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Smart ICU-for Remote TraumaCare Support

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ABSTRACT: Smart ICUs are networks of audio-visual communication and computer systems that link critical care doctors and nurses (intensivists) to intensive care units (ICUs) in other, remote hospitals. The intensivists in the “command center” can communicate by voice with the remote ICU personnel and can receive video communication and clinical data about the patients. Direct patient care is provided by the doctors and nurses in the remote ICU who do not have to be intensivists themselves. In recent years there has been an increase in the number of patients needing ICU care without a corresponding increase in the supply of intensivists. Smart ICUs can be a valuable resource for hospitals faced with the need to expand capacity and improve care for a growing elderly population. Evidence from some early-adopter hospitals indicates that it can leverage management of patient care by intensivists, reduce mortality rates, and reduce LOS. However, positive outcomes appear to depend on the organizational environment into which the Smart ICU is introduced. The dramatic improvements in mortality and LOS reported by some early-adopter hospitals have not been matched in most hospitals. These differences may be due to more complicated organizational structures or less enthusiastic adoption of Smart ICU by physicians. For example, intensivists may only monitor and not manage patient care, or personnel may not be adequately trained in responding to alerts. As with most medical technologies, some applications of Smart ICUs are more likely than others to yield improved outcomes. The limited research available suggests that the best outcomes may occur in ICUs that: Can make organizational arrangements to support the management of patient care by intensivists using Smart ICU; Have little or no intensive staff available to them in the absence of Smart ICU; Have relatively high severity-adjusted mortality and LOS rates; Are located in remote or rural areas where safe and efficient transfer of patients to regional centres for advanced critical care presents difficulties. Smart ICU connects a central command centre staffed by intensivists with patients in distant ICUs. Continuous, real-time audio, video, and electronic reports of vital signs connect the command center to the patients’ bedsides. Computer-managed decision support systems track each patient’s status and give alerts when negative trends are detected and when changes in treatment patterns are scheduled. The patient data include physiological status (e.g., ECG and blood oxygenation), treatment (e.g., the infusion rate for a specific medicine or the settings on a respirator), and medical records.

KEYWORDS: Smart ICU, hospitals, LOS rates, Health care parameters, Sensors.

I. INTRODUCTION

An intensive care unit (ICU) is defined as a specially staffed, specialty equipped, separate section of a hospital dedicated to the observation, care, and treatment of patients with life threatening illnesses, injuries, or complications from which recovery is possible. It provides special expertise and facilities for the support of vital function and utilizes the skill of medical nursing and other staff experienced in the management of these problems. 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

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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. Neuromedical 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. One of the traditional roles of nurses involves surveillance. This might include watching patients for changes in their condition, recognising early clinical deterioration and protection from harm or errors. For over 100 years, nurses have performed this surveillance using the same vital signs: temperature, pulse, blood pressure, respiratory rate and in recent years, oxygen saturation. Prompt detection and reporting of changes in these vital signs are essential as delays in initiating appropriate treatment can detrimentally affect the patient's outcome. Patients admitted to acute hospitals today are sicker than in the past, as they have more complex health problems and are far more likely to become seriously ill during their admission. In addition, patients who were once too sick to be operated on are now undergoing complex surgical procedures. This, coupled with the increasing demand for beds, means that ward nurses are often caring for patients who previously would have been cared for in a high-dependency or intensive care unit. Furthermore, system factors such as skill mix, nurse: patient ratios and bed shortages significantly impact on the quality of nursing care delivered in these environments.

This challenging situation is further complicated by increasing patient survival rates, which have resulted in an increasingly complex and older patient population. Patients aged 65 and older, for example, have twice the risk of younger adults of developing peri-operative complications. They are also more likely to be admitted as emergencies and undergo emergency surgery. Diminished reserves in cognitive, renal and hepatic function also contribute to older patients being a group at high risk of adverse events. As such, the five traditional vital signs may not be adequate to detect clinical changes in patients who have more complex care needs than nurses have encountered in the past. Before an acute change in a patient's physiology can be recognised, the vital signs must be accurately assessed. This paper summarises the five traditional vital signs and recommends additional ones that should be part of an acute care nurses' repertoire of patient assessment.

