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Research Article

"Internet of Things Enabled Healthcare Kit"

Mr. Antim Dev Mishra[1] Dr Naveen Nandal[2]

[1]School of Engineering and Technology, School of Business[2], Sushant University, Gurgaon, Haryana

antimdevmishra@sushantuniversity.edu.in[1] naveennandal@sushantuniversity.edu.in[2]

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Abstract— The Internet of Things (IoT) is a network of intelligent heterogeneous objects that can communicate and share the data. Patients are required to attend the doctor on a daily basis in traditional models of healthcare. Both the patient and the medical personnel can find these traditional procedures inconvenient. The aim of this project is to create a smart IoT-based health monitoring system which have non-invasive sensors to read various health parameters and displays them on an LCD module in real time. The user can also transfer the data to the cloud to be safely stored and can share this data with doctor for treatment. Data can be live viewed from any location on the planet. Since the battery capacity of each system used in this project is minimal, it would reduce the power usage in order to prolong the life of the healthcare kit. The IoT-based hospital healthcare kit developed using an Arduino Uno, ESP8266, pulse rate sensors, blood oxygen sensor, ECG sensor, blood pressure sensor, and temperature sensor is described in this paper. As a result, IoT-enabled systems improve treatment delivery while also lowering costs by continuously collecting and analysing data**.**

Keywords: *IoT, Arduino Uno, Proteus ESP8266, Healthcare, Sensors, Thing-Speak.*

I. INTRODUCTION

Wireless infrastructure has advanced dramatically in recent years. As a result of the need to maintain different industries, the number of people employed is growing. Automation and control are especially important. One of the most recent developments of IoT is in the biomedical field. Better health care is on the rise. Not only in clinics, but also in other locations like our home, office. As a consequence, using a smart system comes with a range of benefits. Furthermore, doctors play a vital part, but the check-up process is very long, as a person must first prepare, then receive an appointment, and finally receive treatment. The check-up reports are then generated later. As a result, working people ignore the check-ups due to long process or put it off. This cutting-edge method saves time. According to my research, residents in rural areas do not have the sufficient health coverage. They still may not have enough medical facilities. A significant number of people goes to hospitals when the illness or fever has progressed to the point of becoming life-threatening. Then, taking into account the quality of care, much of the rural areas medical treatment cost is unaffordable to most individuals.

This project ensures fast and accurate real time health monitoring of a person's health using 5 different sensors and informs the person with his actual health related statistics on his mobile device or PC monitor. The sensors used are powered by Arduino Uno microcontroller which is based on ATmega328P microcontroller [13]. It's clocked at 16 Hz frequency which makes the circuit cost low and efficient. All the sensors are assembled in such a way so that it can wearied on a hand in the form of hand glove. This makes Health Care Kit a wearable Health Care kit. Wearable healthcare Kit would compute data from day to day activities which can be used by physicians to improve diagnosis or treatment.

II. RELATED WORK

In the field of IoT-healthcare, studies are currently being conducted to provide clinical evidence that raw data obtained from wireless network-connected systems has helped in the diagnosis and prevention of chronic diseases. As a result, many health screening systems are becoming more functional in today's world, including glucose sensors, ECG monitors, pulse audiometers, and blood pressure monitors.

"Cooey Smart health allows you to mechanically log your medical knowledge through Bluetooth entitled devices. It takes note of your health by storing, analyzing, and sharing your medical records. It additionally advises you on good tips and services primarily based upon your health analysis. It additionally offers you alerts and messages concerning your health risks. It allows you to remotely monitor the health reports furthermore as additionally has the choice of connecting yourself to varied health service suppliers like company, labs, home care, and teleconsulting. It consists of 3 totally different health watching systems" [1,17]
"Smart pressure level Monitor, good Body instrument, good Glucometer. Cooey is lengthwise health watching IOT platforms that facilitate the suppliers in collection, storing and analyzing of raw medical knowledge thus on offer offer alerts of important signs for patients beforehand. It allows you to select and customize your personalized services primarily based upon your health condition. for purchasers, it's a health management application with personalized services. it's a personalized answer for chronic health management. No different product and app ar ready to offer a last-mile association of a patient together with his health consultants. But, through the assistance of the platform services, Cooey is in a position to interconnect and supply centered services to its customers. a number of the third Platform services that Cooey provides: live and Monitor: good devices like Bluetooth entitled BP monitor and deliberation Scale allows you to mechanically record the medical knowledge and lets your medical health consultants remotely access this knowledge. Engage: totally different knowledge together with the profile of patient, his health organ"[17]

