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Embedded Based Smart ICU-For Intelligent Patient Monitoring

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***Abstract*—** Brilliant ICUs are systems of varying media correspondence and PC frameworks that connection basic care specialists and medical caretakers (intensivists) to escalated mind units (ICUs) in other, remote doctor's facilities. The intensivists in the "war room" can impart by voice with the remote ICU staff and can get video correspondence and clinical information about the patients. Coordinate patient care is given by the specialists and medical attendants in the remote ICU who don't need to be intensivists themselves. As of late there has been an expansion in the quantity of patients requiring ICU mind without a relating increment in the supply of intensivists. Keen ICUs can be a significant asset for healing centers looked with the need to extend limit and enhance tend to a developing elderly populace. Proof from some early-adopter healing centers demonstrates that it can use administration of patient care by intensivists, decrease death rates, and diminish LOS. In any case, positive results seem to rely upon the hierarchical condition into which the Smart ICU is presented. The emotional upgrades in mortality and LOS detailed by some early-adopter doctor's facilities have not been coordinated in most. The constrained research accessible recommends that the best results may happen in ICUs that: Can make authoritative game plans to help the administration of patient care by intensivists utilizing Smart ICU; Have almost no intensivist staff accessible to them without Smart ICU; Have moderately high seriousness balanced mortality and LOS rates; Are situated in remote or provincial zones where protected and productive exchange of patients to local communities for cutting edge basic care presents challenges. Keen ICU interfaces a headquarters focus staffed by intensivists with patients in far off ICUs. Persistent, continuous sound, video, and electronic reports of imperative signs interface the war room to the patients' bedsides. PC oversaw choice emotionally supportive networks track every patient's status and give alarms when negative patterns are identified and when changes in treatment designs are planned. The patient information incorporate physiological status (e.g., ECG and blood oxygenation), treatment (e.g., the implantation rate for a particular prescription or the settings on a respirator), and medicinal records.

Keywords*-Internet of Things, industrial applications, microcontroller, Smart ICU, personal computer.*

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I. INTRODUCTION

An emergency unit is characterized as an extraordinarily staffed, forte prepared, isolate area of a healing facility committed to the perception, care, and treatment of patients with perilous ailments, wounds, or entanglements from which recuperation is conceivable. It gives uncommon ability and offices to the help of fundamental capacity and uses the expertise of medicinal nursing and other staff experienced in the administration of these issues.

Intensive care unit (ICU) equipment includes patient monitoring, respiratory and cardiac support, pain management, emergency resuscitation devices, and other life support equipment. They are designed to care for patients who are seriously injured, have a critical or life-threatening illness, or have undergone a major surgical procedure thereby requiring 24-hour care and monitoring. An ICU may be designed and equipped to provide care to patients with a range of conditions, or it may be designed and equipped to provide specialized care to patients with specific conditions. Aeromedical ICU cares for patients with acute conditions involving the nervous system or patients who have just had neurosurgical procedures and require equipment for monitoring and assessing the brain and spinal cord. A neonatal ICU is designed and equipped to care for infants who are ill, born prematurely, or have a condition requiring constant monitoring. A trauma/burn ICU provides specialized injury and wound care for patients involved in auto accidents and patients who have gunshot injuries or burns. Intensive care unit equipment includes: Patient monitoring devices, Life support and emergency resuscitation devices, and Diagnostic devices.

II. LITERATRURE SURVEY

1. Leo Anthony Celi, MD; Erkan Hassan, PharmD, FCCM; Cynthia Marquardt, RN, MS; Michael Breslow, MD, FCCM; Brian Rosenfeld, MD, FCCM, FCCP proposed "EICU(Electronic Intensive Care Unit);It's not just telemedicine"

This article describes a technology-enabled care model (electronic ICU, or eICU) that represents a new paradigm for delivery of critical care services. A major component of the model is the use of telemedicine to leverage clinical expertise and facilitate a round-the-clock proactive care by intensives -led teams of ICU caregivers. Novel data presentation formats, computerized decision support, and smart alarms are used to enhance efficiency, increase effectiveness, and standardize clinical and operating processes. In addition, the technology infrastructure facilitates

performance improvement by providing an automated means to measure outcomes, track performance, and monitor resource utilization. The program is designed to support the multidisciplinary intensives-led team model and incorporates comprehensive ICU re-engineering efforts to change practice behavior. Although this model can transform ICUs into centers of excellence, success will hinge on hospitals accepting the underlying value proposition and physicians are willing to change established practices.

