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IoT based Siddha diagnosis for human health monitoring

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In Siddha, the process of diagnosis is completely related to physical and clinical metrics of the human body. The art of diagnosing and the prognosis are conveyed by the siddhars by using silk or twine thread, which is an ancient technique followed till now to diagnose diseases in human. This paper proposes an IoT based automated device to detect the disease using siddha methodologies. The aim is to design a novel non-invasive device to identify human health problems using the carpus (wrist) circummetric sign. This device is developed and integrated on the basis of IoT platform for real time usage. It determines the wrist circummetric sign, condition of person health to be measured automatically using IR sensor, color sensor, actuators. Here, we inbuilt the embedded IoT system for validating the accurate results for better performance and display the output results in mobile through MQTT dashboard. This developed human health monitoring device can be used for diagnosing human physiological based parameters related to siddha which is termed as Manikadainool. Results proved that this device can predict the wrist parameters for Manikadainool in accurate and efficient manner.

Keywords: Circummetric sign, Disease diagnosis, IoT sensors, Manikadainool, Siddha

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The Siddha system is an antiquated medicine system that flourished in the Southern Indian state Tamilnadu as well as in Sri Lanka. According to the literatures, siddhars are well versed and have an intrinsic knowledge in many fields including astrology and treatment of aliments. Initially, the pillars for pattern of medicine were siddhars. They were spiritual masters with all the qualities especially 8 powers which is termed as *Ashta siddhis*. Siddha medicinal system has a unique diagnostic method for identifying each disease and their causes in the human body. Identification of caustative factors is through examination of pulse, urine, eyes, and study of voice[1]. Siddha procedure examines the complete system of the human as three life constituents and basic seven elements. Based on this, ectomorph, endomorph and mesomorph, the balance of the body is measured[2]. The Tamil system of medicine is widely used in the ancient Tamil nadu, and it was considered better and as foremost of all other medical system. The root of the Tamil medicinal system dated from 10000 BC to 4000 BC (Old stone age). It consists of the five aboriginals such as Panchamahabhuta (Earth, Water, Air, Fire and Space). Their pathology exists on ninety six Tatwas and in human body there exists 4448 kind of diseases which are formed by the improper arrangement of three life constituents (Vatha, Pitha and Kapha)[3]. These diseases could be classified under Kapha person, Vatha person and Pitha person with the ratio between Kapha, Vatha and Pitha as 1/4:1:1/2. Some phenomenal changes affect the stability of Kapha, Vatha, Pitha and those changes are due to environmental conditions, person's diet, human stress level and physical activities.

Figure 1 shows the timing of triguna for a person. The equilibrium of humors clearly results in the condition of disease and some imbalance in the person health. The nature of the body is correlated with the actions and the food which is consumed by a person. This was already quoted and sung by Saint Thiruvalluvar in the following lines,

Mikinum kuraiyinum noisaium noolor
Valimuthalav enniya moonru – verses 1

The verse 1 depicts the rise and fall of humor due to the rearrangement of three humors namely Pain (Vali), Cry (Azhal), Fear (Aiyam). From the point of Thiruvalluvar, the illness is known due to the variations in equilibrium of three humors[2].

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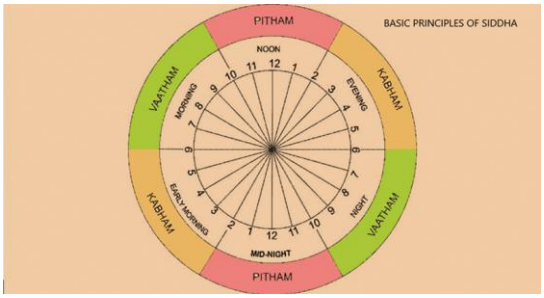

Fig. 1 — Timing of Predominance of Triguna

The prevalent happening in a person related to disease was well said in the verse of *Theraiyar* in his works*:*