II. RELATED WORK

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 behaviour. Although this model can transform ICUs into centres of excellence, success will hinge on hospitals accepting the underlying value proposition and physicians are being willing to change established practices. 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. 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 currently going on, the employee who is working on a particular machine, the rate of production, causes of delays and downtimes everything

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can be monitored by the supervisory or authorities sitting at a remote location almost anywhere in the world. Moreover the system is very simple which can be operated by unskilled workman working on the floor.

In the advancement of Internet technologies all machineries are interrelated. 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. In this paper, monitor patient's heart rate, body temperature, Respiration rate and body movements using Raspberry Pi. After connecting Internet to the Raspberry Pi board it act as a server. Then the server is automatically sends data to the web server. Then these parameters are monitor using webpage anywhere in the world using laptops, smart phone etc. If these parameters go to abnormal, it will automatically send alert message to the doctor. The proposed house security system captures information and transmits it through a 3G modem to a smart phone using web application. Raspberry pi operates and controls motion detectors; video camera for remote sensing, surveillance, streams live video and records it for future playback. Infrared sensor detects the located persons. For example, when motion is detected, the cameras starts recording and the Raspberry pi device alerts the possible illicit having a smart phone. Raspberry-pi includes two main components: 1- Web Application that executes on the mobile device's browser. 2- the server-side scripts that operated by the Raspberry Pi Hardware tool component run in a cloud.

The resolution of an experimental microwave tomography (MWT) system was investigated. Author used two cylindrical nylon targets and an operating frequency of 5 GHz, and achieved a separation resolution of 2 mm, or 1/30 of a wavelength. While this resolution is among the highest reported in the literature, it is not a sufficiently robust indicator of the expected resolution obtainable for complex targets, and this was shown with further examples of more complicated targets. 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. Here, we are using various sensors to sense the physiological parameters like temperature, blood pressure [3] ECG and the level of saline. These sensed signals are transmitted to the Raspberry pi to update the data continuously via ADC which will convert these analog signals into digital signals. Through RF transmitter, the data is sent wirelessly to the monitor screen of the doctor. So, the doctor can visualize the patient's data just by sitting in his cabin. When a critical condition occurs, the visual indications will be sent onto the screen. Emerging IoT (Internet of Things) technologies provide many benefits to the improvement of healthcare service. The successful deployment of IOT depends on ensuring security and privacy that need to adapt to their Processing capabilities. IOT are vulnerable to attacks since communications are mostly wireless. So far, most researchers have only focused on security or privacy issues related to wireless communication in the IOT environment without considering all the communication vulnerabilities. However, since most of biometric data from sensors travel over the cellular network, we are required to study a privacy-enhanced scheme that covers all the secure communications. Therefore, we propose a novel privacy-enhanced mobile healthcare system in the IoT environment. Our proposed scheme provides anonymous communication between a patient and a doctor in a wireless cellular network satisfying security requirements and guaranteeing its efficiency.

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 intensives, unit clerks assist to provide in-time interventions and quality assurance for patients and

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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.

Smart ICU is also known as EICU (Electronic intensive care unit), 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 behaviour. Although this model can transform ICUs into centres of excellence, success will hinge on hospitals accepting the underlying value proposition and physicians are being willing to change established practices.

