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An Intelligent Medical Care Solution for Elderly People with Long Term Health Condition Based on Wireless Sensors Network Technology

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***Abstract*—**Older Adults are facing serious difficulties, on a regular basis, to manage their own daily life activities. To live independently and have a good quality of life is quite a challenge, since the majorly of them have long term health condition diseases. Health services providers across EU, informal and formal carer plays major roles in providing the necessary services and support. Diseases on this society are one of the leading causes of death, from which thousands of people die every year. Many of the non-communicable diseases can be prevented by tackling associated risk factors. The cost of treatment of such diseases in the EU is estimated to be over 70% of the Health Service budget. Treatment includes home-care, medication, consultation and many other relevant services. However, these services are still not adequate, due to the lack of implemented technology that enable the older adults to manage their daily life activities independently, taking medications, receive the necessary health services on time, which, in many cases leads to loss of lives and waste of NHS resources. Daily life activities management and telehealth remote monitoring system is one of the potential innovative approaches, to improve the older adult's quality of life, help live independently, improve NHS services, sustain its economic growth and improve social development. It is a rapidly developing concept where daily life activities, health condition, medical information is transferred through interactive data, and audiovisual media and shared between services provider, informal and formal carer. This paper presents the initial outcomes of the ongoing research program that is planned to develop an Integrated Assisted Living Technology (ALT) multi-functional case driven wireless ad-hoc management system of the daily life activities of older adults using smart sensors and actuators, 3d-video, audio, radio frequency identification and wireless technology, combined with secure cloud and semantic data engineering.

***Keywords*—**Assisted living technology, wireless sensors network, healthcare, telehealth, telecare, digital health care system.

I. Introduction

INCREASINGLY adults are living longer than ever and as such face significant challenges to manage their daily life activities with a good standard of life. To live independently and have a good quality of life is a challenge, since the majority of older adults have a long term health condition (LTC) which requires some intervention. This burden is replicated across health service providers throughout the EU and is shared by informal and formal care providers who play a major role in providing the point of care services and support at the point of need. Furthermore, older adults are affected by a range of chronic diseases such as: cardiac infarction; stroke; macular degeneration; glaucoma; diabetes, dementia, and high blood pressure. All of which require active monitoring and intervention, failure to deliver the necessary care to this community can lead to reduced quality of life and ultimately death. 63% of all deaths in the world are within the older adult population and may have been due to one of these chronic LTC's. Out of the 36 million people who died worldwide from disease in 2008, 29% were under 60 and half were women [1]. By 2020 it is predicted that there will be more than 15 million new elderlies with long term health condition each year [2]. It is also envisaged that these diseases will in the future contribute to seven out of every 10 deaths in developing countries. Many of the non-communicable diseases can be prevented by tackling associated risk factors. The cost of care and treatment of long term health condition diseases for elderly in the EU is estimated to consume over 70% of the overall Health Service (HS) provider budget [3]. Care and treatment includes support daily life activities, home-care, medication, consultation and many other relevant services. However, these services are still not adequate, due to the lack of implemented technology that enable the older adults to manage their daily life activities independently, taking medications, receive the necessary health services on time, which in many cases leads to loss of lives and waste of NHS resources. With the new health services model in many of EU countries and the risk of other health initiative budgets being cut, combined with an ageing population, caring for this sector of society is becoming increasingly more difficult as well as balancing over-inflated costs with timely care, safety measures, and sustained levels of care, while allowing older adults to retain their independence.

Telecare including daily life activities management and telehealth remote monitoring system is one of the potential innovative approaches, to improve the older-adults quality of life, help live independently, improve NHS services, sustain its economic growth and improve social development. It is a rapidly developing concept where daily life activities, health

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condition and medical information is disseminated through interactive data, audiovisual media to individuals and shared between services provider, informal and formal carer and in the case of emergency the clinician. This ongoing research is to develop this new concept, technology and develop an Integrated Assisted Living Technology (ALT) multi-functional case driven wireless ad-hoc management system of the daily life activities of older adults using smart sensors & actuators, 3D-Video, audio, Radio Frequency Identification and ZigBee and or Bluetooth wireless technology, combined with Secure Cloud and Semantic data engineering.

This approach will enable the population of older adults to manage their daily life activities within multiple environments including home, care centre and hospital using a universal platform system. This will represent a paradigm shift within the care sector that offers the vision to managing a multiplicity of parameters including: daily activities, taking medication and general health condition as well as monitoring their personal hygiene throughout the daily life cycle ensuring high quality and true independent living within a familiar home environment. There are significant cost benefits to the health sector in maintaining care provision outside of the clinical environment and this is a major driver for ALT health sectors across the EU member states.

There are a number of daily activities that are also critical to a healthy and sustainable life, such as: management of medication, fluid & food intake and management of diet (obesity is becoming a significant factor in treatment of older adults). If either of these areas are neglected by an individual this will result in a deterioration of physical and mental wellbeing leading to hospitalisation and potentially death. This ongoing research will present an integration of innovative sensor technology to enable active monitoring of medication, fluid and food intake based product which can be wirelessly relayed to a central information hub allowing reactive intervention. A spectrum of scenarios that include at one end reduced liquid intake and at the other excessive fluid consumption can lead to discomfort; reduced mental and physical capabilities, disease (urinary tract infection) and even death. De-hydration leading to impaired cognitive function often results in an inability to remember to drink sufficient fluid in the elderly. This is one of the main factors for institutionalised care and hospital admissions which can be avoided by timely and appropriate intervention at the point of need. The approach described in this research programme provides the necessary innovation to allow for monitoring and intervention in all of the key areas including: medication management; management of fluid & food intake and monitoring of health statistics allowing timely decision making and intervention.