Nokkarrenanadamaadinokkinadamidalam
Noddakkaararinaadinoddamozhikurallal
Novaiyarmaatharodu nova maruvuvathal
Nonpuvirathathipalanorkavarumelival
Nonchaijenavanukunuvunovavayiluvathal
Nondavari thenaverai nondiyaruthlal
Nonaathaveeramadinonavanikuthalanal
Noikalutpaththivakunoikalvinaivithaiyai
Noikalvinaipayalaimeinoikalvalarpajirai
Nojuthavupalanaakinoikalvekumelam
Nothakavuraiththanaminthnoikalaramela
Nojiniki lalar nonmaiyi thiniya. – verses 2

Literature survey

The distinctive detection methods in Siddha system mainly focus to mention the ailments and matter. The identification is observed using metaphysical state of the body that starts from physical examination.

***Meikuri Niram Thoni Vizhi NaaIru Malam kaikkuri* (*Theriyar*)–verses 3**

According to Saint *Theraiyar* in verses 3, the examination includes by his/her organ of sense and senses which were included in Theraiyar En vagai Thervu that is examination of Naadi (Pulse), Sparisam (Skin), Naa (Tongue), Niram (Colour), Mozhi (Speech), Vizhi (Eye), Malam (Faeces), Moothiram (Urine), Manikkadai Nool analysis etc.

"Naadiparisamnaanirammozhivizhi
Malam moothiramivaimaruthuvarayum"
- Theraiyar -verses 4

Among these Manikadainool analysis is a special non-invasive diagnostic method. In Sanskrit language, the word Mani termed as wrist protuberance, Kadai as the breadth of fingers and Nool known as the silk/twine thread. The practice of this circumstantial details mentioned in literary classical medical work done by Saint Agasthya (Agasthya Soodamani Kayaru Soothram). In olden times, pure silk thread was used to measure. Now the availability and standardization based on the characterization (stiffnes) of the thread has changed into twin thread. The circumference of the wrist measured using a silk thread or twine thread as mentioned in the verse by the Siddhar Agasthiar. For each measurement which is expressed in Viralkadai (finger breadth size) particular kinds of symptoms and diseases have been mentioned by him[3]. Hence, it greatly helps in the interpretation of diagnosis and prognosis of a disease. As per WHO reports, 17.9 million, 10 million, 1.8 million, 1.4 million and 1.5 million people die due to cardiovascular, cancer, respiratory diseases, tuberculosis and diabetes mellitus, respectively between the year 2019 and 2020[4]. Hence, by doing prior diagnosis, these diseases could be managed well thus preventing the serious effects. This *Manikadainool analysis* could largely help in diagnosing and treating a disease very well.

Based on the FBS (Finger Breath size) the prolongation of the disease was easily identified. Nowadays anthropometric measurements are to identify the nutritional level of an individual. So it is an important measurement indicator[5]. The indicators are well known by individual and easily obtainable predictors for the person usage by functional impairment and mortality[6]. In recent times the stage of diabetes and pre diabetes are demonstrated in modern anthropometric studies by using wrist circumference as a predictor[7]. The analysis of cardio metabolic risk factors[8], based on the wrist circumference which is made for the calculation of insulin resistance and chronic kidney diseases in elderly person[8,9]. The frame of the body size is differentiated by small bones with wrist circumference, with medium bones and also with large bones related to his/her height[10]. The traditional experimental practices in Siddha system had a unique anthropometric diagnostic practice which is '*Manikadainool*'.

Cloud computing offers on demand services to IoT devices and also to the clients. These cloud services run in hosts if they need any service it is directed to clients such as SaaS, PaaS & IaaS. Cloud IoT is used by the industries for connecting number of devices in the cloud for processing and performing analytics in real time. These devices are fully automated with accuracy using IoT services. Animal Livestock Management System (LMS) with inbuilt cloud IoT

services can monitor the health status of the animals in real time for diagnosing the decrease[11]. Automatic assessment of the animal body system is developed by the capturing the images of the cattle and performing evolutionary algorithm[12]. Here, authors used a technique to detect the health status of animals using the animal body parameters such as heartbeat, humidity, body temperature and rumination process using Zigbee based design[13]. IoT sensors based LMS have the features to monitor record and identify the animal using Unique Identification code[14]. The receiver is a wearable collar tag on animal neck, consists of sensors for the communication to mobile[15].