"Microsoft Health Vault assists you to collect, store, use, and share health data for you and your favored ones. you'll be able to sustain all of your health records at one place that is organized and offered to you on-line (E-Book Keeping) just in case of medical emergencies, it's able to keep track of all the main points in order that you're invariably alerted concerning your wellbeing. It records the information once, and uses it with new information to urge frequent updates concerning your health. Health Vault-connected apps embrace websites, laptop code, and mobile apps which will assist you analyze a lot of out of your captured health data. It additionally options multi-app property in order that the data is shared with anyone. It features" [2,5].
•Up-to-date medication and allergic reaction lists
• Latest home health readings (such as pressure, blood sugar, and weight)
• Your health history
Healthcare kit is an IoT and sensor-based model that is an exploratory study in product innovation in the automotive sector [21]. "HealthVault not solely helps you store, organize, however additionally offers this data to our doctor. It will keep your details at your fingertips and access them from anyplace mistreatment a web association on a computer, smartphone/tablet. It will record and store your diagnostic results, prescription history, Associate in Nursing visit records from an increasing list of connected labs, medical institutes, hospitals, and clinics which might send details to your HealthVault and record it. you'll be able to transfer your medical logs and may simply keep these track records in HealthVault, for future reference. Medical pictures is simply saved and shared together with your medical consultants and keep them handy for future reference. applied math graphs, patterns, and trends ar drawn from the therefore collected information within the HealthVault that helps your medical examiners to create economical and higher health choices. It will simply share data with folks your care consultants in order that they will guide and advise you on correct health management. Weight management dashboard helps you reach your fitness goals by keeping a track of your weight, your daily diet, daily activity, and trailing the progress" [6,7,8].
The sensors' data can also be transmitted to the receiver node using LiFi technology. This technology is only useful in a few situations [19]. Because of its adaptive learning capability, artificial intelligence and machine learning can help to advance this module [20]

III. HARDWARE DETAILS

Table 1: Components used in the project

Sr. No	Name of the component	Roll of component	quantity
1.	Arduino uno	Read the data from the sensors and send data to cloud through esp8266.	1
2.	Esp8266 Wifi module	Connects to internet using Wi-Fi and sends data from Arduino to cloud.	1
3.	Pulse sensor	Gives a digital output to Arduino when figure is placed on it.	1
4.	LM35 temperature sensor	Gives an analog output to Arduino.	1
5.	ECG Sensor	Gives an analog output to Arduino.	1
6.	2x16 line LCD display	Displays temperature and pulse rate.	1
7.	Blood Pressure Sensor	Gives an analog output to Arduino.	1
8.	Blood Oxygen Sensor	Gives an analog output to Arduino.	1

Components Description:

1.Arduino Uno: "The Arduino Uno is a microcontroller board based on the Microchip ATmega328P.Arduino.cc developed this microcontroller. A variety of digital and analog input/output (I/O) ports are available on the board. These pins and can be used to connect to expansion boards (shields) and other circuits Simulation is done on Arduino IDE software. The ATmega 16U2 provides serial data to the main processor and has a built-in USB peripheral. Arduino Uno power cable Standard A-B USB cable. It has 14 digital I/O pins" [3].

