International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 07, Issue 07, July2018, ISSN: 2278 -7798

A Multi-Parametric Home Surveillance & Guidance system for Geriatrics

Satyake Bakshi [1]

***Abstract*— Geriatric patients who have already been treated for their illness often need a high degree monitoring but at the same time it does not make sense for the patient to be admitted in the hospital . The Aim of this work is to design a robotic system for the guidance and surveillance, embedded with an e-health platform to monitor the vitals of the geriatric patient . The system is designed to keep a check on the patient inside the house so that the helper taking care of the patient can aid in negotiating the native environment. The system considers all the existing shortcomings of assistive technologies and incorporates the solutions for the same in the proposed design . A pulse prediction algorithm has also been designed which can estimate the heart-rate from each signal. A computer vision algorithm has also been implemented to isolate the patient in a crowded environment.**

***Index Terms*—SSH,Internet of Things, Robotics, biomedical sensors**

1) INTRODUCTION

In the 21st century with increased economy of nations around the world , the living standards of people are increasing ten-folds, people are living much longer and healthier life-style thanks to the upsurge in medical technology. Even with increased-technological advancement the cost of medical care is increasing at an alarming rate[1].In third-world nations and other developing countries the cost of seeking medical care is more than the affordability of the citizens. Countries which have an aging population like Canada ,UK and others[2]. The cost of seeking care for those old-age patients are increasing. A specific but common scenario is an old age patient who have already been treated but require monitoring and care would not want to shell out thousands of dollars by staying at a hospital. A more suitable answer to this kind of problem is making use of medical tele-robotic solutions to monitor patient well-being remotely and provide navigational assistance . The primary aim of the system described in this paper is navigation assistance and vitals monitoring under one unified platform.

2) RELATED WORK

There is a very high shortage of healthcare professionals in rural communities which is a major problem in both developed and developing countries [1].According to inverse care law as stated by Hart, "Those with the greatest health needs usually have the worst access to healthcare services[1].

Paper[4] talks about the CareNet system . CareNet is an integrated wireless sensor environment for distant healthcare. It has two tier wireless network and an extensible software platform[4].Its main feature is secure and private data-collection.[4] Paper [4] describes the software architecture of the system.

Paper[3] talks about the tele-presence systems. It is seen that a robot which communicates more than simply making use of audio and video but also use gesture ,body poses.etc allows for a more engaging interaction.[3] One such design is the MeBoT platform [3].It is also seen that expressiveness leads to more engaging interactions psychologically.

Patent[7] describes a medical-telerobotic guidance system. The system features a grappler which can be used to hold a medicine container . The system included a video camera and LCD monitor for communication and remote consulting with the doctor. The Camera is mounted on a vertical shaft which is used for the movement of the camera vertically. The system has a holonomic platform which also contains the drive circuitry. The design also features a drawer where the patient can keep important documentation. The system is remotely operated within a closed network i.e. with in an institute example: a hospital.

Paper [6] presents a proof of idea model of a mechanical robotic assistant for the visually debilitated. The system is referred as the robo-cart . It enables visually hindered clients to explore a normal supermarket and carry obtained things .It relies on RFID labels conveyed at different areas in the store. For route the system relies on laser extended finding.