The deep neural network restricted Boltzmann Machine is used to solve the problem of congestion in IOT network. Using Matlab, the data set is used as an input to the machine learning which help in identification of congestion[16]. An android app based IOT provides the control of sensors and actuators of a robotic system by using wireless camera. Through Node MCU and Wi-Fi modules the tasks are stored in the cloud[17]. Machine learning and IOT also results in the high accuracy of predicting diseases in crop using smart sensing technique. The unhealthy crop is checked using multi spectral images linked with UAV. The model evaluated by various machine learning techniques[18,19].

The fundamental benefit of KNN in contrast to other algorithms is that it is applied for multiclass classification. However, it is not applicable for large dataset as it degrades the performance[20,21]. This proposed work utilizes ANN, which is a computational model and performs well in classifying large dataset. But, this work requires accurate solution, in order to predict the type of disease that an individual is affected. Therefore, optimization approach is introduced along with the classification technique.

The usage of ANN and Genetic Algorithm (GA)[22] in combination to find the best values, has been suggested in recent studies. Here, a trained neural network has taken the role of analytical equation for goal function. However, this necessitates manually adjusting ANN parameters, such as identifying buried neurons and layers. It took a lot of trial and error to get it right[23]. The Particle Swarm Optimization (PSO)[24] in which ANN attempts to link the viewpoints of genetic algorithms and evolutionary computation. Its main focal points are its simple implementation and concept, which do not call for expensive processing resources. It is commonly employed for continuous non-linear function optimization. Traditional techniques have three main drawbacks: they are difficult, they can't change to a new unknown environment, and they can't get through a local minimum[25,26]. The shortcomings of traditional methods are solved with the utilization of GWO approach, which provides accurate classification result when combined with ANN approach.

Diagnosis method using wrist circummetric sign

Manikadainool measurement

Manikadainool measurement is the method of measuring finger breadth for four fingers except thumb finger into single measurement. That measured breadth was calculated from the wrist point. The end point of the wrist girth measured by a twine and expressed by a person finger size as units. These units can be interpreted as disease prognosis. *Manikadai* measurement is a range of value from 4 fbs to 11fbs with 0.25 fbs interval between them[27]. It is an ancient method comes under vedhic origin in which people came to know about the usage of iron. The method helps people to predict the disease by themselves and to easily know the disease progress. Manikadainool is a better and cheap tool in daily life prediction. Agasthiyar Manikadainool values is shown in Table 1.

Nooiyinsaram

"Manikadainaalviral Thali vanmaiyaai
Thanikidaikaiyarupotualandhuparkaiyil
Kanithidumviralthanaikandusolavey
Pinithidumnoigalaipirithuraikumey" – verses 5

In the above verses 5, the procedure to calculate the values for Manikadai is given[28]. In Manikadainool, the right/left wrist circumference used to measure the prognosis of device. After measuring the wrist grith, the twine thread is placed in the flat surface for measurement (Fig. 2). The total length of the measured wrist grith is again calculated by total finger breadth size. The twine should be a non elastic thread[29]. By the finger breadth size the value 11fbs indicates the person's health. When the output value of FBS is between 4fbs to 6fbs, it indicates the criticality of person's poor health condition suggesting that without treatment the person cannot survive[30,31]. Manikadainool is thus a screening test method for human body condition which also suggests further investigations for next level diagnosis[32].