Fig. 1. Arduino Uno

2. **Wi-Fi Module:** The ESP8266 wi-fi module is a self-contained SOC with an integrated TCP/IP protocol stack that can provide connectivity through a wireless network to any controller. It uses 802.11 b/g/n protocols. Standby power consumption is less than 0.1mW. The ESP-01 ESP8266 Serial WIFI Wireless Transceiver Module is a self-contained SOC with an embedded TCP/IP protocol stack that will provide access to the data to any microcontroller. The ESP8266 will either host an application or offloading all Wi-Fi networking features to a separate application processor. Each ESP8266 module is pre-programmed with AT command set firmware, so we

can simply connect it to your Arduino board and get around the same amount of Wi-Fi functionality as a Wi-Fi Shield. The ESP8266 module is a particularly cost-effective board with an enormous, and ever-growing, community.[7,10,11]
The ESP8266 module is a low-cost board with a large and rapidly growing community. This module has sufficient onboard processing and storage to enable it to be combined with sensors and other application-specific devices through its GPIOs with minimal creation and loading during runtime. Its high level of on-chip integration allows for a wide range of applications. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existing interfaces; it's a self-calibrated RF that permits it to work altogether operating conditions and has no additional RF parts, and it has a self-calibrated RF that allows it to work in all operating conditions.

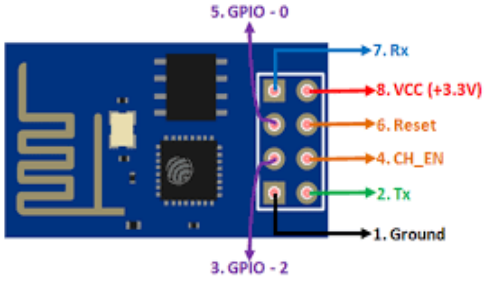

Fig. 2. ESP 8266

3.**Pulse Sensor (MAX30100):** It's a sensor that combines a pulse oximeter and a heart rate monitor. It's an optical sensor that measures the absorbance of pulsing blood through a photodetector after releasing two wavelengths of light from two LEDs – a red and an infrared one.

At that point estimating the absorbance of beating blood through a photodetector. This specific LED shading blend is enhanced for perusing the data through the tip of one's finger. It is completely configurable through programming registers and in this manner, the computerized yield information is put away during a 16-profound FIFO inside the gadget. It has an I2C computerized interface to talk with some microcontrollers.

The oximetry subsystem in MAX30100 comprises of encompassing light crossing out (ALC), 16-cycle sigma-delta ADC, and a restrictive discrete-time channel. It has a super low-power activity which makes it ideal for battery-worked frameworks. MAX30100 works on a stock inside the scope of 1.8 to 3.3V. They are regularly used in wearable gadgets, wellness right-hand gadgets, clinical checking gadgets, and so on The MAX30100 works from 1.8V and 3.3V force supplies and might be shut down through programming with immaterial reserve current, allowing the office supply to remain associated at all occasions.

Fig. 3. Pulse Sensor

Details and options of MAX30100 Pulse measuring device pulse rate sensing element Module: - it's coordinated heartbeat oximetry and pulse screen sensing element arrangement. Coordinated LEDs, exposure sensing element, and superior Analog Front – finish, Complete Pulse measuring device and Heart-Rate sensing element resolution Simplifies style, Measures absorbance of beating blood, I2C interface additionally to INT pin, Tiny 5.6mm x 2.8mm x 1.2mm 14-Pin Optically increased System-in-Package, Ultra-Low-Power Operation will increase Battery Life for wearable Devices Programmable Sample Rate and light-emitting diode Current for Power Savings, Ultra-Low closedown Current (0.7µA, type), Advanced practicality Improves measuring Performance Integrated close light-weight Cancellation, High Sample Rate Capability, quick knowledge Output Capability[

4.Temperature Sensor: "LM35 is an accurate IC temperature sensor providing its output compared with the temperature. It provides an edge over linear temperature sensor calibrated in degree kelvin because it is not

essential to deduct a particular constant voltage from the output in order to get the Celsius temperature"[7].
The characteristics of the temperature sensor are shown in Table 2

TABLE 2: LM35 Temperature sensor specifications

Sensor model	**LM35**
Manufacturer	Texas Instruments
Supply Voltage	4 to 30 V
Accuracy	$\pm 0.5\,^{\circ}C$
Operating temperature	$-55\,^{\circ}C$ to $+150\,^{\circ}C$
Sensitivity	10 mV/$^{\circ}C$
Output max current	10 mA
Output impedance	0.4 Ohm

Fig. 4. Temperature sensor

"The temperature sensor is used to estimate the hotness or coldness of anybody. In health care, using temperature sensor data, the patient's health condition can be estimated. If the temperature crosses a particular threshold, the physician can be alerted regarding the appropriate treatment of the patient" [8].

