

ELDERLY PATIENT MONITORING SYSTEM

Chathurangi W.A.S

(IT14069482)

Bachelor of Science Special (Honors) Degree in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

October 2017

ELDERLY PATIENT MONITORING SYSTEM

Wijesuriya Arachchige Sajini Chathurangi

(IT14069482)

Dissertation submitted in partial fulfillment of the requirements for the degree
Of Science

Department of Information Technology

Sri Lanka Institute of Information Technology

October 2017

Declaration

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to Sri Lanka Institute of Information Technology the non-exclusive right to reproduce and distribute my dissertation in whole or part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as article or books).

Signature:

Date:

Signature of the Supervisor:

Date:

LIST OF FIGURES

Figure 1.1 For the experiments considering 10 different behaviors performed by 9 subjects to detect the human within the image and to assign the sequence to one of the known behavioral categories	9
Figure 1.2 Relationship among the three areas of human motion analysis.....	10
Figure 1.3 Near-Field video: Example walking action	11
Figure 1.4 Medium-field video: Example video sequence of a simulated bank attack (courtesy [8]). (a) Person enters the bank. (b) Robber is identified to be an outsider. Robber is entering the bank safe. (c) A customer escapes. (d) Robber makes an exit.	11
Figure 1.5 Nine "atomic" ballet moves.	12
Figure 2.1 Identification and tracking of the person	15
Figure 2.2 Frame Subtraction	17
Figure 3.1 In order to track every single motion.....	21
Figure 3.2 In order to track motions in particular time period.....	22

LIST OF TABLES

Table 2.1 Get Notifications.....	17
Table 2.2 Abnormal Behavior Recognition	18

ABSTRACT

This research is purely based on reviewing and automating the existing Domestic Environment Process specially to monitor the Elderly Patients who are having Respiratory disorders in accordance to the 21st century. Abatement of birth rates and longer living people are the major reasons to increase ageing population. Thus, they need more concerns and treatments on health, it is becoming a problematic scenario to look after them regularly. Nowadays people are very busy with their tough schedules so Time is the most limitable variable most of the lives. Most of the elder people are getting affected by respiratory disorders and monitoring of their health conditions has become a must. The purpose of this patient monitoring system is to implement an inexpensive system which can monitor multiple necessary facts about the patient's health along with the observation in patient's behaviors, emotions and respiratory sounds. In here the system will cover all paths that can monitor the patient. Computer vision and IOT based approaches are proposed to monitor the patient, identify the anomalies in the patient and finally alert the responsible person with an appropriate alerting system. Process of patient monitoring at the domestic level is hardly been implemented via a proper technological solution, hence the system implemented as the result of this research can be effectively used for the monitoring of the patient.

ACKNOWLEDGEMENT

Special thank goes to our supportive supervisor Mr. Yashas Mallawaachchi, who gave our project group CDAP - ----- the completest support and supervision throughout the entire project. Our grateful thank goes to all the personnel of the Sri Lanka Institute of Information Technology who contributed with essential information.

I would like to express intense gratitude to Mr. Jayantha Amararachchi, our lecturer in charge of the course Comprehensive Design and Analysis of Project (CDAP) for constantly providing me with the guidance and assistance to carry out the research successfully.

Furthermore, a special gratitude to our group members who supported me and invested their time and effort in the team towards achieving the goal.

Finally, a special thank goes to my family for their constant encouragement without which this project would not have been possible.

Thank you.

TABLE OF CONTENTS

Contents

Declaration	3
LIST OF FIGURES	4
LIST OF TABLES	4
ABSTRACT	5
ACKNOWLEDGEMENT	6
1. INTRODUCTION	8
1.1 Background context (Literature Survey)	8
1.2 Research gap	12
1.3 Research Problem	13
1.4 Research Objectives	14
2. METHODOLOGY	15
2.1 Methodology	15
2.2 Testing & Implementation	16
2.3 Research findings	19
3. RESULTS & DISCUSSION	20
3.1 Results	20
3.2 Discussion	20
4. CONCLUSION	23
5. REFERENCES	24
GLOSSARY	25
APPENDICES	25

1. INTRODUCTION

The Patient Monitoring Process/Patient Monitoring is a very critical process/ system, it is used for specially monitoring physiological signals including Electrocardiograph (ECG), Respiration, Oxygen Saturation in Human Blood (SpO2) etc. Because of the globalization, air pollution, industrialization and different kind of facts elderly people are easily affected to respiratory disorders [1]. And the rate of the growth in ageing population is too high, there should be some different ways to tackle the problems when monitoring them.