Those practiced in the art will appreciate that modern wireless technology and microelectronics makes it possible to cheaply mass produce very small but sophisticated devices for timing, weighing, measuring and providing simple logic, which consumes little power. Thus, the final system will also contain an electronic module that is programmed to alert end-users with the timing pattern of their medication, to monitor dose taking, track and check the medication doses profiles, and communicate the necessary information to a central information hub. This allows for appropriate clinical intervention when required as well as providing an audit trail for future clinical use in decision making on treatment. Often efficiency is reduced when medication is not taken correctly however it is vital that the clinical team recognise that the approach is still the most appropriate form of treatment. When incorporated into the organisation's telehealth system, or incorporated into systems used by others, the device can report that information to a central master unit, to a patient's history file, to a career or relative's mobile phone, etc.

Ideally the final system should be capable of: (a) offering Triage to consultants, carers and the like based on captured data and preferably compared with historical data for that patient to identify unusual patterns, and (b) where accumulated data assists the clinician to evaluate the condition of the patient and record any improvement or deterioration, and (c) monitor the provision of adequate warmth, food and drink, to sustain an individual, and (d) the correct taking of any medication or deviation from that programme, in addition to many other factors relevant to particular diseases.

The system should be also adaptable to monitor certain factors relevant to that older-adults' daily life activities and health condition. For example, someone with blood circulation problems should be monitored to ensure they are in a warm environment, that they move around sufficiently to stimulate their circulation, and that they take the correct medication since taking too little or too much of their blood-thinning medication could be dangerous..

II. State of the Art of Assisted Living Technology

Investigation into the "state-of-the-art of the current technology" relating to daily life activities, telecare and telehealth solutions products, particularly in respect to elderly people conclude that the potential manufacturers of telecare, telehealth products and ongoing projects are: Tunstall/Bosch/Docobo are the major market leaders across EU, with 70% of the current Telehealth and Telecare markets. Accenture: is an American company and is the main player in TeleHealth IT solutions at the moment. They are looking to adopt "Cloud" as their future, however they do not address the issue of Integrated Monitoring systems with case driven data solutions, nor do they seem to address the issues surrounding "who owns what data". CSC Scandihealth eMEDlink®: is a Scandinavian company providing a telemedicine solution (CSC eMEDlink®) for chronic patients and health professionals, which does not appear to be integrated with any case management solution, and would also appear to be autonomous based, therefore not open to generic integration. Mirth Corporation: is an American organization specializing in open source IT communication software aimed at multiple platforms. Their solution can listen, send and connect to ALL forms of protocols. Medway EPR: is a UK Company: Medway EPR is a family of products, built specifically for the UK health sector, which appear to cover all aspects of patient management and care, however we have identified that there seems to be no case driven aspect to their EPR with built in alerts and monitoring solutions integrated with monitoring devices and sensors. There are also a number of UK companies who are focusing in telehealth care products manufacturer and development, such as MedilinkWM-, Baxter Healthcare Ltd, Telehealth Solution Ltd, Healthcare at Home Ltd, Care Monitoring 2000 Ltd - http://www.cm2000.co.uk/home.aspx. There are also a number of EC & UK development projects which are still at the very early stage such as DHIS (District Health Information System) and I-DEAL. The DHIS2 project is a highly flexible, open-source health management information system and data warehouse, and a solution under scrutiny for potential adoption into the Case Driven solution. I-DEAL is a TSB & EPSRC project and is focused on a technology for health, Social care and user need. Alvolution, the assisted living division of MedilinkWM are the leading partners of the project. They are aiming to bring a range of new products to market ranging from Telemedicine through to Environmental control in the context of home and community based assisted living. Hitherto, attempts have been made to design health monitoring around a bespoke system of devices such as a blood pressure meter, a thermometer …etc., connected by a bespoke system attached to a telephone or Bluetooth communication module. Such systems suffer serious drawbacks the most obvious being that the system cannot be expanded to include other types of daily life activities & medical and physical measuring device, or those of other manufacturers. Realizing these some of the current limitations of developed and under development system, this ongoing research programme is developing a universal system based around well-established and permanent technologies of well proven qualities, suitable for embedding into many devices, systems, products and locations, coupled to an intelligent trusted-expert management system suitable for adaptation into all currently foreseen situations and applications, and ready for those of the future.

This integrated ALT ad-hoc wireless telehealth monitoring system will allow any front end products from any manufacturer to be incorporated into the system, enabling the individual, their vital signs, their lifestyle, daily life activities, their home and their surroundings to input useful data so that the expert semantic (trusted) computerized system assimilates all aspects of their existence and uses that data to monitor changes in it, and deterioration of their telehealth or habits so that correctly informed clinical decisions can be made and emergencies can be quickly addressed. The system will be integrated with an intelligent self-assessment close loop platform, enabled self-assessment at the front-end device [4-5]. This is to make sure plugged in daily life activities & medical devices are performing well and if there is any sign of degradation, the necessary action can be taken to replace the device, in appropriate time, to maintain real time monitoring. Those proficient in the art will appreciate that this system (which is an ideal platform for monitoring the elderly) is also perfectly adaptable to many other situations in which monitoring is desirable on elderly care, compassion, medical risk, military, financial and environmental grounds. Thus the system is applicable to many groups of individuals, particularly the elderly and infirm, but also baby monitoring, child care, mental illness and dementia, depression and those at risk from diabetes complications, cardiovascular disease, plus workers at risk such as those working in hot or confined spaces and susceptible to heat exhaustion, etc.