5.**ECG Sensor (AD8232):** "ECG Monitor Module is predicated on AD8232 Analog Device IC. This can be a low cost electrocardiogram device wont to live the electrical activity of the guts. This electrical activity will be charted as an electrocardiogram or graphical record and output as an analog reading. ECGs will be very strident, out AD8232 Single Lead Pulse Monitor acts as an op-amp to assist a transparent signal" [13].
The AD8232 is AN integrated signal acquisition block for electrocardiogram and alternative bio potential measuring applications. It's designed to extract, amplify, and filter little bio potential signals within the presence of strident conditions, like those created by motion or remote conductor placement.
The AD8232 module have out 9 connections from the IC that we just will solder pins, wires, or alternative connectors too. SDN, LO+, LO-, OUTPUT, 3.3V, GND are essential pins for the operation this monitor with an Arduino or alternative development board. Additionally, provided on this board square measure RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins to connect and use its own custom sensors. to boot, there's a crystal rectifier indicator light-weight that may pulsate to the rhythm of a heartbeat.

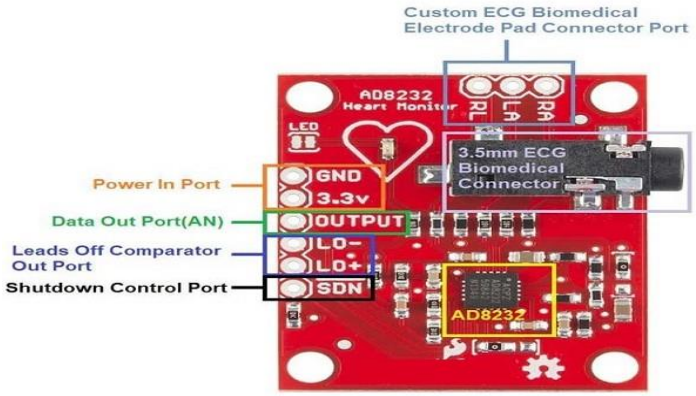

Fig. 5. ECG Sensor

6.**LCD Display (16x2):** This is a basic 16 character by 2 line Alphanumeric display. White text on Blue background. Utilizes the extremely common HD44780 parallel interface chipset. You will need Minimum 6 general I/O pins to interface to this LCD screen. Includes LED backlight. Works in 4bit and 8 bit Mode

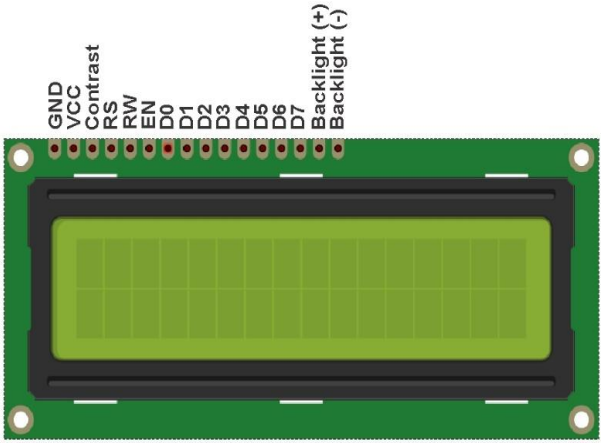

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Fig. 6. LCD Display

Features: 16 Characters x 2 Lines, Blue Backlight,5x7 Dot Matrix Character + Cursor, HD44780 Equivalent LCD Controller/driver Built-In.