This system will monitor the patient under four components which covers all the facts that can monitor a Respiratory Patient [2].

1. Respiratory Sound Analysis
2. Sensor configuration and anomaly detection via sensor inputs
- 3. Abnormality detection of behaviors**
4. Abnormality detection in emotions

When considering internal health parameters internally, it's a must to **monitor the patient externally by focusing Their Behaviors**. Because no one can be monitor the patient in every single second, since its practically hard to humans. Throughout this document it will describe the contribution of the component of **Abnormality detection in behaviors** of the patient.

1.1 Background context (Literature Survey)

There is a research done by the Christian Thureau Czech University, Faculty of Electrical Engineering Department for Cybernetics on an approach for human detection and simultaneous behavior recognition from images and image sequences [3]. It is done by an action representation is derived by applying a clustering algorithm to sequences of Histogram of Oriented Gradient (HOG) descriptors of human motion images.

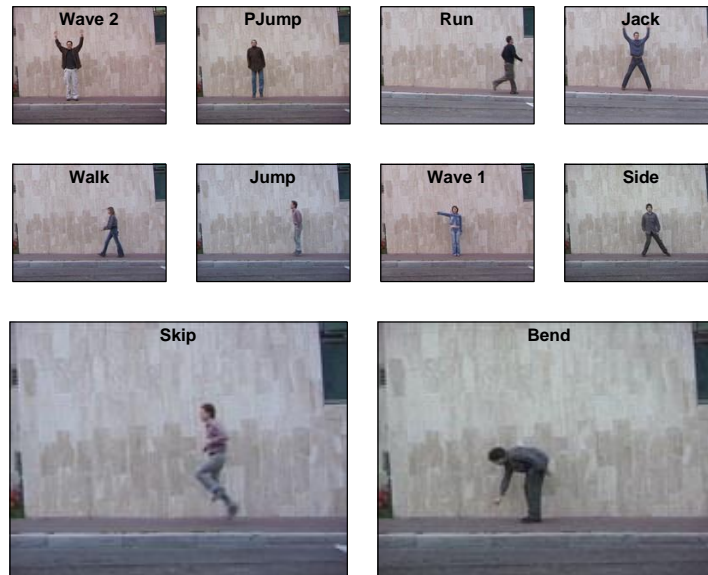


Figure 1.1 For the experiments considering 10 different behaviors performed by 9 subjects to detect the human within the image and to assign the sequence to one of the known behavioral categories

In this case, they considered 10 different behaviors performed by 9 subjects. The task is to detect the human within the image and to assign the sequence to one of the known categories like Jump, run etc. They detect humans by comparing extracted HOG descriptors to template HOG descriptors of human poses. The templates are automatically clustered from a set of training sequences. They select the best matching action primitives for a novel image, and thereby create a sequence of action primitive indices. And they express the sequential observation of basic action units using n-grams, a popular representation used in text analysis or bioinformatics. Though they classify behaviors by means of histogram comparison.

There is another research done by J.K. Aggarwal and Q. Cai, the university of Texas at Austin, Department of Electrical and Computer Engineering based on Human Motion Analysis [4]. In their survey they concentrated on motion analysis of the human body, which is a non-rigid form. They covered their areas 1) motion analysis of the human body structured, 2) tracking of human motion using a single or multiple camera and 3) recognition human activities from image sequences. And they followed a bottom up approach in describing the general tasks for each area. They consider that motion analysis of the human body usually involves the extraction of the low-level feature, such as body part segmentation, joint detection and identification, and the recovery of 3D structure from

the 2D projections in an image sequence and tracking moving individuals using a single or multiple camera involves applying visual features to detect the presence of humans directly.