2. Atharva Bubal, ArchanaChorge, PriyankaChoure, Prof. A. B. Vitekar proposed " Automated Oxygen Level and Blood Pressure Sensing Using Embedded System"

Blood pressure and the oxygen related problem has become more critical. So we are implementing an automated oxygen and blood pressure sensing system. The blood pressure sensing system will give the diastolic and systolic pressure reading on the display. In the oxygen sensing system the concentrations of oxygen is evaluated in both breath in and breathes out air in non-invasive manner in which the luminescence is generated by the oxygen sensitive luminophore. It directly depends on the concentration of the surrounding oxygen.

3. AmitRana, Dr. Smt. A.S. Bhalchandra proposed "Machine Monitoring on Cloud using Raspberry Pi and Internet of Things"

This paper demonstrates a novel approach in industrial machine monitoring on cloud server using Internet of Things implemented on Raspberry Pi. The raspberry pi is a small credit card sized computer which can directly send data to the cloud server. Any kind of CNC or industrial machine can be connected to Raspberry pi giving logical inputs and can be monitored on the internet based server so that the real time production data, the work

4. R.Kumar, Dr.M.Pallikonda Rajasekaran proposed "Raspberry pi Based Patient Health Status Observing Method Using Internet of Things"

In the advancement of Internet technologies all machineries are interred related. Using the technology improvement, we can make many things in high effective and simple for human life. There are several places of Internet of Things (IOT) is used. Such as smart environment, smart home, smart city, smart parking, agriculture fields and medical fields. In medical field also, there are several process are used internet.

5. Yogita Vijay Narkhede, S. G. Khadke proposed "Application of Raspberry Pi and PIR Sensor for Monitoring of Smart Surveillance System"

This paper represents the design and implementation of smart surveillance monitoring system using Raspberry pi and PIR sensor for mobile devices. It increases the usage of mobile technology to provide essential security to homes and other control applications. The proposed house security system captures information and transmits it through a 3G modem to a smart phone using web application.

6. Mendel Biswas, Rupali S. Landge, Bhagyashree A. Mahajan, Sharada Kore proposed "Raspberry Pi Based Patient Monitoring System using Wireless Sensor Nodes"

The monitoring of the patient wirelessly is a major improvement in the medical domain. The micro sensors when integrated into a wireless communication network, helps to remotely collect physiological signals of patient and avoid monitoring using traditional medical instruments which makes the patient tether. In this project, the monitoring of the patient is done by the doctor continuously without actually visiting the patient.

III. PROPOSED SYSTEM

Health is one of the global challenges for humanity. In the last decade the healthcare has drawn considerable amount of attention. The prime goal is to develop a reliable patient monitoring system so that the healthcare professionals can monitor the patients, who are either hospitalized or executing their normal daily life activities. Smart ICU is a scheme where we use cutting-edge technology to provide ICU expertise and leadership and improvising outcomes with measurable results. It is a remote monitoring hub for all critically ill patients in the health care system. In the Smart ICU, nurses, an intensivist, unit clerks assist to provide in-time interventions and quality assurance for patients and beside clinical.

An Intensives or a Trauma care specialist can monitor or address the ICU patient even if he is not present in the hospital, with the help of the display units which shows all the patient's parameters. The doctor can address the bedside nurse with the medicine and other required procedures, also communicate with the patient directly. Our main objective here is to make improvement in patient's outcome including reducing hospital mortality and patient's length of stay in the ICU irrespective of the locations.

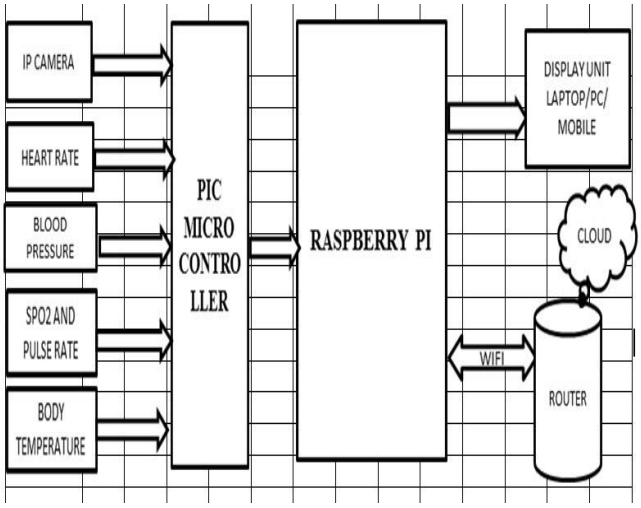

Fig 1: Proposed Architecture

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In this project there are certain parameters which I am going to measure, the parameters are as follows:

Blood Pressure and your body:

High blood pressure has many harmful effects on the body. It increases the risk of having a heart attack or stroke. By taking control of your blood pressure you can make a positive step towards reducing your overall risk of developing cardiovascular disease. Ireland has one of the highest incidence rates of Stroke and Coronary Artery Disease in Europe, with one in seven of all Irish adults having high blood pressure. High blood pressure can cause silent damage to the blood vessels and the heart. If left untreated the damage may progress and result in a stroke or a heart attack. Blood pressure is the force of blood against the walls of the arteries when the heart contracts. Everyone has blood pressure. While a certain amount of pressure is needed to keep the blood flowing, this pressure can increase if the blood meets resistance in the arteries. Blood flowing through the arteries at high pressure can damage artery walls. If this pressure is persistently high, this is called high blood pressure or "hypertension". High blood pressure is a sign that the heart and blood vessels are being overworked.

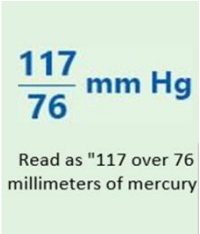

Fig 2: Blood pressure ratio

Blood Pressure Category	Systolic mm Hg (upper #)		Diastolic mm Hg (lower #)
Normal	less than 120	and	less than 80
Prehypertension	120 – 139	or	80 – 89
High Blood Pressure (Hypertension) Stage 1	140 – 159	or	90 – 99
High Blood Pressure (Hypertension) Stage 2	160 or higher	or	100 or higher
Hypertensive Crisis (Emergency care needed)	Higher than 180	or	Higher than 110

Table 1: blood pressure chart

SPO2

Pulse oximeters provide a spectro photometric assessment of functional arterial hemoglobin oxygenation (SpO2). Pulse Oximetry is based on the following two principles: First, hemoglobin (Hb) and oxygenated hemoglobin (HbO2) differ in their absorption of red and infrared light. Second, the volume of arterial blood in tissue (and therefore light absorption by the haemoglobin) changes during the pulse. A pulse oximeter passes red and infrared light into an arteriolar bed, measures changes in light absorption, and determines SpO2. Chronic respiratory diseases such as COPD and asthma are among the most common health conditions seen in primary care practices, affecting more than 1 billion patients worldwide. Primary care clinicians are also often the first point of contact for patients suffering from acute respiratory infections such as influenza and pneumonia. These health care professionals need tools to help them evaluate, monitor, and decide when to refer patients with respiratory conditions.

ECG

Populations of cells eliciting changes in their membrane potential at a given point in time; it shows electrical differences across the heart when depolarization and repolarization of these repolarization of these atrial and ventricular cells occur. The human body can be considered, for the purposes of an ECG, a large-volume conductor. It is basically filled with tissues surrounded by a conductive ionic fluid. You can imagine that the heart is suspended inside of that conductive medium. Moves, there will be one part of the cardiac tissue that is depolarized and another part that is at rest or polarized. This results in a charge separation, or dipole, which is illustrated. During the cardiac cycle, the heart contracts in response to action potentials moving along the chambers of the heart. moves, there will be one part of the cardiac tissue that is depolarized and another part that is at rest or polarized.

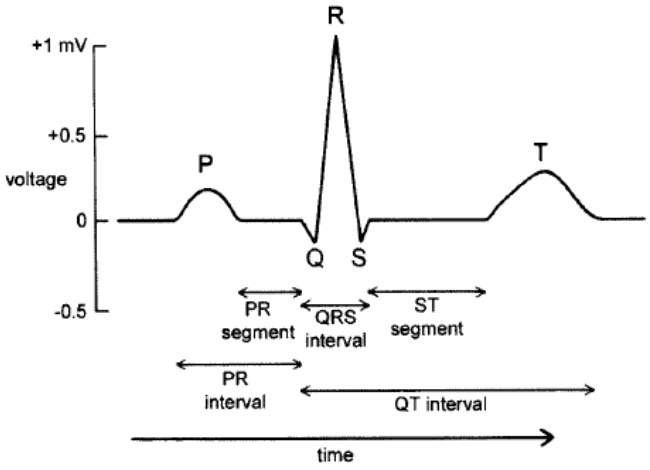

Fig 3: ECG waveform

IV. DESIGN METHODOLOGY

This third and last portion of this arrangement on creative plans for the keen ICU tends to the means associated with conceptualizing, completing, utilizing, and keeping up the propelled ICU informatics framework and frameworks. The