3) DESIGN AND PROCESS FLOW

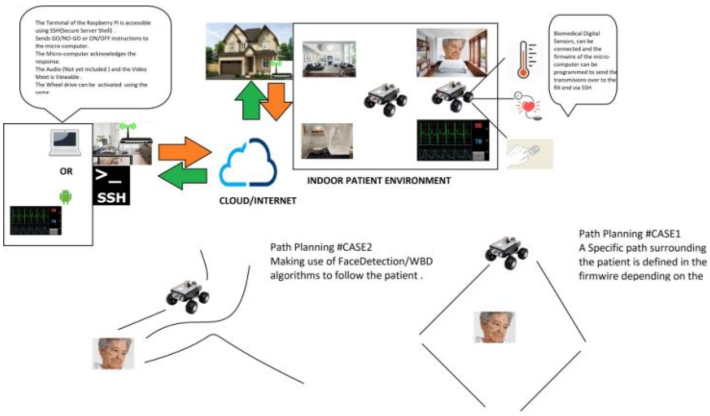

Fig.1 The entire schematic of the system

The rectangular box at the top right section indicates the patient environment. The environment is seen to have a bedroom,living-room,bathroom. The robot can be placed in any part of the house. The patient is physically connected to 'n' number of biomedical sensors. These sensors are made to interact wirelessly with the miniature vehicle's onboard micro-computer. The only requirement for the patient environment is that it must be a Wi-Fi enabled area, which is not difficult to achieve. The Wi-Fi of the home has the virtual server which is created and hosted on the cloud. The server accepts and acknowledges any incoming connection from the client. The control area ,here in this case the office has an access terminal which can be any PC or MAC. The operator can SSH to the remote IP address of the micro-computer of the robot to gather and view data of the patient and enable monitoring. The sensor data and the physical movement of the robot is controlled from one single terminal.

High Resolution video feed is captured from the camera. The system makes use of a voice synthesizer to assist the patient in negotiating tough terrain. The system can be operated either using Whole-Body detection to fully track the patient or the system's firmware is programmed to follow a specific path which the patient frequents, this would allow a certain degree of automation to the operator.

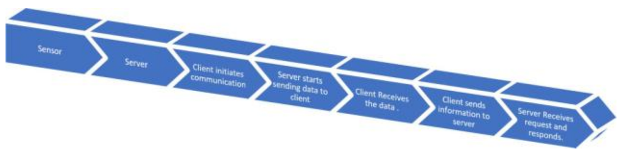

Fig.2 The process flow of the communication

When any registered client connects to the server the server accepts the connection and establishes a tunnel though which the client sends requests and the robot performs the specific task. The connection can be terminated by using standard Linux command 'sudo shutdown -h now'.

4) Proposed Methodology

The system is built on the raspberry pi platform running the latest version of Raspbian jessie. The Pizero has been chosen as the primary driver of the motor systems because of its compactness and less power requirement. The Vision system of the robot is designed using the Picamera module and a modified version of the motion Eye operating system. Motion Eye operating system is responsible for the camera control and the feed quality . Motion eye offers multiple options for adjusting the frame-rate depending on the existing connection speed. Motion Eye also has provisions for motion detection algorithm which is built into the software .

Fig.3 shows the interface of the custom motion eye operating system.

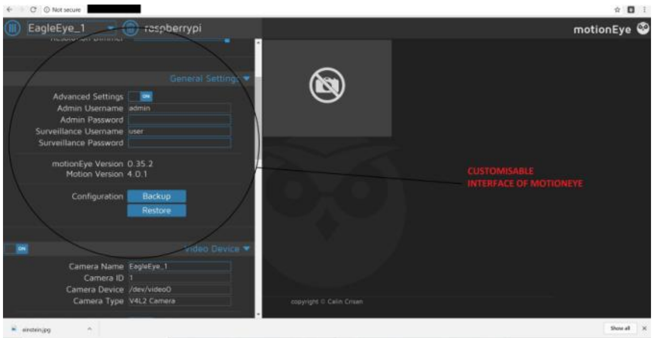

Fig.3 The MotionEye Interface

A speaker system has been included for high quality vocal feedback from the operator. There are also pre-defined vocal functions which have been designed which gives directional aid to the patient. The system currently features 5 directional and 1 reminder aids i.e. "Patient Forward" , "Patient Backwards", "Turn Right", "Turn Left", "Stop patient", "Its time for your medication" these can be programmed based on the type of patient to be monitored . These commands are mapped to individual keys. The vocal synthesizer has been designed off the espeak module in python .