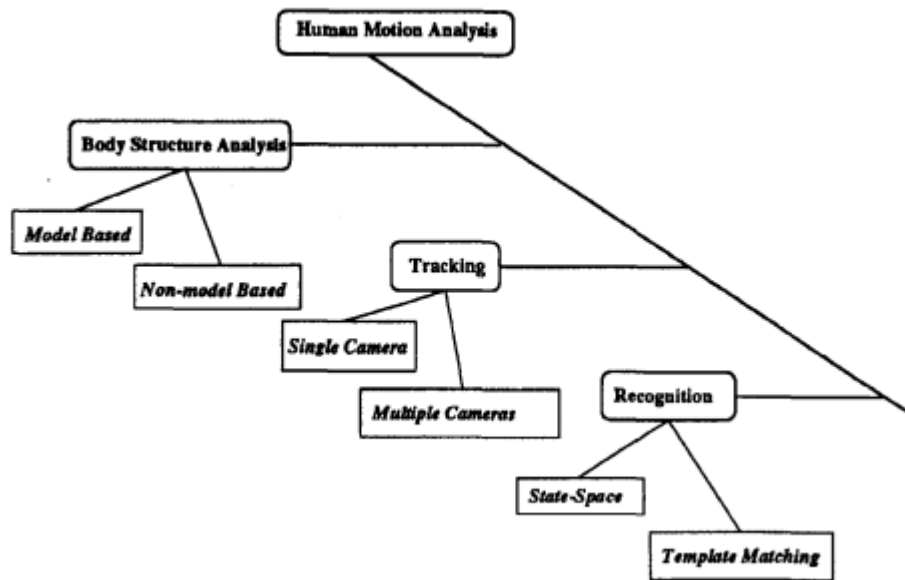


Figure 1.2 Relationship among the three areas of human motion analysis

Another research named, Machine Recognition of Human Activities done by Pavan Turaga, A Student Member, IEEE, Rama Chellappa, Fellow, IEEE, V. S. Subrahmanian, and Octavian Udrea. According to their research the terms “action” and “activity” are frequently used interchangeably in the vision literature. In the ensuing discussion, by “actions” we refer to simple motion patterns usually executed by a single person and typically lasting for short durations of time, on the order of tens of seconds. Examples of actions include bending, walking, swimming, etc. (e.g., Figure-1). On the other hand, by “activities” they refer to the complex sequence of actions performed by several humans who could be interacting with each other in a constrained manner. They are typically characterized by much longer temporal durations, e.g., two persons shaking hands, a football team scoring a goal, or a coordinated bank attack by multiple robbers(Figure-2). This is not a hard boundary and there is a significant “gray area” between these two extremes. For example, the gestures of a music conductor conducting [6] an orchestra or the constrained dynamics of a group of humans is neither as simple as an “action” nor as

complex as an “activity” according to the above interpretation. However, this simple categorization provides a starting point to organize the numerous approaches that have been proposed to solve the problem.

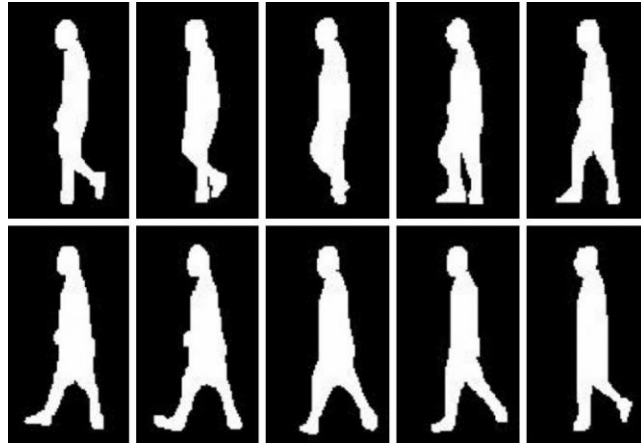


Figure 1.3 Near-Field video: Example walking action



Figure 1.4 Medium-field video: Example video sequence of a simulated bank attack (courtesy [8]). (a) Person enters the bank. (b) Robber is identified to be an outsider. Robber is entering the bank safe. (c) A customer escapes. (d) Robber makes an exit.

Recognition of Human Body Motion Using Phase Space Constraints done by Lee W. Campbell and Aaron F. Bobick MIT Media Laboratory, Perceptual Computing Group 20 Ames st., Cambridge, MA. The problem of understanding human body motion from images is one that leads into such diverse areas as dynamics, athletics, and cognitive science. So, they focus on a symbolic description of action that translates the continuous domain of human motion into a discrete sequence of symbols. With few exceptions, (e.g. finger manipulation) human body motion has many constraints. Some of the constraints come from the laws of physics: arms do not separate at the shoulder and people need to maintain balance to stay off the ground. Other constraints, which come from the rules of

an athletic or artistic form, we call cultural constraints. The fundamental idea of the work presented here is that by recognizing the presence of these constraints it is possible to recognize the motions [7].