shrewd ICU thoroughly and electronically incorporates the patient in the ICU with all parts of care, shows information in an assortment of configurations, changes over information to noteworthy data, utilizes information proactively to upgrade understanding wellbeing, and screens the ICU condition to encourage persistent care and ICU administration. The keys to accomplishment in this mind boggling informatics configuration process incorporate a comprehension of cutting edge informatics ideas, complex arranging, and establishment of a vigorous framework fit for both availability and interoperability, and execution of middleware arrangements that offer some benefit. Albeit new advancements normally seem convincing, they are likewise confused and testing to consolidate inside existing or developing healing center informatics frameworks. Subsequently, cautious investigation, ponder testing, and a staged way to deal with the usage of creative advancements are important to accomplish the multilevel arrangements of the brilliant ICU. Presently we have joined the dialysis machine with the brilliant ICU approach making it a "Savvy Laryngoscope".

HDMI CABLE

Predominant Audio/Video Signal Performance: PCT's improved protecting execution High Definition Multimedia Interface (HDMI®) links by PCT® give fast, present day home theater associations. With only one link, uncompressed sound and video signals are transmitted between shopper electronic gadgets. This link gives fresh, clear solid and a sharp, clear picture with splendid, exact hues and precisely nitty gritty pictures. Offering our clients items and administrations with the most noteworthy quality execution and long haul unwavering quality is dependably at the pinnacle of our targets. That is the reason PCT's manufacturing plant has earned the authority Certified HDMI Adopter status with HDMI Licensing, LLC. For our clients, this implies when you buy PCT's High Speed HDMI links, you realize that our links are composed and tried as per stringent HDMI Adopter Agreement particulars.

RASPBERRY PI MODULE 3

The Raspberry Pi 3 Model B is the third generation Raspberry Pi. This powerful credit-card sized single board computer can be used for many applications and supersedes the original Raspberry Pi Model B+ and Raspberry Pi 2 Model B. Whilst maintaining the popular board format the Raspberry Pi 3 Model B brings you a more powerful processer, 10x faster than the first generation Raspberry Pi. Additionally it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected designs RS Part Number 896-8660.

Fig 4: ECG waveform

Upgraded switched power source up to 2.5 Amps (can now power even more powerful devices over USB ports) The main differences are the quad core 64-bit CPU and on-board Wi-Fi and Bluetooth. The RAM remains 1GB and there is no change to the USB or Ethernet ports. However, the upgraded power management should mean the Pi 3 can make use of more power hungry USB devices For Raspberry Pi 3, Broadcom have supported us with a new SoC, BCM2837. This retains the same basic architecture as its predecessorsBCM2835 and BCM2836, so all those projects and tutorials which rely on the precise details of the Raspberry Pi hardware will continue to work. The 900MHz 32-bit quad-core ARM CortexA7 CPU complex has been replaced by a custom-hardened 1.2GHz 64-bit quad-core ARM Cortex-A53 In terms of size it is identical to the B+ and Pi 2. All the connectors and mounting holes are in the same place so all existing add-ons, HATs and cases should fit just fine although the power and activity LEDs have moved to make room for the WiFi antenna. The performance of the Pi 3 is roughly 50-60% faster than the Pi 2 which means it is ten times faster than the original Pi. All of the connectors are in the same place and have the same functionality, and the board can still be run from a 5V micro-USB power adapter. This time round, we're recommending a 2.5A adapter if you want to connect power-hungry USB devices to the Raspberry Pi.

SENSORS

LM35 TEMPERATURE SENSOR

The LM35 arrangement are accuracy incorporated circuit temperature sensors, whose yield voltage is directly corresponding to the Celsius (Centigrade) temperature. The LM35 consequently has leverage over straight temperature sensors adjusted in ˚ Kelvin, as the client isn't required to subtract a vast consistent voltage from its yield to get helpful Centigrade scaling. The LM35 does not require any outside adjustment or trimming to give average exactnesses of ±1⁄4˚C at room temperature and ±3⁄4˚C over a full −55 to +150˚C temperature run. Ease is guaranteed by trimming and adjustment at the wafer level. The LM35's low yield impedance, direct yield, and exact characteristic adjustment make interfacing.