Relative Manikadainool value analysis for cancer

Cancer is the second most life threatening disease worldwide. Worldwide nearly 1crore annual death

Table 1 — Agasthiyar Manikadainool values

AgasthiyarNool Values	Agasthiyar Verses	Person's Condition
4	*Thetiyanaaladhuthitamangkandilil,* *Vaatiye Mugathinil Mayangidum Kanagalum,* *Meetiya Kaaludan Veekamum Mutridum* *Thetiya Savadhuthinnamumanjiley.*	Person faints, Oedema of legs, Death occurs on the 5th day.
4 ¼	*Naaludan Kaalkandal Nadukalumayala* *Kaalungkaiyasanthidungkarku Menmugam* *Kaalavey Nedumoochaduthandivaangidum.*	Shivering of the body, Fatigue, Blackening of the face may be observed and the person dies in 2 days.
4 ½	*Nanarinalarai Naadikaangaiyil* *Pannari Porudal Patri Veengidum* *Vannarikkangalumvalaindhumulvizhum* *Annarionbathagumsavathey.*	Anasarca would be exhibited and the person dies by the 9th day.
4 ¾	*Naalviralmeley Mukkalnavindridakkandidil* *Aavudalthannaiyamarivadhuketidum* *Naavudanvarandidumnadunadungidum* *Saavadhuezhunaal than iyalbuaagumey*	The condition of body couldn't be sorted out. Dehydration occurs and the person dies in 7 days.
5	*Anjudhanviraladhualandhukaankaiyil,* *Minjiyeudaladhuveluthukulirthidum* *Thanjiye silerpandhthadhuthuthoondaiyil* *Nanjipolathaithudalpadhariyesavathey.*	The body gets cooled and sputum gets accumulated in the throat and death results.
5 ¼	*Anjinilkaalviraladhigamkandidil* *Minjiporpadhmummeielangkuniye,* *Anjuvorpolaveythuyilumporunthidum* *Vanjamummarunaalmaranamumkitumey.*	The condition of the body is exhausted and feels sleepy and the person will die in next few days.
5 ½	*Anjaraikaanungaiyaalamarnthoornoyellam,* *Minjiyesirasinilvishamadhagidum* *PanjipolMookumvenpalkarukidum* *Thanjamampathunalsavadhuthinnammey.*	The person may get exposed to many diseases the teeth become blackened and death occurs in ten days.
5 ¾	*Anjudanmukkalalandhuparkaiyil,* *Minjiyesanninooimigudhiyagidum,* *Anjaveymayakkamumaasthiaagidum* *Kanjiyekudhithalkaalanpolumey.*	The person may get apoplexy and giddiness resulting in death.
6	*Aaradhamangulamaanadhilkandidil* *Seruthalandriyesilerpanamnenjinil* *Ooraveyadandidhumullammayangidum* *Maarumveragaveymaranamvandhidum.*	The person may be affected by tuberculosis, asthma. Death may occur within twenty days.
6 ¼	*Annameyaarudanamarndhukaalkandal* *Munameymoolamamithirakkiraniyaam* *Pannameythuyililaappadunkazhichalam* *Vanamumverellamvaladhuvinaiye.*	The person may get chronic diarrhoea with foul smell, burning sensation in chest and abdomen, sour belching due to acidity, vomitting, dysentry.

(*Contd*.)

Table 1 — Agasthiyar Manikadainool values (*Contd*.)