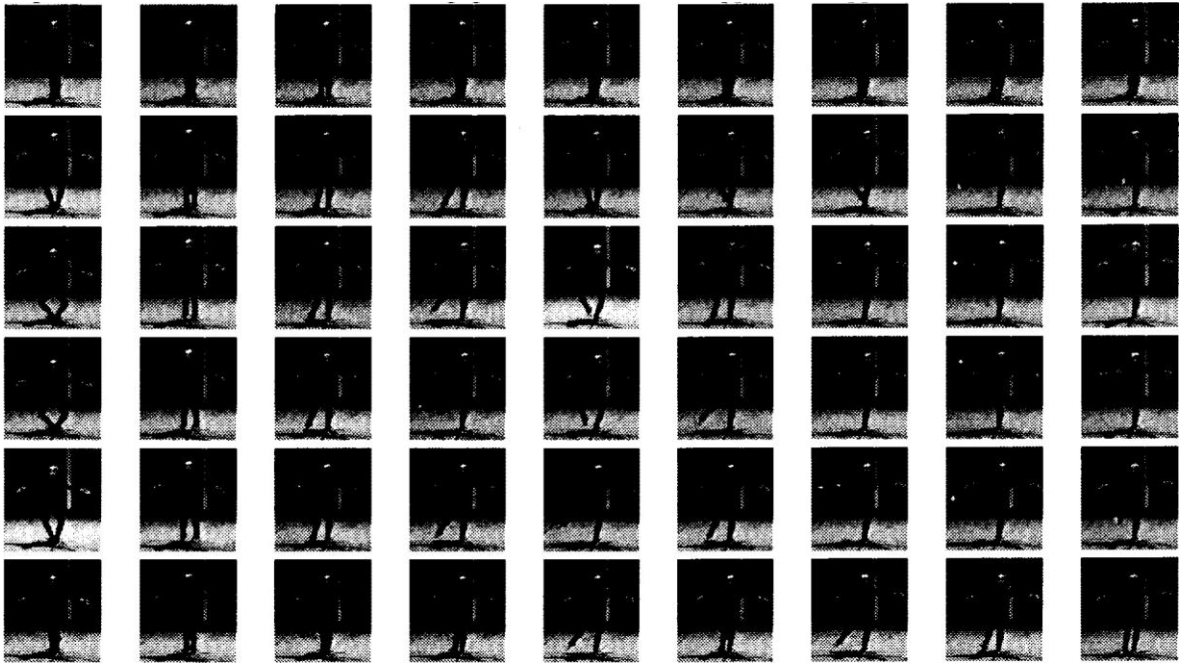


Figure 1.5 Nine "atomic" ballet moves.

1.2 Research gap

In local and international market also, there are several computerized patient monitoring systems available to date, but which are lack of many mandatory features worth to their extreme cost. Most of them are not cover a large area compared to our system and do not cover a large area compared to our system. Modern monitoring systems are covering only few areas only a few health parameters like physiological signals including Electrocardiograph (ECG), Respiration, Oxygen Saturation in Human Blood (SpO2) and heart rate etc. Only displaying the result of any above health parameter is not giving any benefit to the Patient or the caregiver. Since there is no point of paying an extra money for a monitoring system and a caregiver.

Rather than considering internal health parameters it is a must to consider about the patient externally by focusing the patient's behaviors. Under this monitoring system its basically focusing on Elderly patients who are having respiratory disorders. Doctors are normally

guide to these patients as bedridden patients because of their health conditions. When monitoring this kind of patient, it's a must to consider about his or her behaviors. Because they need someone's attention in every second. Every single behavior such as sudden wakeups, falling downs will affect to the patient's life. Thus, it's a must to keep eye on the patient, every single second to identify if there is any abnormal behavior is occurring or not.

1.3 Research Problem

Declining birth rates and longer living people are the major reasons to increase the ageing population since they need more concerns and treatments to maintain their health condition in good manner. And they require caring with continuous human monitoring. Finding well qualified caregivers/private nurses is not an easy task while they are limited and already assigned for jobs. It requires high concentration level even for well trained and qualified caregivers to monitor the patient in every single second.