Figure 1 shows the initial Body Area Network and possible health care sensors. It provides initial indications of the health care data that can be obtained and collected.

Figure 1 Body area network and possible integrated wireless sensors [4]

III. Proposed Integrated ALT System Architecture

Figure 2 shows the proposed integrated ALT system architecture. It compromises of two main parts, the front end part and this is to integrate the different devices from different manufactures in ad-hoc base protocol. This will be working on the base of developing sniffing add-hock devices protocol that can obtain all the readings and measurements from the font end devices. These data to be send wirelessly to a platform that has a database and intelligent algorithms for processing. The algorithms that will process this data is mainly present in the second part of the back-end. This will process this information to certain level and will alert and report the initial findings to the care-givers, doctors or family members.

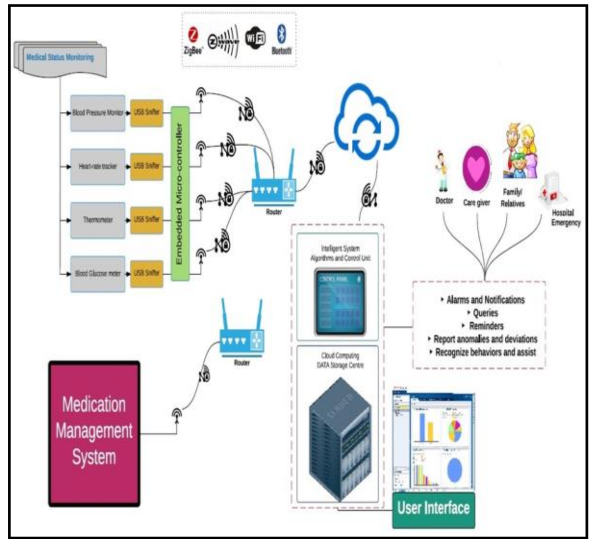
The architecture design and interoperability scenario will be tested in staged phases within different care environments at individual's homes, home care centres, hospitals and carer sites.

IV. Integrated ALT Ad-Hoc System Inter-Operational Scenario

This under development integrated wireless telehealth monitoring system using ZigBee-enabled technology that is in intimate contact with the body or made available at the point of care, linked to a hub communications system hosted locally with the facility for archived data to be hosted on a private cloud. The system also has the facility to provide cross platform (monitored and secure) internet access and hence available simultaneously to any and all those provided access to remotely monitor the user's vital signs, medical condition, changes in physical ability, medicine management, the taking (dosage) of medication, food and liquids …etc. The system can include many other factors. This system will allow someone with compromised health to be monitored and live independently with a high level of care and safety without the necessity of constant one-to-one care; it will allow individuals to be personally monitored and objects to be monitored remotely. The system is universal, since it can be applied to numerous devices simultaneously with minimum adaptation. The system will be multi-functional since it can be applied to the body's vital signs, to medical equipment, to furniture, to household items such as heating, cooking, lighting and refrigeration, and to mobility indicators such as accelerometers, pressure mats, cushions, light switches, lavatory handles, taps, and so on, all of which may indicate the level of mobility of the occupant.

The system will be adaptable since it permits multi-occupancy use in dwellings such as may apply to married couples, hostels, care homes, and even large hospitals and the system is fully and infinitely scalable. The system is intelligent and self-evaluating and reports any problems such as low battery voltage. The system is also expandable by permitting the inclusion of the many domestic appliances and utilities such as electricity supply meters and water meters that use ZigBee processing. The system is reusable since the system interface can easily be removed from one device and fitted to another should the original device be no longer required, become faulty, or become redundant. The system is sustainable, since the system can adapt to improvements in hardware and connectivity, and the software is intelligent and is able to refine its parameters of operation automatically. The data which is generated is very small and can be efficiently stored electronically to be archived or explored to provide statistical data. This data which the devices generate is semantic and contextual, allowing local case-by-case environmental decisions to be made almost instantly locally, followed by interpretation and alerts from that data if necessary, with this data and non-critical data stored on server stacks either locally or in the cloud depending on the requirements of the client. The system uses semantic (trusted) data memory and is complemented by accumulation of historical data for each individual and each set of circumstances, but encrypted and linked in a non-obvious relational way (for security and patient confidentiality reasons).

The system also will benefits from extremely long battery life because the ZigBee-enabled technology hibernates and only wakes and communicates when required on a need-to-know basis. The system is re-usable and of low energy requirement or energy neutral, since it can use power from the equipment to which it is fitted into, or it can operate on battery power, or from solar power or other forms of renewable energy and remote power systems such as inducted power or Seebeck power.