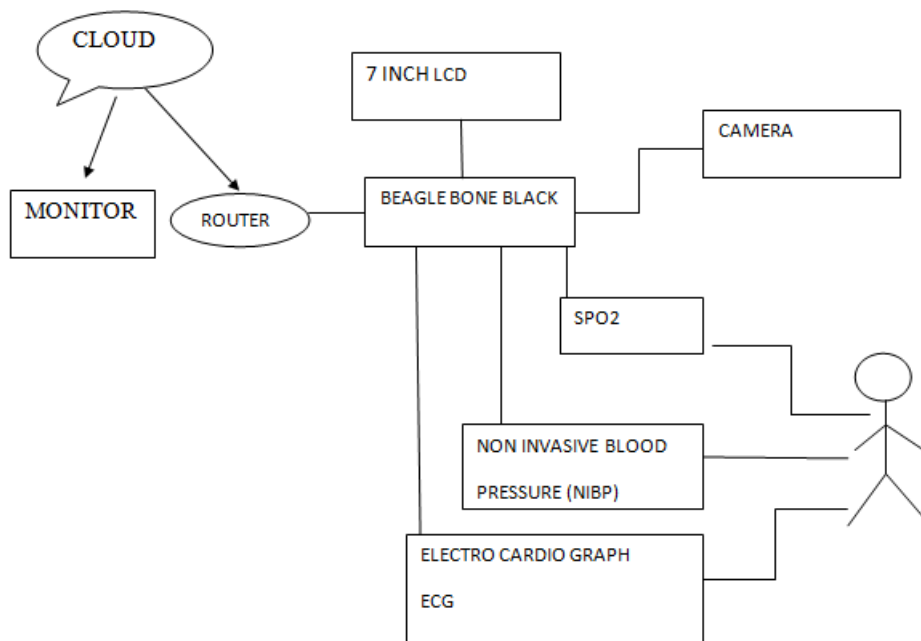


Fig 1: Proposed system block diagram

In the phase 1 of my 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

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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.

SPO2

Pulse oximeters provide a spectro photometric assessment of functional arterial haemoglobin oxygenation (SpO₂). Pulse Oximetry is based on the following two principles: First, haemoglobin (Hb) and oxygenated haemoglobin (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.

Heart Rate

We should all aim to do at least 150 minutes of moderate intensity exercise every week. Moderate intensity means that you should feel warm and slightly breathless, but still able to hold a conversation. Aerobic exercise, such as cycling and dancing, is best as it helps improve the fitness of your heart and circulation and helps develop stamina. Your target heart rate (THR) is between 50% and 70% of your maximum heart rate. You should aim to exercise with your heart rate between these two figures. To work out your target heart rate, multiply your maximum heart rate by 50% and 70%. Example To work out the target heart rate for a 42 year old: $178 \times 50\% = 89$ bpm $178 \times 70\% = 125$ bpm So a 42 year old person should aim to exercise with their heart rate between 89 and 125 bpm.

Many of the medicines used to treat heart conditions can slow down the heart rate and prevent the heart from responding as it normally would. So, if you are taking medicines, such as beta blockers for example, it may be easier and more effective to do the ‘talk test’ while you are exercising, rather than monitoring your heart rate. If, while you are walking, you feel warm and are breathing more heavily than normal, but you can still talk, you are probably walking at the right pace.

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 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. These results in a charge separation, or dipole, which is illustrated in cause current flow in the surrounding fluid, creating an electric field that could be detected by electrodes placed in the solution. A similar electrical field around the heart can be detected using electrodes attached to the skin. The intensity of the voltage detected depends on the orientation of the electrodes with respect to that of the dipole ends. The amplitude of the signal is proportional to the mass of tissue involved in creating that dipole at any given time. Using electrodes on the surface of the skin to detect the voltage of this electrical field is what provides the electrocardiogram. It is important to note, as might be expected, that because the ECG is measured on the skin, any potential differences within the body can have an effect on the electrical field detected. This is why it is

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considered important for diagnostic purposes that, while recording an ECG from an individual, the individual should remain as still as possible. Movements

Heartbeat Sensor

Heart beat sensor is designed to give digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heartbeat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.

IV. DESIGN METHODOLOGY

This third and final instalment of this series on innovative designs for the smart ICU addresses the steps involved in conceptualizing, actualizing, using, and maintaining the advanced ICU informatics infrastructure and systems. The smart ICU comprehensively and electronically integrates the patient in the ICU with all aspects of care, displays data in a variety of formats, converts data to actionable information, uses data proactively to enhance patient safety, and monitors the ICU environment to facilitate patient care and ICU management. The keys to success in this complex informatics design process include an understanding of advanced informatics concepts, sophisticated planning, and installation of a robust infrastructure capable of both connectivity and interoperability, and implementation of middleware solutions that provide value. Although new technologies commonly appear compelling, they are also complicated and challenging to incorporate within existing or evolving hospital informatics systems. Therefore, careful analysis, deliberate testing, and a phased approach to the implementation of innovative technologies are necessary to achieve the multilevel solutions of the smart ICU. Now we have combined the dialysis machine with the smart ICU approach making it a “Smart Dialysis Machine”.