Under this Monitoring system mainly covered the elderly patients who are suffering from respiratory problems. Respiratory disorders in the sense lung problems, breathing problems, wheezing etc. Since they need more attention rather than other patients who are suffering from another disease. Suppose there is a patient who are discharged from the hospital near here, that first few days it's a must to pay attention for the patient in every single second because any change of a small behavior will affect to the life of this kind of patient. But as to a caregiver / private nurse / family member this is not a practical task. Because no one can keep eye for one thing in 24 hours. Because of the life styles, touch schedules and time limitation this is a huge problem nowadays.

And according to the gathered records by the doctors, after the completion of treatments this kind of patients are not discharged because rather than treatments they need more attention according to some health conditions of them. Doctors assume that they can give that protection and attention in the hospitals than domestic environments. This is also a big problem these days. If the hospital is a private one must pay more extra cost as the hospital charges, treatment charges and sometimes to the caregiver. Because every single behavior of this kind of patient will affect to their lives. And in domestic environment also should hire a caregiver. Sometimes should hire more than one. Or must become a caregiver to family member. Because for this kind of patient must need attention in every single second; 24 hours.

1.4 Research Objectives

- To implement an inexpensive, efficient and a reliable system which can effectively monitor elderly patients who are having respiratory problems and detect anomalies to minimize adverse events.
- To ease up the duties of the family caregiver where he/she can manage the day to day work while taking care of the patient and can save the amount of cost which is needed for a separate caregiver or a nurse.
- Provide continuous monitoring of the patient of his/ her **every movements or the behaviors** and primary health parameters to minimize the adverse events which can occur.
- Reduce cost and time that requires to attend at hospital and clinics to monitor the health conditions.
- Provide a mechanism to alert the caregiver in case of an abnormality of the patient detected.

2. METHODOLOGY

2.1 Methodology

In this area portrays strategies and methods the **Detection of abnormality of behaviors** of the patient to come up with inexpensive, efficient and a reliable system which can effectively monitor multiple necessary facts of the patients and detect anomalies to minimize adverse events because of the Behaviors. The primary focus here is clarifying the flow of the abnormality detection in behaviors of the patient throughout the research project.

Behaviors in the sense, it depends on person to person. In this system the importance of behavior is, this system covers mainly elderly patients who are having respiratory problems. The respiratory diseases are the conditions that affect the nose, throat, larynx, bronchial tree and lungs. They constitute the commonest reason for consulting a general practitioner and cause large numbers of deaths, so that it is particularly important to ensure that they are treated effectively. Normally doctors are considered these patients are bedridden patients. A little tired can affect to their lives. Since when monitoring those patient, it's a must to focus every little movement of those patients.

To detect Abnormality of behaviors of the patient, the High-resolution camera will be mounted in the patient's room and the captured video will be send to the PC. On living beings with visual ability, this continuously changing image appears in the retina while artificial systems, thus it is captured by a light sensor in the camera. The identification and alerting processes are done in the computer in order to detect the abnormalities.

As the very first step, system will identify and track the patient by analyzing the captured video [5].

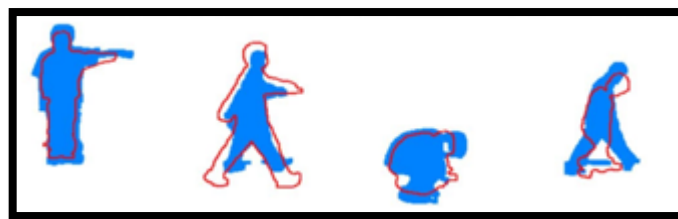


Figure 2.1 Identification and tracking of the person

To do this tracking task Gaussian method is used. In the defined frame, the system will track only the patient ignoring all the other things with the aid of Gaussian algorithm. Then collect all the data related to behaviors of the patient including all abnormal and normal behaviors.