AgasthiyarNool Values	Agasthiyar Verses	Person's Condition
6 ½	*Anbudananarinilyaraiyumkanavey* *Vembiyaudambellamvedhuputhagumam* *Kumbiyumporunthidukundhalmelelam* *Vambinivaraithidumaranathegamey.*	Body conditions for the person are: withering of body, extreme thirst, anorexia.
6 ¾	*Aarudanmukkalkandalandaithilvaayvuundagum* *Therumeykangalrendusevaandhidumayakkamundaam* *Kooriduvarudamoondrilkurukkaneeradaipundagum* *Veetridakaikaalnovaamvaraithidumugathilthaney.*	The person may get affected by benign prostate hypertrophy, ophthalmodyina, urinary obstruction, renal calculus, burning sensation over palm and feet, perspiration of face.
7	*Thitamaezhukandaalsirasileypithameeri* *Natamamvaayilrathamnavilumseiyumagum* *Maatavirkaalungkaiyumvandhidusilandhithoonum* *Undinamigudhiyundamularndhidumalamviyadhi.*	The person may gets haemoptysis, tuberculosis, burning sensation over palm and feet, venereal ulcer, increased body warmth.
7 ¼	*Ezhadhukalungkanumidupinilvaliyundagum* *Meelavumsirasilpithamigudhikondirukkakandaai* *Suladhuvinaiyinaleythudaveypaandumuundu* *Aanadhukaalumkaiyumsumandhunithiraiyumpaazham.*	The person may be affected by back pain, muscular spasm, ophthalmodyina, anaemia, oedema, burning sensation of hands and feet, hypersomnia.
7 ½	*Etramezharaiyukandalelumbadhuurugikaanum* *Katradhuvayitrilvimmummugamelammerivukaanum* *Motravalutrukannumudambellamkaaichalundagi* *Thootriyakaalilnovudhudaiyilvipruthiyamey.*	The person may be affected by tuberculosis, venereal diseases, diabetes, flatulence, increased warmth of the body, eye irritation, joints pain, tumour.
7 ¾	*EzhinilmukkalkannilezhumbidumkezheyMoolam* *Thazhvadhurendukaalumthalaiyaadumagathunirkum* *Theraladhuvarushamaandaithoondridumkandamaalai* *Naaladhuselaselanachiyilrathamkaanum.*	The person gets affected by burning sensation of hands and feet, growing fatty, cervical lymphadenopathy, epistaxis.
8	*Ettenumviralkadaivayadhumaaridil* *Katrenumvayitrinilkadhaithudalvesugamam* *Thutiyapeenisamthoondainodhalal* *Kotiyavayitrinilkunamidhamey.*	The person affected by venereal heat, stomach upset, flatulence, anorexia, changes in the body appearance due to any disease.
8 ¼	*Kaatiyaeetodukaalviralkaai* *Kootiyapithavaaikuraisurameyil* *Naatiyapiramiyamnavilumkamiyam* *Vaatiyasirsilnooivarumoraandiley.*	The person get obesity accompanied with body pain, dryness of head due to constitutional heat, sinusitis, perspiration, wheezing.
8 ½	*Vitudanirumalumvedhupumelallam* *Kitidumsilaiyumkirangikaanumey.*	The person may affected by withering of the body, gonorrhoea, venereal ulcer, leprosy, severe itching, a disease in which intestine is rendered weak with rumbling noise and pain in stomach with constipation, spermatorrhoea.
8 ¾	*Etinilmukkalkaanililagiyaudambukaayum* *Thotiyakudampolasilvidampalavumthoondrum* *Mutiyavayitrinuleymulaipoleyvaayumkuthum* *Vetriyakanvaaikaigalvelundhidumpitharogam.*	The person may get flatulence due to air in the sacral region, cataract, sinusitis.
9	*Kazhindumenbadhuviralkadaikaankaiyil* *Vizhindhuseviyilullakuthumandhamam* *Kulindhungkurukinil korai vaayuvey* *Azhindidhumarudhudaiayarindhukuzhumey*.	The person may expose to dullness in hearing, presbyopia, pain in the lumbar region.

(*Contd*.)

Table 1 — Agasthiyar Manikadainool values (*Contd*.)

AgasthiyarNool Values	Agasthiyar Verses	Person's Condition
9 ¼	*Theetiyaonbathukalukandhuthinamam* *Eeytilsiruganeerithusuzhdidum* *Suttilkanvizhithuyilumillaiye.* *Vaatiyapeneesamvandhuthoondrumey.*	The person may get eye irritation, painful micturition, insomnia, sinusitis.
9 ½	*Onbathuaraiyadhuugandhukankaiyil* *Ennoboduudambellamveluthusudhatam* *Thunpaduiruvizhikaiyindhumunsaram* *Nanbadhumasanamvitudalumvatrumey.*	The person will affected by Withering of the body, whole body oedema, increased body warmth, eye irritation, diabetes or venereal diseases, vomiting & regurgitation.
9 ¾	*Onbatheymukkalugandhukankaiyil* *Ennbathuzharaiyapeymeithidum* *Vanboduirumalumvartchithoondridum* *Pinpadhoorvarudathilpelikaithoondurumey.*	The person gets affected by bubos, cracks, dryness, cough.
10	*Kuraindhuviralkadaieerandhukaankidil* *Viraindhuvenpiniudambirsarnthidum* *Niraindhakaalumkaiyudalnerungidum* *Thiraindhavayitrinilthiralumkunmamey.*	The person will get affected by Withering of the body, pricking pain in the joints and epigastric region, ulcer.
11	*Nanniyapaathinondrunaadikangaiyil* *Enniparuthudaliyambavilaiya* *Annalseividhiyandriazhivaadhilaiya* *Naniyakaalanumyamanumilaiye.*	The person health is good without any causes of diseases.