IV. PROPOSED MODEL

Our system monitors the patient's vital signs in real time and detects any anomalies. Medical personnel are given t he tracked info. When irregular parameters are detected, the device notifies the medical personnel. As a result, the re is less of a requirement for medical personnel to conduct physical supervision. Our proposed framework makes use of an Arduino and an esp8266 to transmit data from sensors to a cloud network thingspeak [14]. The esp8266 module on the Arduino has been programmed with the API key received from the Thingspeak website. Using the thing talk access key, any number of users will view the medical records stored on the device. [5,6]

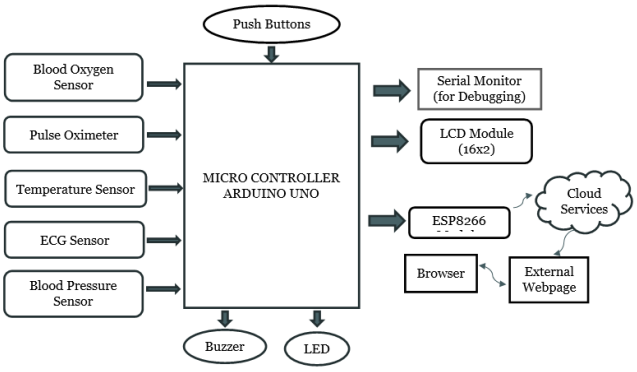

Fig. 7. Block Diagram of Healthcare Kit

V. IOT PLATEFORM

Transfer data to the cloud from every Internet-connected computer using the Think speak platform [11]. After that, we can set up activities and warnings depending on the information gathered. Unlock the importance of your real-time results using visual methods to evaluate data. Take advantage of ThinkSpeak's which allows to collect sensor data quickly and easily transform it into useful information. "Thing Speak is available as a **free** service for noncommercial small projects (<3 million messages/year or ~8,200 messages/day). Thing Speak is bought in units, where one unit allows 33 million messages to be processed and stored in a one-year period (~90,000 messages/day)" [3].

```
const int httpPort   = 80;
String url     = "/update?api_key=IEA8ZS4ELWF7PCUW&field1=";

int setupESP8266(void) {
  // Start our ESP8266 Serial Communication
  Serial.begin(115200);
```

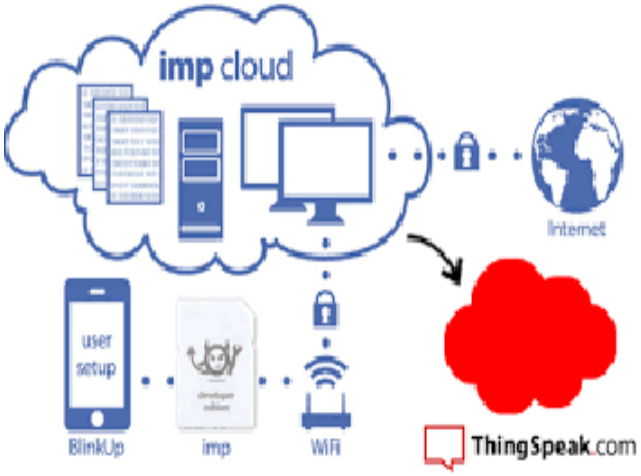

Fig8 : Thingspeak Model and its API key

Fig9: Wearable Healthcare Kit

VI. EXPERIMENTAL RESULT

The ESP8266 and Arduino Uno module is connected to the LM35 and pulse device with this IoT-based medical kit. This entranceway is employed to gather, analyse, store, and send medical information to the cloud through a secure link. The Kit has five sensors like MAX30100 is accountable to live Blood Glucose Level and pulse, the DS18B20 device is employed to live temperature, the AD8232 device senses electrical activity of the center, and a pressure sensor. The user has option to select and pick information through the pushbuttons, the actual device to

be used at the instant and has an option whether send or not to send the information to the cloud. Whenever a sensing mode is chosen the LCD glows and therefore it shows digital display alphanumeric values on display module. Displays the chosen unit and starts to display the output in each three seconds. [15,18]

The sensors send information to the Arduino UNO, that is associate ASCII code to microcontroller board developed by Arduino. Cc which support the ATmega328P. The UNO processes them and sends it over to the digital display and Serial Monitor. It conjointly receives commands from the user through pushbuttons throughout transmission over Wi-Fi. It sets up the ESP8266 module and sends signals using "AT" commands.

This command shows information on Serial Monitor (used for debugging purposes) and therefore on the digital display module. The Serial Monitor is that the "tether" between the pc and the smart board Arduino—it lets one send and receive text messages, handy for debugging and conjointly use the Arduino from a keyboard.