Image subtraction is used for motion detection. In a minute, there are 24 to 30 frames and all those will be captured. Image subtraction is performed in order to identify a motion as soon as it happened. After the motion detection, system will consider about the abnormalities of those identified motions. Same disease can be affected by several ways to a patient. According to the health condition of the patient system will allow to adjust some parameters manually thus it will focus the patient until the recovery of the patient. In the newly stage of the discharged period of the patient should have to focus the patient strictly. It is a must to strictly monitor the patient in his/her early discharged period Thus, the system will allow to adjust the sensitivity parameter and it will have a focus on every simple motion of the patient. Time to time patient's health condition can be changed. According to several conditions that have occurred, the system can be used by adjusting the relevant parameters.

2.2 Testing & Implementation

Implementation stage of any project is a true display of the defining moments that make a project a success or a failure. The implementation stage is as the system or system modifications being installed and made operational in a production environment. This is an important phase of the system development life cycle as coding of the system being from here.

When describing the individual component of Abnormality detection in behaviors process in simple, to capture the patient high resolution camera is mounted to capture the patient and that captured video is send to the computer. In a minute, there are 24 to 30 frames and all those will be captured. Image subtraction is performed in order to identify a motion as soon as it happened. If there is any difference between those considered two frames consider that motion is occurred. Time to time this frame differentiation will happen. To do that task considered two frames as current frame and next frame at put it in to an array. Then check those two frames and identify if there is any difference or not and always, till the computed sending the captured video next frame become the current one and get the processed frame.

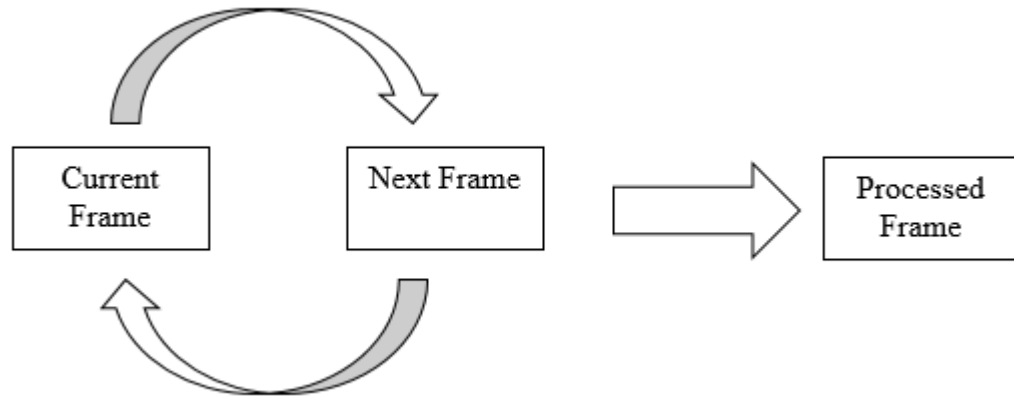


Figure 2.2 Frame Subtraction

Time to time, according to the patient's health condition system will allow to adjust some parameters like threshold value to detect every little movement of the patient.

Whole design process is divided into several parts because of the continence and throughout this document it will explain the contribution of **Abnormality detection in behaviors** of the Patient. Among them one part is recognized as a unit. Each unit is tested under unit testing process. System design documents should be received before starting the actual coding. Work load is divided into modules after receiving above document. Units are the most valuable things at the beginning of the developing process. All the units are integrated later. Purpose of having unit testing is to check whether the units are going to access their specifications. Each unit is developed and tested for include the functionality.

Table 2.1 Get Notifications

Use case 01	Get Notifications
Description	Get Notifications on abnormal situations of the patient.

Primary Actors	Caregiver
Pre-conditions	<ol style="list-style-type: none"> 1. The mobile application is up and running. 2. Mobile data is turned on. 3. User has already registered. 4. User has already logged in to the mobile application.
Main Success Scenarios	<ol style="list-style-type: none"> 1. User taps on the notifications.

Table 2.2 Abnormal Behavior Recognition

Use case 02	Abnormal Behavior Recognition
Description	Analysis of abnormal behaviors in order to detect the anomalies of the patient's behaviors
Primary Actors	System
Pre-conditions	<ol style="list-style-type: none"> 1. Inputs from the video camera (captured video) has to be properly transmitted in to the PC.
Main Success Scenarios	<ol style="list-style-type: none"> 1. Analyze the captured video
	<ol style="list-style-type: none"> 2. Frame Subtraction in order to detect the motions. 3. Normal or abnormal event detects.