Fig. 2 — Procedure to measure wrist using thread (Silk)

due to cancer has been reported by WHO[4]. Risk factors include sedentary lifestyle, physical inactivity, genetic factors, etc. The common cancer types include carcinoma, cervical cancer, prostatic adenocarcinoma, gastric cancer. Cancer might be managed as long as the diagnosis is done earlier. It tends to grow progressively to fret the person and ultimately produce death). So Manikadainool value of seven and half viralkadai can also be taken for cancer suspicion (Table 2). It is analyzed that each one Manikadainool values correspond to any of the 8th and 9th viralkadai along with the above said symptoms may indicate the danger of developing cancer[33]. Further, for Manikadainool value of 7½ Viralkadai, it has been mentioned that Vippuruthi may develop, which is taken as an immediate equivalent for Tumour (Vippuruthi)-A malignant tumour characterized by the formation of a network of connective tissues connecting the epithelial cells.

Table 2 — Symptoms and values of cancer

Common symptoms of cancer	*Manikkadainool* Values (*Viralkadai*)
Loss of Appetite	8,9.25
Weight loss	10,9.25 ,8.25 ,8
A lump formation	9.75
Coughing out of blood	7

Methodology

Architecture

The proposed system consists of microcontroller, IR sensor, ultrasonic sensor, relay, motor, mobile display, transmitter, receiver and actuators (Fig. 3). This device is structured for finding the circumference of the wrist for human. This device mainly comprises

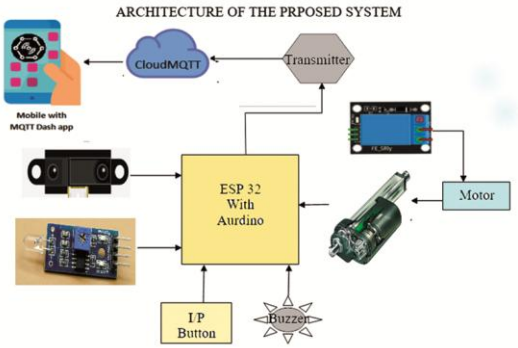

Fig. 3 — Proposed System Model

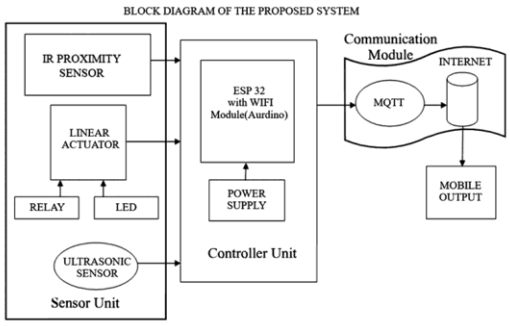

Fig. 4 — Block Diagram of the Proposed System

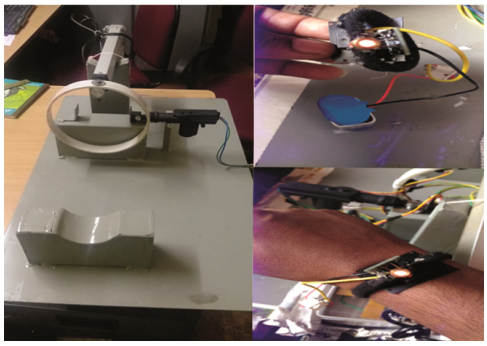

Fig. 5 — Hardware design

of three (input, communication & output) modules and it is based on individual working principle. Using this device, different sample of wrist structure is analyzed and it is compared to the manikadai value which denotes the diseases for each value of circumference calculation. The value is compiled by embedded C programming using through serial bus for transmitting signal based on IoT wireless technologies.