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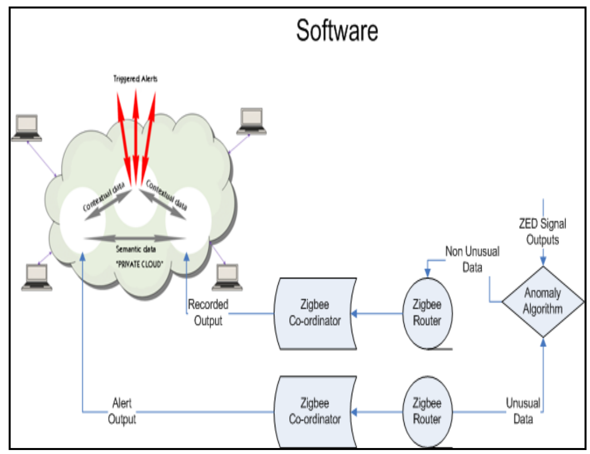

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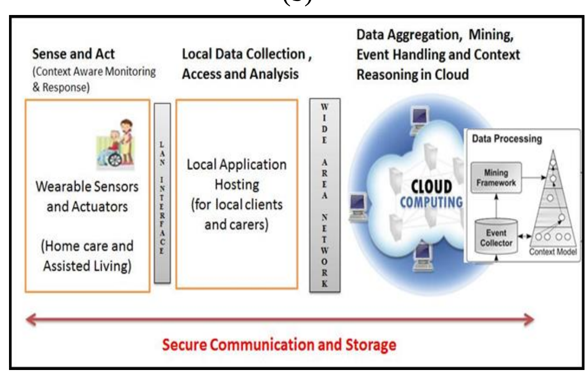


(c)

Figure 1 (a) System overall architecture, (b) schematic view of one typical arrangement of the hardware associated with this application, and (c) tangible example scenario of the implementation of the system idea and possible integration of units using smart ZigBee protocol

Another feature the system will be fully portable and can be fitted anywhere including transport facilities such as ambulances, paramedic operations, and in remote locations where community care becomes challenging and other forms of communication prove difficult. The system provides mapping and location identification from its transmission characteristics. The system is designed based on ad-hoc and can be automatically incorporated into continuous monitoring when transporting the patient in an ambulance for example. The system is case-driven and each patient or device may be combined ad-hoc into a patient's case file or personal monitoring programme. The system utilities are of proven design such that they will not interfere with other communications systems particularly those used in hospitals or used for other medical equipment. The system may also monitor the performance of remote equipment, (for example correct performance from medical instruments, calibration, overheating; correct actions from points, signals and proximity switches in railway operations, and the like).

It has been known that the WSN involve low-power consuming instruments for gathering medical information. Their nodes sense and gather information and then interconnect to a remote monitoring tool/coordinator directly by making use of the technology of wireless information transmission. In addition, the PAN (Personal Area Network) controller possesses memory of large size as well as the firm processors to examine and present the information. Moreover, the layer of physical radio describes the modulation scheme, operating frequency, rate of network data as well as the hardware boundary amongst the nodes. Depending on diverse medical purposes, including periodic or continuous monitoring, the scope of the physical information packet, system speed, transmission range as well as numerous other technologies particularly the wireless ones can be espoused.

Various wireless technologies involved in healthcare application are: IEEE 802.15.1 (BLUETOOTH), IEEE 802.15.3A (ULTRA WIDE BAND), EEE 802.15.4 (ZIGBEE PROTOCOL) and WLAN (Wireless Local Area Network). Why ZigBee? ZigBee is Reliable and self-healing, supports large number of nodes, Easy to deploy, very long battery life, Secure and Low cost. The motivation behind the ZigBee Alliance are: Organization with a mission to define a complete open global standard for reliable, cost-effective, low-power, wirelessly networked products addressing monitoring and control. ZigBee alliance provides: Upper layer stack and application profiles, Compliance and certification testing. Result is a set of recognizable, interoperable solutions.

V. INITIAL INTEGRATED ALT SYSTEM DESIGN AND DEVELOPMENT

Figure 3 illustrates a mini develop system that initially included two front end sensors, the heart-rate and the temperature sensor. These sensors are connected to microcontroller Arduino for signal interpretations. The data is to be sent wirelessly using RF transmitter/receiver based on XBee/ZigBee protocol. The receiver is mounted to PC station with LabVIEW (laboratory virtual instrument electronic workbench) which has a user interface and monitoring window to the patients' data.

Arduino is the brain of the whole system, since it reads and interprets the data from the Heart Rate circuit output and the temperature sensor output. Arduino has certain advantages when compared with other microcontrollers. It simplifies the amount of hardware and software developed. The Arduino hardware platform communicates with the microcontroller over the USB. In addition, the I/O pins of the microcontroller are already fed out to sockets/headers for an easy access. Arduino also provides number of libraries to make programming easier. Arduino Leonardo is a microcontroller board based on ATmega32u4 that is currently made in Italy by Smart Projects. It has 14 digital input/output pins, 6 analogue inputs, 16 MHz ceramic resonator, a USB connection a power jacket, an ICSP header, and a rest button.