The alarm unit consists of a five-volt electricity buzzer and a rectifier. The information communication at the IoT platform consists of 4 main parts—ESP8266 Wi-Fi module, cloud-based knowledge storage and thing speak which is external Webpage, and eventually accessing it through an online browser. ESP8266 module will act as a standalone microcontroller however during this system, it's used solely as a Wi-Fi module.

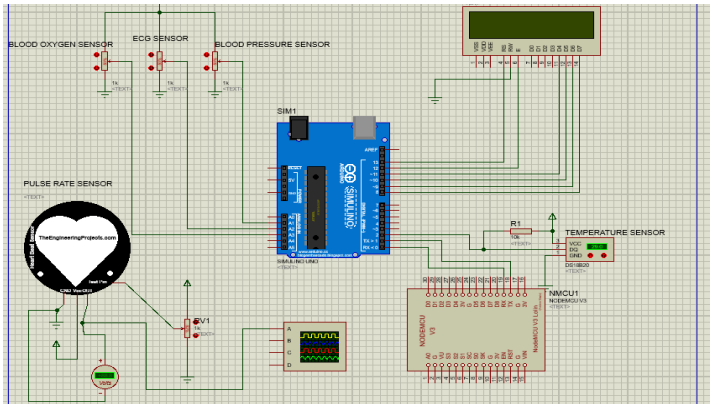

Fig10: Circuit Diagram

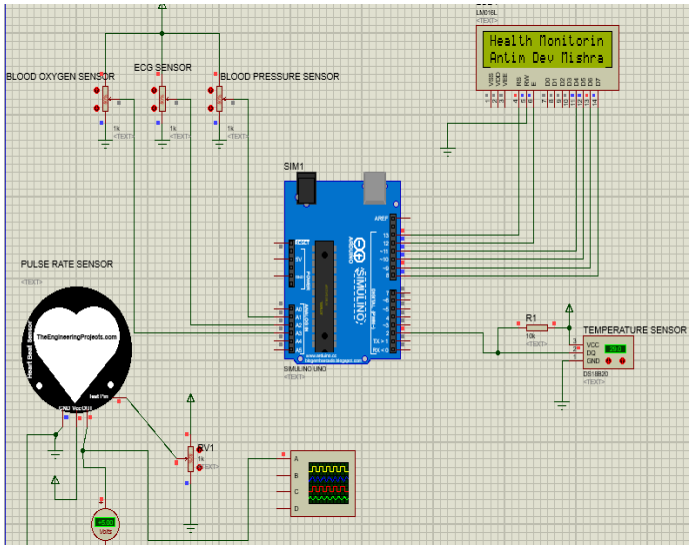

Fig11: Simulation of Circuit

Fig12: Sensor Output on serial monitor and ThingSpeak

VII. CONCLUSION

The proposed system's primary goal is to provide cheaper and more efficient care for patients by developing a digitally enabled cloud that allows professionals and physicians to collaborate more effectively. The final model has included features that allow a doctor to examine a patient from any location and at any time. In an emergency, we can send the patient's current condition and a complete medical history to the doctor. The Internet of Things (IoT) is a set of technologies that allow a broad range of appliances, computers, and objects to connect and communicate with one another through various networking protocols. IoT may be used for a wide range of uses, including healthcare, which is the subject of this study. Interconnected mobile devices are used in healthcare systems to create an IoT network for healthcare research, patient management, and instantly identifying situations requiring physician intervention.

The information gathered from various sensors must also be validated using real-time hospital sensors.

References

[1] Cooey Health (2021, January 1). Re-imagine Healthcare. Retrieved from https://www.cooeyhealth.com.

[2] Raja Jayaraman (2019)," Improving Opportunities in Healthcare Supply Chain Processes via the Internet of Things and Blockchain Technology": Volume 14, Issue 2, International Journal of Healthcare Information Systems and Informatics (IJHISI) DOI: 10.4018/IJHISI.2019040104.