2.3 Research findings

“Elderly Patient Monitoring System” is a system which helps everyone who are having elderly patients suffering from respiratory disorders. System is developed based on openCV libraries are supported in abnormal detecting and identifying process.

Early warning indicators will have a huge impact on informing care giver to be better equipped to make better care decisions and eventually will reduce the number of adverse events to improve patient outcomes. Money and space can be saved at clinics and hospitals with 24-hour monitoring of the patient about that patient’s every single behavior and superior care given by the caregiver. Doctors can discharge the patients with safe health care conditions knowing that automated system is there for further monitoring at the domestic level. Healthcare cost will be less expensive comparing with the bedside devices used nowadays in the hospitals. People who are having bedridden patients in their home will be directly benefited with the proposed system. Elder’s homes and Elder care agencies will be assisted by the suggested patient monitoring system. System will eventually ease up the duties of the family caregiver where he/she can manage the day to day work as while taking care of the patient and can save the amount of cost which is needed for a separate caregiver or a nurse.

3. RESULTS & DISCUSSION

3.1 Results

In this section the process of Abnormality Detection in Behaviors Process will be discussed with the results. A behavioral disorder should be included in the differential diagnosis of any patient who presents with repeated complaints, especially fatigue, insomnia, pain or just feeling overwhelmed. The bedridden patients are naturally obstinate in behavior and the face may negatively impact to their health condition due to various kind of accidents. Sleeping sessions, sudden wakeups and falling down will get in to major consideration. The main objective of this component is to identify the abnormal behaviors of the patient (such as sudden wakeups, falling downs etc).

If some abnormality occurs in behaviors it will alert to the caregiver by an alarm and sending a text message. And at the same time an image of every motion of the patient will be saved another location as an image log of the patient. It will help to the doctor when examine the patient.

3.2 Discussion

When considering the behaviors of a patient the critical part was to how exactly categorized the normal and abnormal behaviors. According the information gathered from the doctors, came up with successful solution that adjusting some parameters to track the patients motions time to time. Here are some results of them.