The physical chassis of the system is built on a typical robotic platform made of acrylic plastic and modified to a sledge-wheel configuration . The front wheel is passive, and the backward wheels are connected to stepper motors . The speed of the system is adjusted by making use of PWM (Pulse Width Modulation).

For greater field of view servo camera brackets have been used and an interface for controlling the rotation has been designed on the Tkinter library . Figure 4 shows the Panning interface .

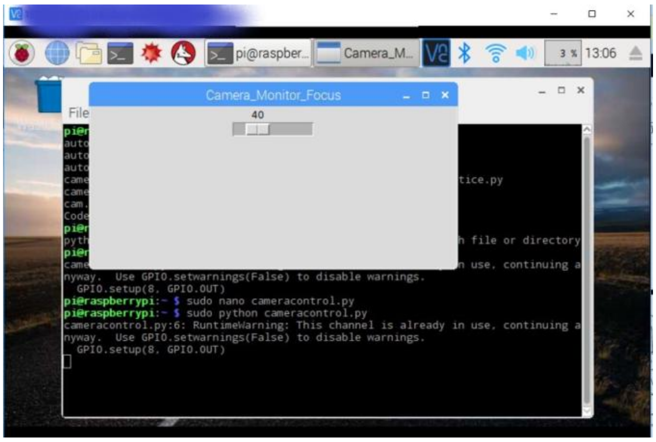

Fig.4 The panning interface

The slider translates to the 180 degrees of movement of the camera module.

Figure 5 shows the complete protype build of the robotic system

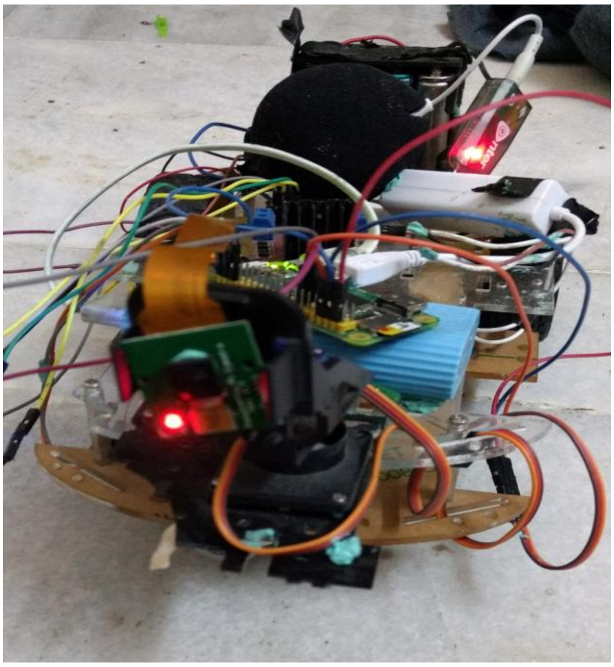

Fig.5 : The complete build of the robot

E-health Sensor module:

A custom digital sensor part 1157 of sunrom technologies has been used for this purpose. A body temperature and a pulse predictive sensor has been designed and implemented under one platform.

The pulse sensor is a typical digital sensor which generates "ones" when high and "zeros" when low. The algorithm works by assuming the targeted health pulse range of the patient typically 45 to 110 beats per second . It first counts 1 pulse signal i.e. One "Ones" and calculates the time taken for that "One" to appear following which the potential pulse rate is calculated depending on the targeted pulse which is assumed .

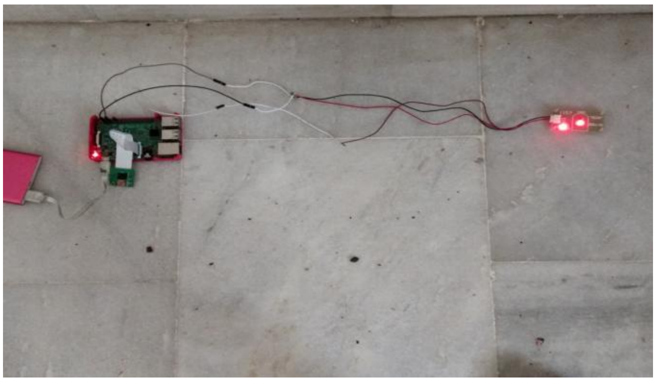

Fig.6 The Digital Sensor used for Pulse prediction

Figure 7 shows the live data that is being generated from the algorithm .

