have been embedded in the design of telehealth equipment, as demonstrated by feasible algorithm computations.

DNA computing is data processing using DNA molecules as a computer processor rather than the usual silicon chips. Recently, DNA computing has been used in the academic community to analyze and address difficult issues. Yet, despite this, it isn't easy to grasp. This paper explains DNA computing in layman's terms so that even a novice may follow along. Computing with DNA is sometimes referred to as molecular computing. It's computing with molecular information processing power instead of traditional digital hardware. It's a computer strategy that doesn't rely on silicon. It has been proved that DNA has enormous processing capacity, which could allow a DNA-based computer to quickly and accurately tackle even the most difficult problems. Leonard Adleman first introduced the idea of using DNA in computations in 1994. He employed DNA to solve a miniature version of the travelling salesman problem to determine the most time- and cost-effective way to visit seven locations linked by fourteen separate one-way flights. Adleman's solution to this issue involved making DNA strands to stand in for each aircraft and then combining them to make every feasible route. Adleman's writings have sparked innovation in fields far and wide. It ushered in a paradigm shift in the history of computers. Chemistry, molecular biology, computer science, mathematics, and technology have joined together to form the interdisciplinary discipline of DNA computing.

DNA, or deoxyribonucleic acid, is a crucial component in DNA computing. It permeates every single one of our cells. It is a medium for storing the DNA code that determines the characteristics of every living thing. Nucleotides are its building blocks, and they feature four distinct bases: bases A, G, C, and T for adenine, guanine, cytosine, and thymine (T). A and T, or G and C, are complementary pairs. Every single living thing has its own set of nucleotides and a special arrangement of those nucleotides. In this paper, we establish the following definition for the complement operation: G, and A, C T, T A C. A, G, C, G, and T form a sequence that can be thought of as DNA strands. The problem is encoded in DNA sequences, and the computation is simulated using biological processes.

For instance, a length of one strand with the base sequence TAGCC will bind to a segment of the opposite strand with the base sequence ATCGG. A piece of DNA can be compared to the tape in a Turing machine. Double-stranded DNA consists of two identical long strings coiled around each other. DNA computers do their calculations by synthesizing DNA and allowing it to react in test tubes. DNA can be synthesized, allowing for the creation of specific strands; segregated, allowing for the sorting of strands by length; and merged, allowing for the joining of two distinct strands by simply pouring their contents from separate test tubes into a single one. DNA can be: - isolated by isolating strands with the desired sequence - melted or annealed to separate or bond molecules with complementary sequences - amplified by having multiple copies made - cut by using restriction enzymes - recombined using "sticky ends" - detected to confirm the presence or absence of DNA i. Pieces of DNA and a few enzymes make up the input. (Enzymes perform certain cellular tasks.) The result of these manageable biological processes is DNA strands. A DNA computer takes in DNA and spits out DNA as its input and output. Computing with DNA is similar to parallel computing because it uses several DNA molecules to test multiple hypotheses simultaneously. DNA libraries, also called DNA codes, are needed to conduct DNA computing. DNA computing might theoretically outperform conventional digital computers in terms of speed. The usage of natural enzymes, which only work on specific sequences, is a present bottleneck. The DNA computer is still in its early stages of development and can only execute the most basic tasks at this time. The quantity of memory needed to generate answers to even trivial issues may be prohibitive. Some methods for carrying out elementary operations, like logical or arithmetic operations, are required to apply DNA computing to a broad spectrum of issues. DNA computing research is still in the proof-of-principle phase. At least a few years will pass before it may be used in the real world[26].

9. DISCUSSION

Challenges of fully adopting telehealth around the globe

Irrespective of the numerous benefits accruing from telehealth devices in healthcare delivery, there are factors which tend to discourage large scale adoption of teledevices.A typical limitation is the cost of acquiring these telehealth devices. According to a report in the New York Times, a humanoid which attends to elderly people in old people's home in Japan cost a whooping sum of 3,962 dollars. The handheld digital ultrasound which was highlighted in this paper cost over $2000 .Thus an average hospital may find it difficult to purchase these telecommunication devices, let alone an average poor individual in a remote area.

There is limited knowledge on how to use telecommunication gadget among the larger population on earth's surface today. Sometimes there is weak internet connectivity in remote areas, thereby making the reception of both audio and visual signals difficult. Nations of the world should borrow a leaf from the people of China and build more anticipation and emphasis on telehealth devices. China's first robust five year framework for the health sector ,sets out clear target for 2021 and states that at least 70 percent of the total telehealth technologies used in China ,must be domestically produced in China. This offers an incentive to the country, which as well boosts the well being of the entire populace in China.

10. CONCLUSION

DNA computing is a new area still in its early stages, and its many potential uses have only just begun to be explored. It can supplement living cells in telehealth equipment, allowing for improved detection techniques. Adaptable molecular algorithms are on the upswing, which means a programmable tile set might be used to create a complicated structure at the nanoscale. The idea of developing solutions beyond silicon-based telecommunication devices' coverage is conceivable. It will give rise to many other applications and processes, but replacing silicon-based computers seems unlikely. Companies that produce computer chips are now working on the next generation of microprocessors, which will have improved functionality. A new prevailing paradigm will emerge at some point. Soon, the limitations of speed and downsizing for silicon processors will be reached, and bio-chips will take centre stage. DNA (deoxyribonucleic acid) molecules, which make up a gene, are essentially natural supercomputers, and millions are inside every human being. If used to their full potential, they could perform mathematical calculations at speeds far exceeding those of even the most powerful computers currently available. DNA integration onto a computer chip to produce a biochip will improve digital diagnostics and patient treatment. Evidence suggests that DNA computers can store billions of times more information than the wired and wireless networks now in use on Earth's surface. Suppose the human body is home to natural supercomputers. In that case, it will behove us to perform substantial work to integrate those biochips into telehealth devices, boosting their processing speed and other functionalities. Researchers and electronic engineers are working tirelessly to include more advanced features into today's telehealth equipment, ensuring a bright future for telehealth. Many benefits of health care delivery over telecommunications have already been highlighted. Travelling is less expensive and takes less time. Telehealth provides an alternative to the current shortage of health care providers. It promotes a policy of social distance, which has been shown to reduce the mortality rate among medical professionals. Telehealth also reduces the need to travel to a medical centre, which in turn speeds up the process of receiving treatment[27].

The evolution of communication technologies has been crucial in shaping the modern healthcare system.

In the face of the Corona epidemic and other disease outbreaks, wired and wired systems are a social distance strategy, as explained in this research. However, the work of communications and electrical engineers is not limited to merely disease diagnosis. Deterministic Turing machine models and silicon-based circuits form the basis of modern computers and communication devices[28].

The DNA computing model we propose will allow for a more holistic strategy for preventing and treating disease when completely implemented. To improve upon these current telehealth systems, DNA-driven sensors should be integrated into them. As a result, patients can use DNA systems to diagnose and treat biological disorders. DNA systems are expected to gradually replace older forms of communication technology. The exorbitant cost of medical care may be greatly reduced if the DNA computing concept were implemented in telehealth tools. Bio-inspired computing, artificial immune system, artificial intelligence, artificial neural network, cellular automation, cognitive modelling, emergent systems, fuzzy logic, genetic algorithms/programming, granular computing, neutrosophic systems, organic computing, and particle swarm optimization are all examples of rapidly developing tele-assisted fields that could benefit from more focused attention. Finally, a more robust telecommunications approach is necessary to completely fulfil the World Health Organization's millennium goal[29].

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