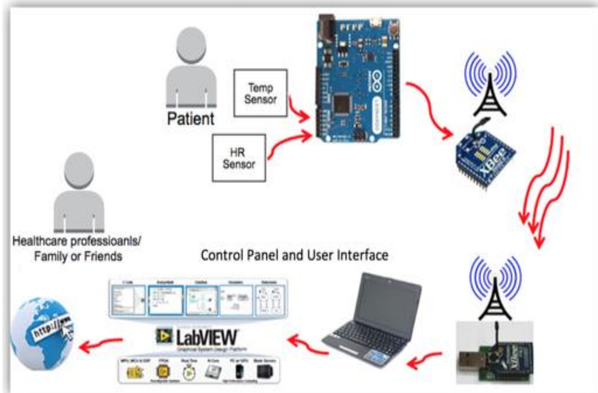


Figure 3 Initial integrated ad-hoc wireless system overview using ZigBee protocol and units inter-operational scenario

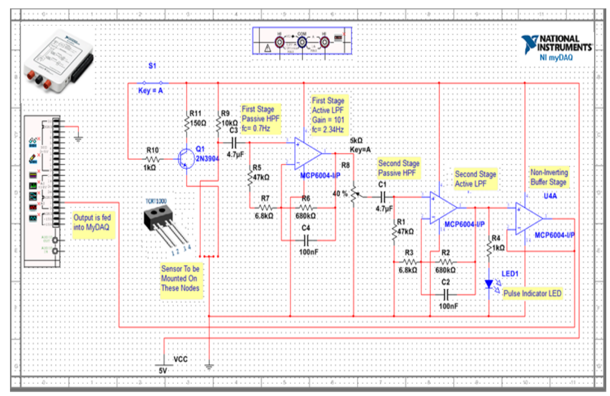


Figure 4 Heart rate sensor circuit design and CAD simulation showing the various stages of interface signal conditioning unit

The LM35 temperature sensor is an integrated circuit sensor which is used to measure temperature; the sensor provides analogue output proportional to the temperature in Celsius. One of the distinctive features of the LM35 sensor is that the temperature is automatically calibrated in Celsius scale. The sensors operate from 4 to 30 Volt. The LM35 only draws 60 µA from the supply; it operates form -55°C to +150°C. The heart rate sensor utilized in the initial integrated ALT system here is TCRT1000 obtained from Vishay (www.vishay.com). It is an Optical Reflective Sensor, and in order for the sensor to operate and functions properly it necessary to have a biasing source in place. This is what will make the diode to emit and activate the sensor. The simple front end circuit designed and developed is shown in **Figure 4**.

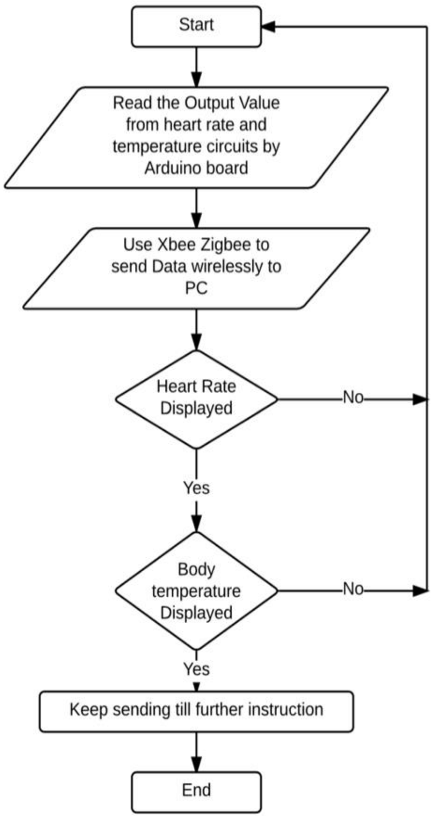


Figure 5 Arduino programming code flow chart

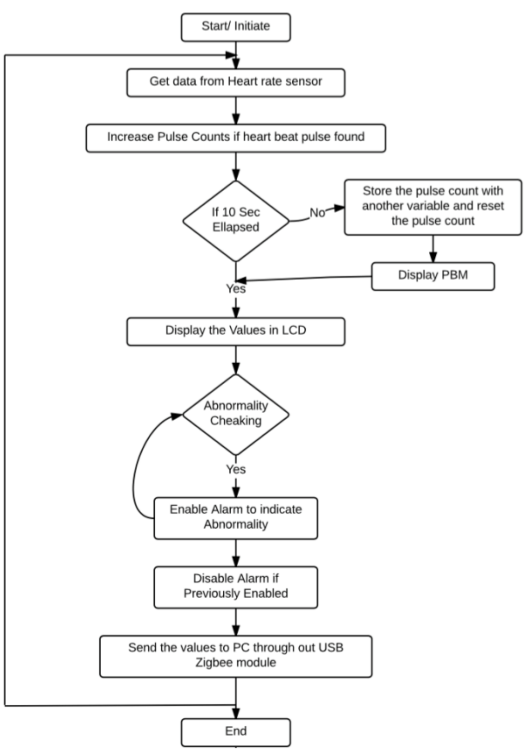


Figure 6 Heart-rate code flow chart

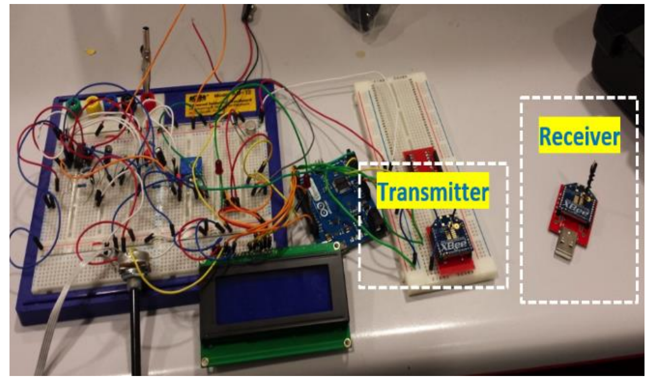


Figure 7 The initial integrated ALT system prototype setup and wireless mapping of the transmitter and receiver of the system

Figures 5 and **6** show the flow chart of the Arduino Programming Code Flow Chart for both the, Heart-rate and temperature sensor. ZigBee Series 2 is used in this initial integrated ALT system development. It has been utilized to transfer the data wirelessly to the central data base unit. It has been integrated with Arduino board through the following connections RXD, TXD, GND and VCC. Both ZigBee boards are the same but it depends on the programming which one is used as a transmitter or receiver.