Block diagram

The components are connected with Arduino Module (presented in Fig. 4) for diagnosing the disease and sensors and actuators as a Micro Electrical Mechanical System (MEMS). In this block diagram, Input module contains sensor & actuator unit, then the processing and transmitting module having an ESP32 Microcontroller with WiFi router for processing data using low power consumption with the reliable results. Also, the output module has receiving signal unit, which is used to implement the coding into the hardware part through MQTT dashboard. It is used for simple and easy transferring of data in message queue. Mobile unit display the actual wrist circumference measured from the fingers.

Experimental setup

Hardware design

The proposed implementation of hardware design (Fig. 5) consists of ESP32 module, driver circuit, LED, ultrasonic sensor, relay circuit, mobile unit with internet, RS232 serial cable, and IR proximity sensor. In the Arduino circuit board system, the program code is written in embedded C^{++} and loaded into the kit and it is converted as a coded file into the circuit. The program dumped in ESP32 Arduino WiFi module for processing the data calculations. Mobile device with internet facility uses a protocol as MQTT. For each hand the finger length are calculated and verified with the wrist circumference.

The proposed system is fully based on automatic disease detection, reducing the ancient manikadai analysis efforts. The main idea is to develop the concept into an automated device for disease diagnosing; it can predict the values and diseases in an easy manner. Hardware design consists of two unit namely Patient unit and Doctor unit are shown in figure. The patient unit is used to find the length based measurement of the hand. That is measured using LED and it act as an Ultrasensitive light sensor. Here, the LED light is place with the wrist band and the sensing unit is attached with the ring of the hardware which is connected with the IR sensors. This unit is to identify the starting point as threshold value. The doctor unit comprises all kinds of sensors, actuators, controller circuit. This unit is to analysis the calculation and the signal received from the patient unit the length of the fingers are measured using actuators and then the IR sensor distancing arrangement made without coincidence of the signal. Then the results are calculated using the controller unit.

MQTT dash application

The MQTT protocol is used to share the message that is to communicate with machine to machine.

MQTT is a message queuing telemetry transport protocol which was introduced by IBM. It is light weighted protocol used for messaging. Actually it is an easy interface with a friendly configuration best suitable for graphical user interface uses on the all android smartphones. This app is configured to the ESP32 and with the MQTT broker on IoT based Cloud MQTT which has connection remotely over the Internet. This app can be installed in smartphones for sharing the data in the IoT. It is effective to check the result of the patient in mobile itself. Based on this architecture, this server act as a broker between clients to pass information.

Results and Discussion

The proposed device for finding the wrist circummetric area using the sensors and actuators are giving the values with the reliable results and easily mentioned output from the MQTT dash application (Fig. 6).

Also by the discussion of the device the basic primary analysis taken for 150 persons and that is calculated using Machine learning implemented in Arduino. The output analysis is presented (Fig. 7) according in 4 types based on confusion matrix as TP, TN, FP, FN.

Fig. 6 — Mobile Output screen

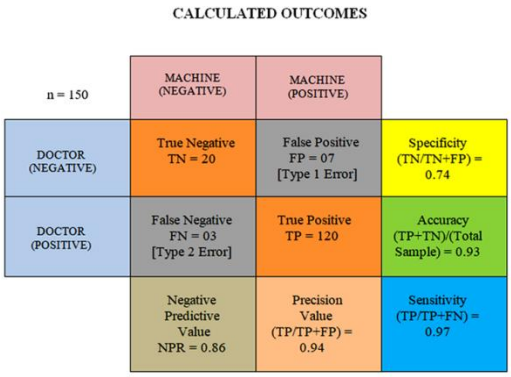

Fig. 7 — Outcomes for the learning model

Case 1: TRUE POSITIVE (TP)

From the 150 cases the machine output which we predicted Yes and the actual doctor output was also Yes. That indicates both the values are positive termed as TP (True Positive).