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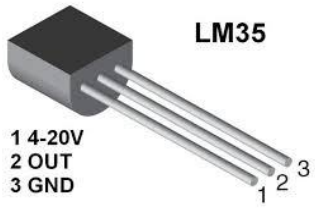

Fig 5: LM315 PIN Diagram

Readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1˚C in still air. The LM35 is rated to operate over a −55˚ to +150˚C temperature range, while the LM35C is rated for a −40˚ to +110˚C range (−10˚ with improved accuracy).

BLOOD PRESSURE MODULE

Blood Pressure & Pulse reading are shown on display with serial out for external projects of embedded circuit processing and display. Shows Systolic, Diastolic and Pulse Readings. Compact design fits over your wrist like a watch.

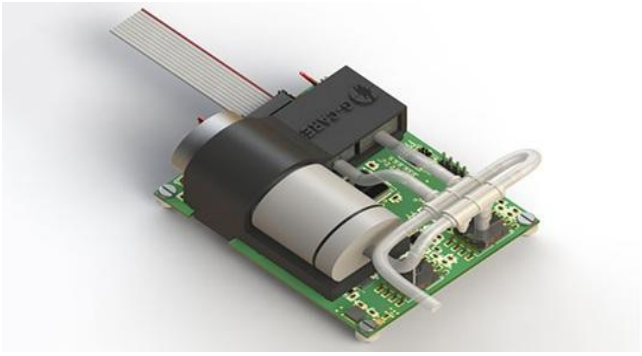

Fig 6: LM315 PIN Diagram

Blood pressure is the pressure of the blood in the arteries as it is pumped around the body by the heart. When your heart beats, it contracts and pushes blood through the arteries to the rest of your body. This force creates pressure on the arteries. Blood pressure is recorded as two numbers— the systolic pressure (as the heart beats) over the diastolic pressure (as the heart relaxes between beats). The unit which measures this is called Sphygmomanometer.

ECG SENSOR

This sensor is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and output as an analog reading. ECGs can be extremely noisy, the AD8232 Single Lead Heart Rate Monitor acts as an op amp to help obtain a clear signal from the PR and QT Intervals easily.

MAX30100- PULSE OXIMETER

The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor solution. It combines two LEDs, a photo detector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

Cuff:

The sleeve is an indispensable piece of the circulatory strain analyzer venture and is a standout amongst the most imperative parts. The sleeve is ordinarily set easily and cozily around an upper arm, at generally an indistinguishable vertical range from the heart while the subject is situated with the arm bolstered. It is fundamental that the right size of sleeve is chosen for the patient. At the point when too little a sleeve brings about too high a weight, while too expansive a sleeve brings about too low a weight, so it comes in four sizes, for youngsters up to stout grown-ups. Additionally, it is made of a non-flexible material, and the sleeve utilized is around 20% greater than the arm. The sleeve is expanded until the point when the conduit is totally impeded. At that point, the sensor makes a move detecting the brachial corridor at the sleeve; the microcontroller controls the valve which gradually discharges the weight in the sleeve. As the weight in the sleeves falls, a throb sound is heard when blood stream first begins again in the vein. The weight at which this sound started is referred to and recorded as the systolic pulse. Moreover, the sleeve weight is additionally discharged until the point that the sound can never again be heard. This is recorded as the diastolic circulatory strain. There are two primary circulatory strain streams, for example, systolic pulse and diastolic pulse. The following are the meanings of each blood stream.

RASPBERRY PI CAMERA

This record portrays the utilization of the three Raspberry Pi camera applications. There are three applications gave: grate still, scratched and raspistillyuv. Both grate still and raspistillyuv are fundamentally the same as and are proposed for catching pictures, while raspivid is for catching video. Every one of the applications are summon line driven, written to exploit the mmal API which keeps running over OpenMAX. The mmal API gives a simpler to utilize framework than that displayed by OpenMAX. Note that mmal is a Broadcom particular API utilized just on Video center 4 frameworks. The applications utilize something like four OpenMAX (mmal) parts - camera, see, encoder and invalid sink.