Figure 7 shows the initial integrated mini ALT system. **Figure 8** shows the front end heart rate sensor TCRT1000 of the integrated ALT mini system with MYDAQ LabVIEW Instrument. **Figure 9** shows the Front end sensor integrated into NI data acquisition unit and some of the outputs displace on an analogue oscilloscope. The system has been fully integrated and tested. The integrated final system was included ZigBee transmitter and receiver, connected to the Arduino along with LCD displaying, heart-rate beats and the body temperature. The LCD main function is to display on real time the output of both front end sensors.

The TCRT1000 Optical Reflective Sensor packaged in way that the IR LED infrared light emitting diode and the phototransistor close to each other and facing up making the sensor works on reflection of the light, transmitted by the LED to the phototransistor. The operation principles is based on when the finger is placed on the sensor, it will block the light and only a very small amount of this light will be reflected due the heart beats and the blood flow in the artery.

The phototransistor determines the intensity of the light reflected. The sensor has an LED oriented indication light and it has a very solid size. The sensor operates form voltage +5DC and needs 100mA. The LED will emit and represent the heart-rate beats. The hear-rate circuit is connected to an oscilloscope to display the beat signal. This can be obtained recorded and transmit using ZigBee wireless protocol to the data base system for further analysis. XCTU software was used to map out the system communication.

XCTU software needs to be configured first. This is started by selecting the communication port (COM depends on the USB ports available) and make sure the baud rate chosen is right as shown in **Figure 10 (a)**. The baud rate used in this case is 9600. Then click the Test/Query button. If the hardware setup is connected correctly, it should display “Communication with modem is OK” and the information regarding the ZigBee is displayed. Then click option ‘OK’ to continue for the next level of setup. **Figure 10(b)** shows the com test/query modem appeared.

Figure 9 shows the next step of ZigBee programming by pressing read tab to test whether the connection is good or not. Then if the reading successful the pan ID, destination address low, serial number high and serial number low will have to be changed accordingly to the other XBee ZigBee module.

Changing the parameters should be exactly the same as the other XBee (ZigBee module) to understand each other. AT this stage one of the XBee units should set as coordinator and the other as router both working on the same baud rate. **Figures 11** and **12** show the communication between both units the transmitter and the receiver. Using two XBEE transmitter and receiver to log the data and signal reading to a laptop which has the user interface monitoring window.

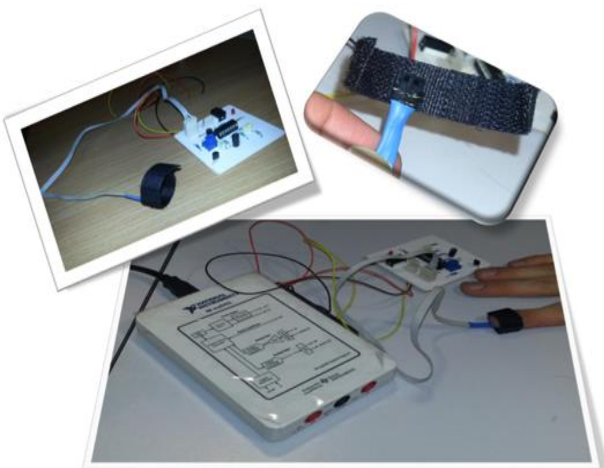


Figure 8 The front end sensor of the integrated ALT mini system with MYDAQ LabVIEW instrument

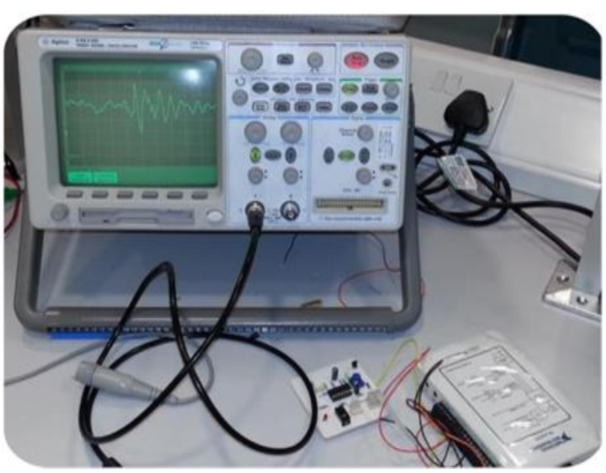
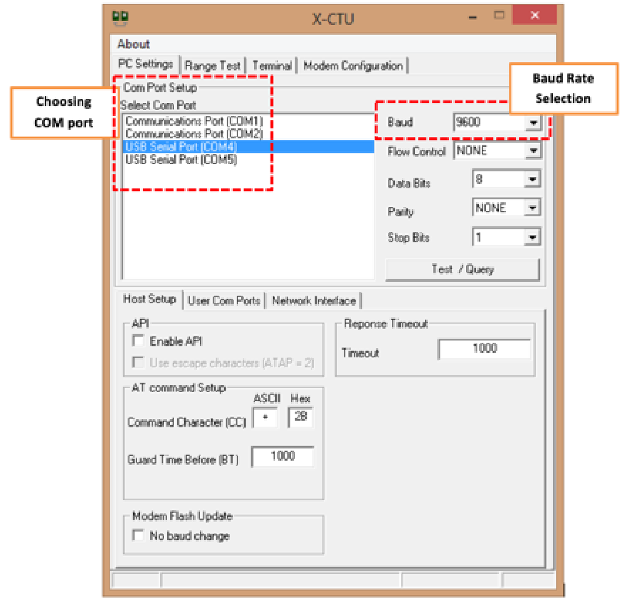