Case 2: TRUE NEGATIVE (TN)

From the cases the machine output which we predicted No and the actual doctor output was also No. That indicates both values are negative termed as TN (True Negative).

Case 3: FALSE POSITIVE (FP)

From the cases the machine output which we predicted Yes and the actual doctor output was No. That indicates one is Positive and another is Negative is termed as FP (False Positive).

Case 4: FALSE NEGATIVE (FN)

From the cases the machine output which we predicted No and the actual doctor output was Yes. That indicates one is Negative and other is Positive is termed as FN (FALSE NEGATIVE).

The evaluation based on these values using multi class learning model, n=150; TP = 120; TN = 20; FP = 7; FN = 3.

For calculating the accuracy of the system, precision of the system, Sensitivity, Specificity and F1 score (Performance of the system), the values of TP, TN, FP, FN values are needed by using the formula,

$$\text{Accuracy} = \frac{(TN+TP)}{(TN+TP+FN+FP)} = \frac{(20+120)}{(20+120+3+7)} = 0.93*100 = 93\%$$

$$\text{Precision} = \frac{(TP)}{(TP+FP)} = \frac{(120)}{(120+7)} = 0.94 * 100 = 94\%$$

$$\text{Sensitivity (TPR)} = \frac{(TP)}{(TP+FN)} = \frac{(120)}{(120+3)} = 0.97 * 100 = 97\%$$

$$\text{Specificity (TNR)} = \frac{(TN)}{(TN+FP)} = \frac{(20)}{(20+7)} = 0.74 * 100 = 74\%$$

$$\text{F1 Score} = 2 * \frac{1}{\frac{1}{Precision}+\frac{1}{Recall}} = 2* \frac{1}{\frac{1}{0.94}+\frac{1}{0.97}} = 0.95 * 100 = 95\%$$

Classifier on machine learning

The algorithm which is implemented is Supervised Learning which can be classified as Regression algorithm and Classification algorithm. Here the usage of Classification algorithm by supervised learning multiclass classifier which suits for this method. The analyzing part based on training values, input variables from all other algorithm ANN is best for finding the results with accuracy.

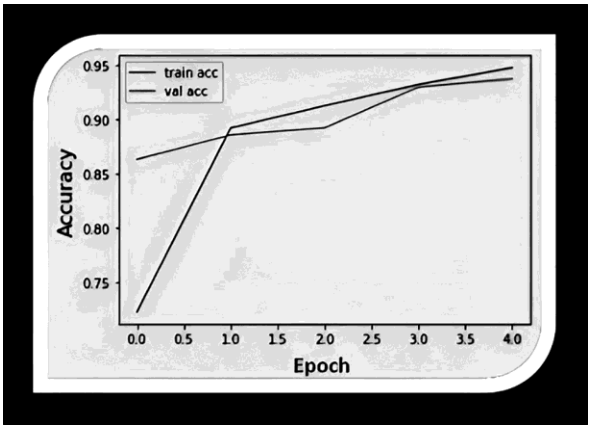

Fig. 8 — Accuracy of Classifier

For measuring the accuracy in this system the ANN classifier-GWO algorithm is used to measure the accuracy graph (Fig. 8) is between the trained accuracy and valid accuracy.

Conclusion

In this paper, we proposed the automated Siddha based disease diagnosis device using IoT environment for finding the results easier without any errors and manual intervention. It is the easy method for finding most of the diseases. By extending the features, we can able to predict the circumference and their symptoms relating to the health using this device. The device is user friendly to find out the prognosis of the diseases. Diagnosis of more number of the diseases such as Covid-19 can be implemented in the future based on the particular circumference. This device can be cost effective and act as a doctor without any help. The results are accurate and can be displayed in the mobile device.

Conflict of Interest

The Authors declared that they have no conflict of interest.

Authors' Contributions

YA: Designed, analyzed and experiment setup, documented; SK: Guide for the study and design of this experiment, paper writing and editing.

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