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V. RESULTS AND DISCUSSIONS

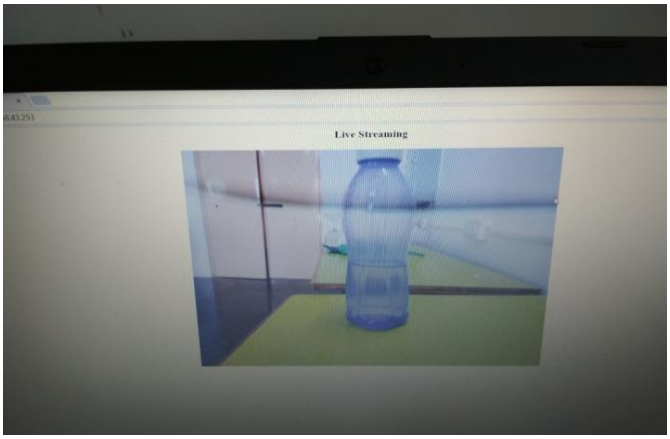

Figure 7: output of visualized graphically live stream

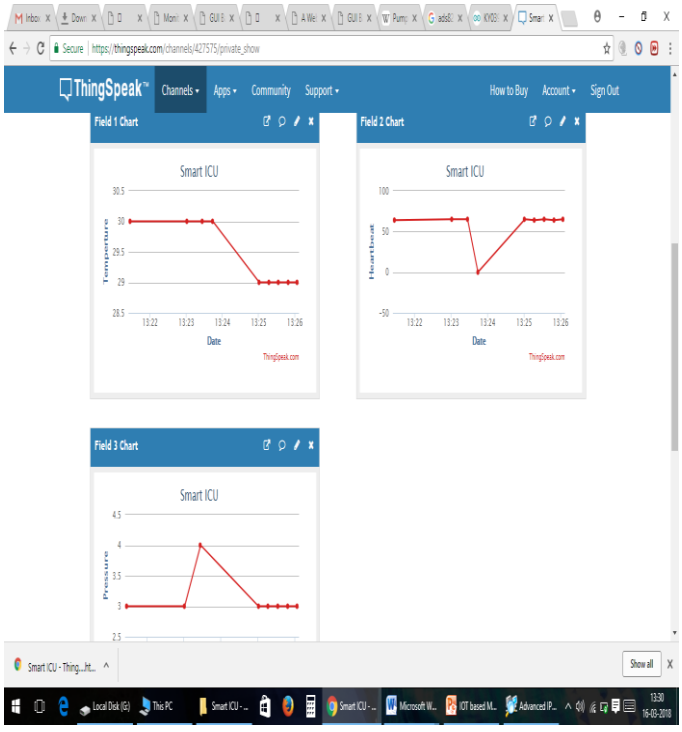

Figure 8:Output Waveform

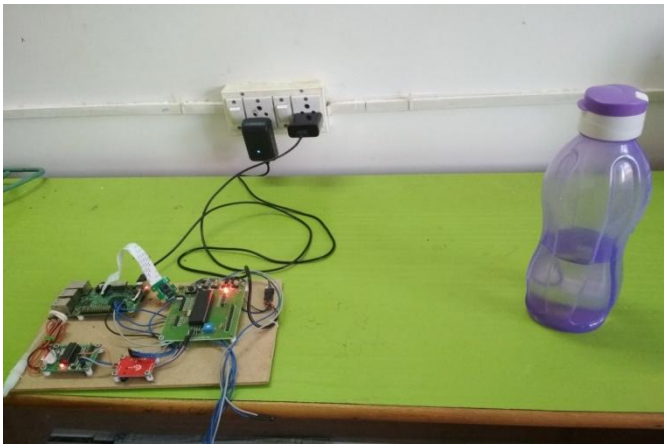

Figure 9: output of Stage 2 live streaming

VI. CONCLUSION

This project describes about the modern health care system known as Smart ICU or EICU. It is an intelligent technology along with sensors for health monitoring and diagnosis. Doctors and the nurses have to attend different patients every day, so they won't be able to concentrate on one patient throughout the day. During this period the patient in the ICU might get critical and because of the medical personas absence the patient might die too. So to overcome such cases the Smart ICU comes handy. It will show all the patients parameters and the doctor can check it from anywhere in the world with a simple cloud id and the internet. Problems like records, communication won't be an issue as everything is possible in Smart ICU even video calling and communicating with the nurses or the patient.

The future of the project will show the expansion of eICU or the Smart ICU technology. With this technology being adapted the doctors will be at ease and so the communication problem with the doctor and the patient will also be solved. The doctor will be able to track the patients anytime and from anywhere in the world. There might also be a possibility of adding the zooming facilities in the Smart ICU approach with higher security facilities.

VII. ACKNOWLEDGMENT

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