Figure 9 Front end sensor integrated into NI data acquisition unit and some of the outputs displace on an analogue oscilloscope



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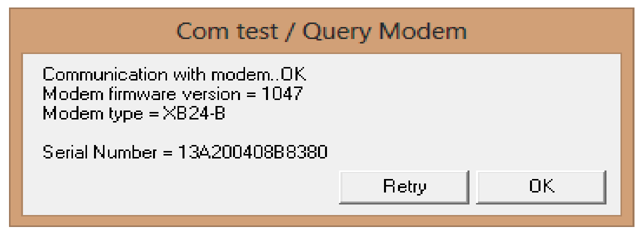

(b)

Figure 10 XCTU software configurations

The LabVIEW software tools is used to display the data and results in a User Friendly Interface (GUI) Screen which has been designed and developed for this particular system. The data displayed in GUI screen is to be monitored in near real time by the doctors, nurses or caregivers.

The LabVIEW started by creating a VISA Configures Serial Port which functions to initialize the serial port specified by VISA resource name to the specified settings. Then, VISA read is applied to read the specified number of bytes from the device or interface specified by VISA resource name and returns the data in read buffer.

In the heart rate signal block diagram, decimal string to number is created to converts the numeric characters in strings, starting at offset, to a decimal integer and returns it in number. Then, the output is divided by 1024 because Arduino can read 10 bytes and multiply the output with 5 which represents 5V. Finally, the heart rate signal displayed in the waveform chart as shown in **Figure 13**.

For the body temperature block diagram, there have some differences compared to the block diagram of heart rate signal. VISA resource name and VISA read is created same like heart rate signal block diagram as shown in **Figure 14** but added read buffer and the thermometer which act as indicator to the reading values as shown in **Figure 15**.