RS-232

An RS-232 serial port was once a standard feature of a personal computer, used for connections to modems, printers, mice, data storage, uninterruptible power supplies, and other peripheral devices. However, RS-232, when compared to other serial interfaces such as RS-422, RS-485 and Ethernet, is hampered by low transmission speed, short maximum cable length, large voltage swing, large standard connectors, no multipoint capability and limited multidrop capability. In modern personal computers, USB has displaced RS-232 from most of its peripheral interface roles. Many computers no longer come equipped with RS-232 ports (although some motherboards come equipped with a COM port header that allows the user to install a bracket with a DE-9 port) and must use either an external USB-to-RS-232 converter or an internal expansion card with one or more serial ports to connect to RS-232 peripherals. Nevertheless, thanks to their simplicity and past ubiquity, RS-232 interfaces are still used—particularly in industrial machines, networking equipment, and scientific instruments where a short-range, point-to-point, low-speed wired data connection is adequate.

Sony Camera

IMX219 is a diagonal 4.60mm (Type 1/4.0) CMOS active pixel type image sensor with a square pixel array and 8.08M effective pixels. This chip operates with three power supplies, analogue 2.8V, digital 1.2 V, and IF 1.8 V, and has low power consumption. High sensitivity, low dark current, and no smear are achieved through the adoption of R, G, and B primary colour pigment mosaic filters. This chip features an electronic shutter with variable charge-storage time. In addition, this product is designed for use in cellular phone and tablet pc. When using this for another application, Sony does not guarantee the quality and reliability of product. Therefore, don't use this for applications other than cellular phone and tablet pc. Consult your Sony sales representative if you have any questions.

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Beagle Bone Black (BBB)

The Beagle Bone Black is the latest addition to the BeagleBoard.org family and like its predecessors, is designed to address the Open Source Community, early adopters, and anyone interested in a low cost ARM Cortex-A8 based processor. It has been equipped with a minimum set of features to allow the user to experience the power of the processor and is not intended as a full development platform as many of the features and interfaces supplied by the processor are not accessible from the Beagle Bone Black via onboard support of some interfaces. It is not a complete product designed to do any particular function. It is a foundation for experimentation and learning how to program the processor and to access the peripherals by the creation of your own software and hardware.



Fig 2: Beagle Bone Black

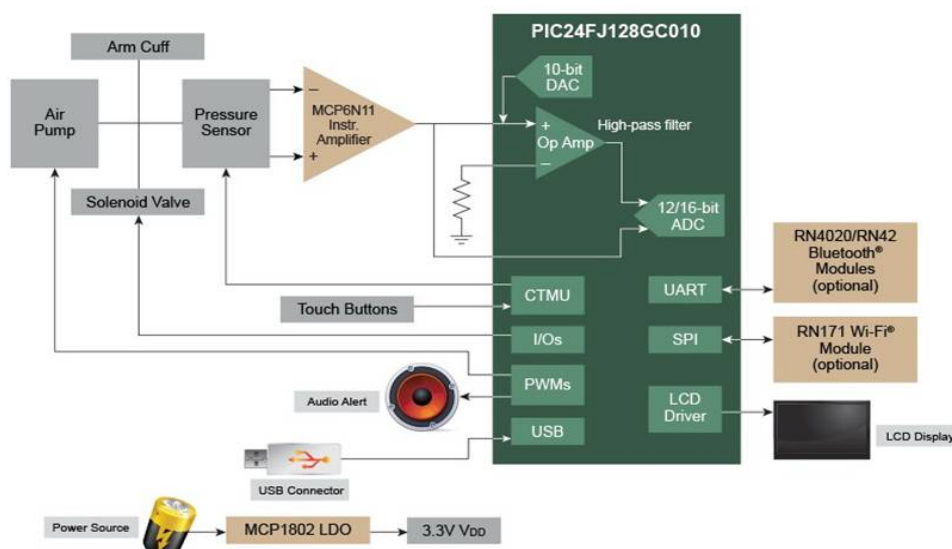


Fig 3: Blood pressure meter block diagram

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V. 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 person's absence the patient might die too. So to overcome such cases the Smart ICU comes handy. It will show all the patient's 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.

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