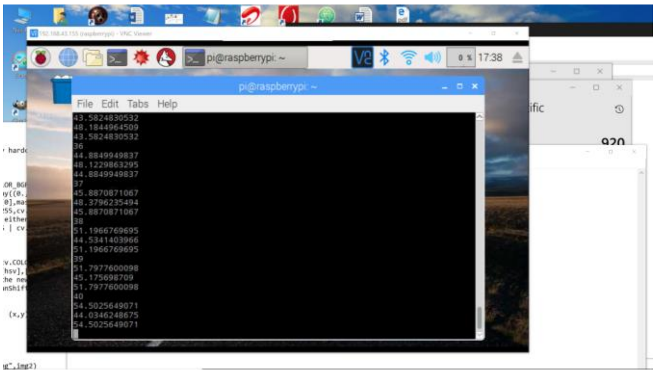

Fig.7 Prediction algorithm
The third row of every line gives the potential pulse rate .

The body temperature monitor is calculated by standard ADC values . The graph of the temperature data is obtained and shown remotely through the boltiot platform in figure 8.

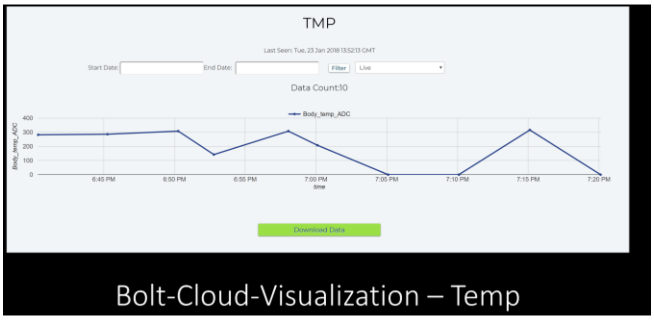

Fig.8 Graph generated from the ADC values

Computer Vision algorithm

The computer vision algorithm's main task is to isolate the patient in a cluttered environment i.e. if there are other patients in a room and the patient to be identified is not in direct line of sight of the robot.

The patient to be identified is fitted with a unique marker which is a unique color shade . The tracking is done using the mean shift algorithm . The patient wears the unique marker and the camera can recognize only that part of the patient containing the marker. The program is developed in open CV . The meanShift is based on a narrow band of HSV values. The system creates an ROI around the marker and tracks the patient . For more objects to be identified the lower HSV and the upper HSV values can be widened.

Fig.9The unique color chosen (acts as the marker)

Here a unique Yellow color range has been chosen. The next figure shows the output of the camera system.

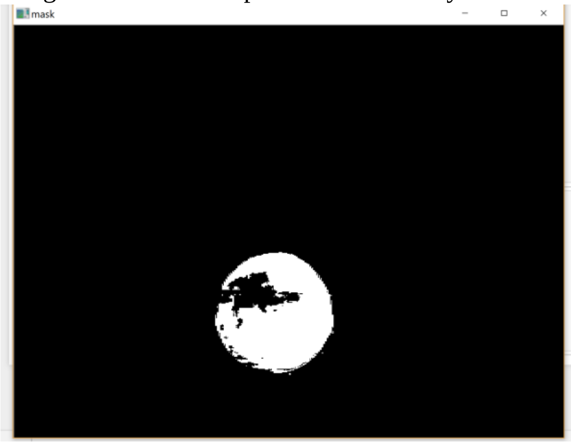

Fig.10The output as seen from the camera

The algorithm works by creating a new mean around the targeted range of HSV values which acts as the center pixel. The center value shifts as the object is brought in or out of focus of the camera system.