Figure 3.1 In order to track every single motion

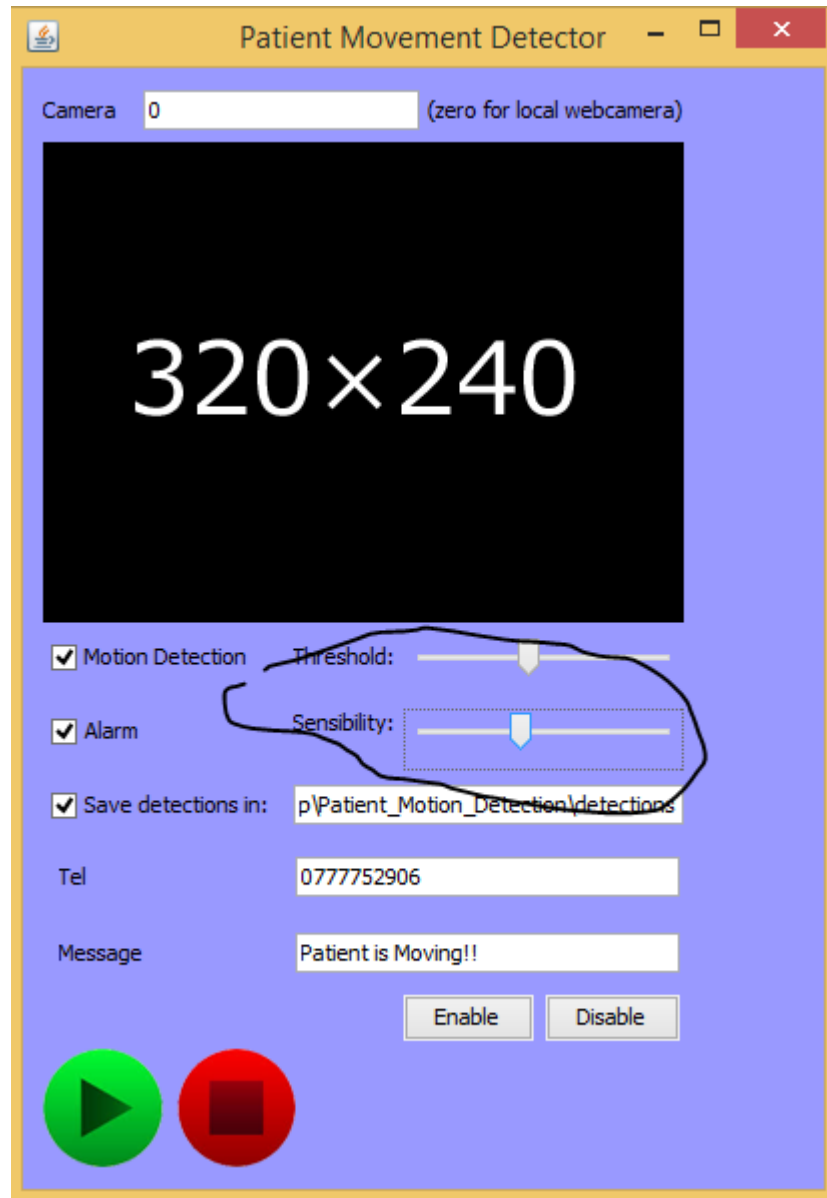


Figure 3.2 In order to track motions in particular time period

Supposed in first few days of after discharging from the hospital there is a must to focus every single motion of the patient. Because abnormality in behaviors will depend on the patient's situation.

4. CONCLUSION

Majority of the elderly bedridden patients are getting treatments under their own roof and require special caring with continuous human monitoring. Problem with the human monitoring is that it requires well trained caregiver with sound knowledge and skills to keep eye on the patient all the time. Finding well qualified caregivers/private nurses is not an easy task while they are limited and already assigned for particular jobs. It requires high concentration level even for well trained and qualified caregivers to monitor the patient in every single second. There are several computerized monitoring systems available to date, but which are lack of many mandatory features worth to their extreme cost. Therefore, an inexpensive system which can monitor multiple necessary facts about the patient's health would be ideal. Luxury of an automated patient monitoring system is that even a family member can become a caregiver to look after the patient since all the monitoring tasks is done through the system. Patients with respiratory issues are having restlessness in case of a situation where they need more oxygen. Restless patients tend to change their position in the bed to gain more oxygen in to the body. Thus, it's a must to monitor every motion of the patient.

5. REFERENCES

- [1] "Respiratory Diseases in the Elderly page 9", *Reader.erspublications.com*, 2017. [Online]. Available: <http://reader.erspublications.com/respiratory-diseases-in-the-elderly/9?ajax>. [Accessed: 08- Mar- 2017].
- [2] "COPD in the Elderly Patient", *Medscape*, 2017. [Online]. Available: <http://www.medscape.com/viewarticle/730813>. [Accessed: 08-Mar-2017].
- [3] Christian Thureau " Behavior Histograms for Action Recognition and Human Detection" Czech Technical University, Faculty of Electrical Engineering Department for Cybernetics, Center for Machine Perception 121 35 Prague 2, Karlovo náměstí, Czech Republic.
- [4] J. K. Aggarwal, Q. Cai, W. Liao, and B. Sabata. Non-rigid motion analysis: Articulated & elastic motion. accepted by CVGIP: Image Understanding.
- [5] IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, VOL. 19, NO. 7, JULY 1997
- [6] Somchanok Tivatansakul and Michiko Ohkura, "Healthcare System Focusing on Emotional Aspects using Augmented Reality," International Conference on Biometrics and Kansei Engineering '5-7, July, 2013, pp. 218–222.
- [7] N. Gal, D. Andrei, D. I. Nemes, E. Nadasan, and V. Stoicu-Tivadar, "A Kinect based intelligent e-rehabilitation system in physical therapy," Studies in health technology and information, pp. 489-493, 2015.
- [8] https://www.researchgate.net/publication/3669570_Pfinder_Real-time_tracking_of_the_human_body
- [9] Wenbing Zhao, Hai Feng, Roanna Lun, Deborah D. Espy and M. Ann Reinthal, "A KinectBased Rehabilitation Exercise Monitoring and Guidance System," In Proc. 2014 5th IEEE International Conference on Software Engineering and Service Science (ICSESS), June 27-29, 2014, Beijing, pp. 762–765.

[10] B. Li, M. Maxwell, D. Leightley, A. Lindsay, W. Johnson, and A. Ruck, "Development of Exergame-based Virtual Trainer for Physical Therapy using Kinect," in Games for Health 2014, 2014, pp-79-88.

GLOSSARY

APPENDICES