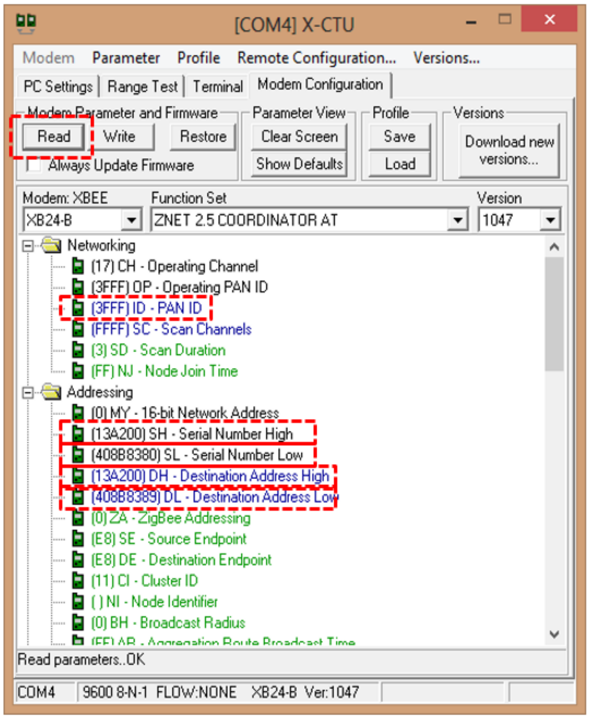

Figure 11 Reading XBee modules

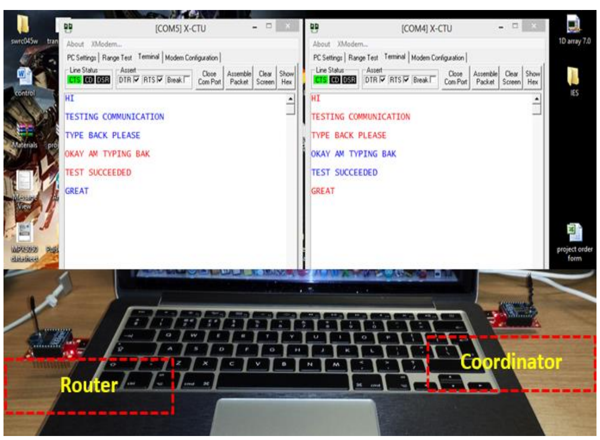

Figure 12 Communication between transmitter and receiver modules

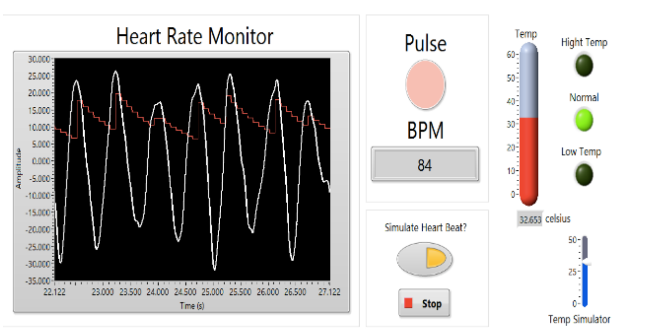

Figure 13 Developed user interface system using LABVIEW tools

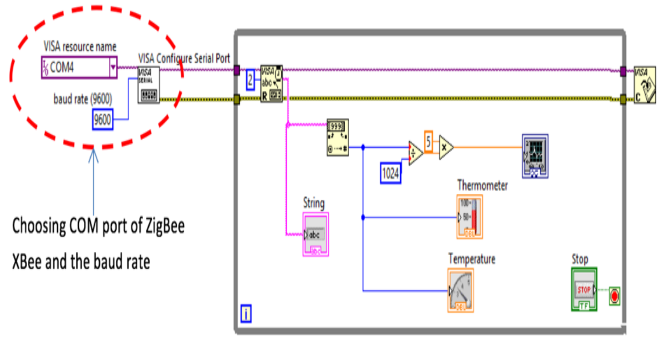

Figure 14 LabVIEW block diagram window

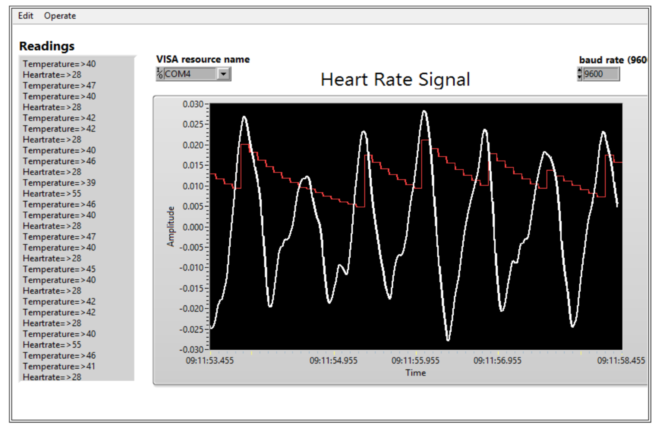

Figure 15 Temperature readings and hear-beat combined waveforms

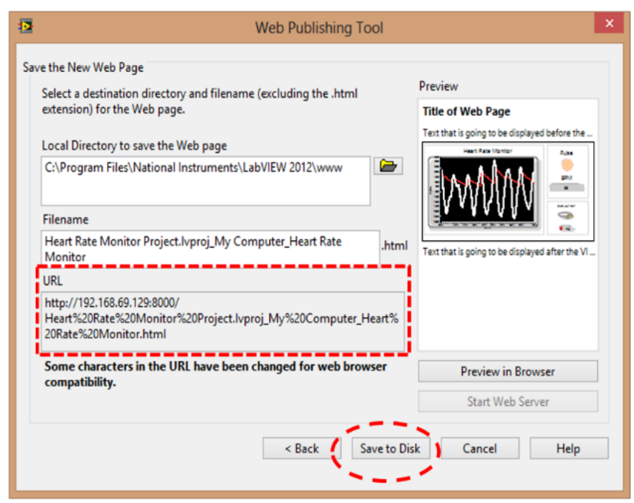

Figure 16 LabVIEW publishing tool and option that can be utilized by the end user

The following logs the data obtained from the sensors to waveform heart-beat signal and a chart for the temperatures readings, the readings logged as temperature and heart-beats simultaneously. From LabVIEW properties the completed logging user interface window is published to the Internet for remote monitoring using an IP Address which can be shared with family relative and doctors as well the GP or hospital for regular checks. **Figure 16** shows the user interface shared on the Internet using IP Address for remote monitoring.

The collected data from such integrated ALT system is supposed to be processed by some intelligent back end algorithms that are relevant to each specific data obtained and specific purpose. This data can be also processed locally, or send to main data base or uploaded to high confidential website as a record or for final check-up and process. In the initial integrated ALT system here the data and results uploaded to the internet using web publishing tools, to demonstrate the possible options of sharing the patient data and possible real near time update process can take place.

VI. CONCLUSION

An Intelligent Medical Care Solution for Elderly People with Long Term Health Condition Based on Wireless Sensors Network Technology is presented in this paper. The initial mini prototype of the system developed has shown the potential of the solution. A wireless communication link has successfully established using ZigBee modules, Arduino and LabVIEW tools. The data was processed and displayed nicely in the serial monitor on LabVIEW software user friendly interface screen. LabVIEW Publishing Tools has been also utilized and has given the end user the option to use IT resources to access the system data.

The research program is at the very early stage and many developments are still ongoing. This is focus on the development of: Smart Sensors and Actuator, 6D Smart Medication Dose Containers, Smart Incontinence Management system, Smart fluid & Food Intake Management Platform and or Container, Wireless Technology, Ad-hoc Networking using ZigBee and or Bluetooth Platform & RFID, and an innovative unified platform using iCloud & Semantic Data Solutions Technology.

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