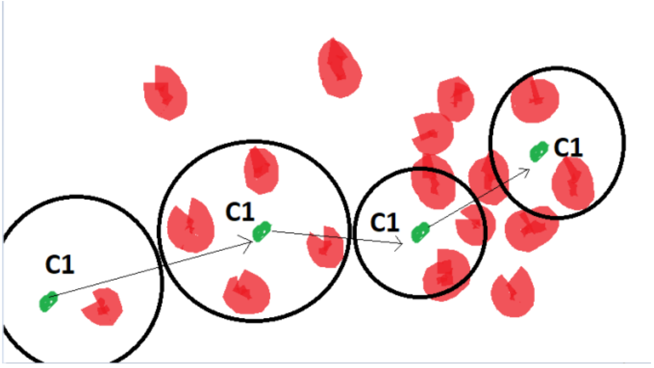

Fig.10 The logic behind meanshift

Fig 10 shows the C1 which is the mean value which shifts as the object to be identified is moved .

6) Conclusion & Future Scope

Therefore, it has been discussed how the system to would aid the geriatric patient. The system can be modified to include more camera systems for more angle of view.

The system can be modified to accommodate more number of sensors to take advantage of the raspberry pi's 40 pin GPIO board.

The system can also be converted to an aerial drone which can be flown over a target village or town for telemedicine-based applications i.e. patients can line up in a designated area below the drone to get their conditions assessed remotely .

The computer vision algorithm can be modified to perform better imaging by making use of high end camera equipment and implementing artificial neural networks for better labeling of patent targets.

The system has a lot of potential to reduce the cost of healthcare by eliminating the need for the patient to travel to a primary healthcare provider .

REFERENCES

1) Kenneth Joseph Arrow. Uncertainty and the welfare economics of medical care (american economic review , 1963).*Journal of Health politics, policy and Law*,26(5):851-883,2001.

2) Kaare Christensen, Gabrriele Doblhammer, Roland Rau and James W Vaupel. Ageing populations: the challenges ahead . *The lancet*, 374(9696) : 1196-1208,2009

3) Sigurdur O Adalgeirsson and Cynthia Breazeal.MeBot: a robotic platform for socially embodied presence.In *Proceedings of the 5th ACM/IEEE international conference on Human-robot interaction, pages* 15-22.IEEE Press,2010.

4) Shanshan Jiang,Yanchuan Cao, Sammer Iyengar, Philip Kuryloski,Roozbeh Jafari, Yuan Xue, Ruzena Bajcsy, and Stephen Wicker. Carenet: an integrated wireless sensor networking environment for remote healthcare. *In Proceedings of the ICST 3rd international conference on Body area networks*, page 9. ICST(Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), 2008.

5) C. Y. Lin, M. Wu, J. A. Bloom, I. J. Cox, and M. Miller, "Rotation, scale, and translation resilient public watermarking for images," *IEEE Trans. Image Process.*, vol. 10, no. 5, pp. 767-782, May 2001.

6) Vladimir Kulyukin, Chaintanya Gharpure, John Nicholson, and Grayson Osborne. Robot -assisted wayfinding for the visually impaired in structured indoor environments. Autonomous Robots, 21(1):29-41, 2006.

7) Yulun Wang, Charles S Jordan, Keith Phillip Laby, Jonathan Southard and Marco Pinter. Healthcare tele-robotic system with a robot that also functions as a remote station, January 30 2007. US Patent 7,171,286.

Satyake Bakshi just completed his undergraduate in Biomedical Engineering from Vellore institute of technology. He has deep interest in rehabilitation engineering and Medical Robotics. He is an adept python programmer .He is currently to pursue his master's in biomedical engineering from Carleton University ,Ottawa Canada. He is a member of IET.