[3] Satya Prakash Dash (2020, Nov. 03)," The Impact of IoT in Healthcare: Global Technological Change & The Roadmap to a Networked Architecture in India", Issue Oct 20, Springer Nature Switzerland AG. Part of Springer Nature. DOI: https://doi.org/10.1007/s41745-020-00208-y.

[4] Tekeste Habte T., Saleh H., Mohammad B., Ismail M. (2019) IoT for Healthcare. In: Ultra Low Power ECG Processing System for IoT Devices. Analog Circuits and Signal Processing. Springer, Cham. https://doi.org/10.1007/978-3-319-97016-5_2

[5] Zissis D. & Lekkas D. (2012). Is cloud computing finally beginning to mature? International Journal of Cloud Computing and Services Science (IJ-CLOSER). Available . http://iaesjournal.com/online/index.php/IJCLOSER/article/view/1248.

[6] G. Aceto, V. Persico, A. Pescapé, The role of information and communication technologies in healthcare: taxonomies, perspectives, and challenges, J. Netw. Comput. Appl. 107 (2018) 125–154, https://doi.org/10.1016/j.jnca.2018.02.008

[7] G. Aceto, V. Persico, A. Pescapé, A survey on information and communication technologies for industry 4.0: state of the art, taxonomies, perspectives, and challenges, IEEE Commun. Surv. Tutor. (2019), https://doi.org/10.1109/COMST. 2019.2938259.

[8] Marinescu, D. (2012). Cloud Computing: Theory and Practice. Retrieved from http://www.cs.ucf.edu/~dcm/LectureNotes.pdf.

[9] Buyya, R. et al. (2009). Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility. Future Generation Computer Systems. Retrieved from http://portal.acm.org/citation.cfm?id=1528937.1529211.

[10] F Sharevski (2018). Towards 5G cellular network forensics. Eurasip Journal on Information Security, 2018, 8, Published on: 11 July 2018

[11] A Sitek and Z Kotulski (2018). POS-originated transaction traces as a source of contextual information for risk management kits in EFT transactions. EURASIP

[12] M. H. Jhaveri, O. Cetin, C. Gan˜an, T. Moore, and M. V. Eeten. Abuse reporting and the fight against cybercrime. ACM Computing Surveys (CSUR), 49(4):68, 2017.

[13] L. Wang, K. P. Dyer, A. Akella, T. Ristenpart, and T. Shrimpton. In ACM CCS, pp. 57–69, New York, NY, USA, 2015. ACM.

[14] Sharma S, Tim US, Gadia S, Wong J. "Proliferating Cloud Density through Big Data Ecosystem, Novel XCLOUDX Classification and Emergence of as-a-Service Era".pp.-1-20 (2015) .

[15] Rintala, Mikko, Jussi Sormunen, Petri Kuisma, and Matti Rahkala. "Automation System Products and Research."(2014).

[16] Sandeep Patel, Punit Gupta, Mayank Kumar Goyal, "Low Cost Hardware Design of a Web Server for Home Automation Systems", Conference on Advances in Communication and Control Systems(CAC2S), 2013

[17] Golzar, M.G. ; AsanPardazan Co. ; Tajozzakerin, H.R., "A New Intelligent Remote Control System for Home Automation and Reduce Energy Consumption", Mathematical/Analytical Modelling and Computer Simulation (AMS), 2010, IEEE.

[18] Alkar, A.Z., Hacettepe Univ; Roach, J. ; Baysal, D., "IP based home automation system", Consumer Electronics, IEEE Transactions on (Volume:56 ,Issue: 4), November 2010, IEEE.

[19] Arti Vaish, Sheetal Singh" Li-Fi: The Emerging Technology and the green avatar of Wi-Fi", International Journal of Recent Research Aspects, ISSN: 2349-688, Volume 5 Issue 1 March 2018.

[20] Latika Singh "Comparisons of Speech Parameterization Techniques for Classification of Intellectual Disability Using Machine Learning" International Journal of Cognitive Informatics and Natural Intelligence ISSN : 1557-3958 2019.

[21] Nandal Naveen Etal "An Exploratory Research in Product Innovation in Automobile Sector" Journal of Critical Reviews ISSN: 2394-5125 2020