DAYANANDA SAGAR COLLEGE OF ENGINEERING

AN AUTONOMOUS INSTITUTE AFFILIATED TO VTU, APPROVED BY AICTE & UGC, ACCREDITED BY NAAC WITH 'A' GRADE.
BIOTECHNOLOGY, CSE, ELECTRICAL, MECHANICAL & TELECOMMUNICATION ENGINEERING ACCREDITED BY NBA

DEPARTMENT OF MEDICAL ELECTRONICS

REPORT
ON

CardioHealth

Home Based Rehabilitation System for People with Cardiovascular Diseases

BY

STUDENT NAME	USN
DEEKSHA V	1DS15ML006
FIHA AFRA	1DS15ML009
PRATHIBHA K P	1DS15ML023
SYED FIZA	1DS15ML032

OF
VIII SEMESTER

Project guide: Prof. Sahana M Kulkarni

ABSTRACT

The proposed project idea is concerned with the utilization of Serious Games in terms of home-based patient rehabilitation. The main goal here is to attempt to provide motivation during the exercises as well as monitor their condition and heart rate while using the Microsoft Kinect 2 integrated into a customized open source game engine. The problem to be solved is to monitor that patients follow their exercise programmes regularly. Doctors/Physiotherapists may also be updated with their progress without consistent visits.

MOTIVATION

In India we are concentrating only on phase of 1 of cardiac rehabilitation when the patient is very much in the hospital but the other 3 phases are kept untouched. It is important to keep the right track of patients going to work and enjoying all his recreational activities/hobbies.

Comparing ourselves to west where every cardiac patient is receiving cardiac rehabilitation, as the starters we can at least put priority patients of heart failure in cardiac rehabilitation so that their wait for Left ventricular assist device or Heart transplant doesn't become unmanageable.

The future of cardiovascular disease treatment is a whole package of curative, preventive and providing a more conditioned state of health to its patients, where symptoms can be managed as closely as possible.

BACKGROUND

CARDIOVASCULAR DISEASES AND CARDIAC REHABILITATION:

Cardiac rehabilitation is a medically supervised program that involves exercise, diet, psychological condition to help improve heart health after a person has undergone a surgery, or suffers a heart attack or other significant cardiac event. Cardiac rehabilitation is often divided into phases that involve monitored exercise, nutritional counseling, emotional support, and education about lifestyle changes to reduce risks of heart problems. The goals of cardiac rehabilitation is to establish a customized plan to help the patient to regain strength, to prevent the condition from worsening, to reduce the risk of future heart problems, and to improve the patient's health and quality of life.

The main area of rehabilitation focused on for this project is rehabilitation of people with cardiovascular diseases. Cardiovascular Disease (or Heart disease) is a class of diseases that involve the heart, the blood vessels (arteries, capillaries, and veins) or both.

Patients that require rehabilitation for cardiovascular diseases must perform consistent exercises as a crucial element in their overall physical and mental rehabilitation. These exercises help the patient in many ways:

- Strengthens the heart
- Will help to improve congestive heart failure symptoms
- Lowers blood pressure
- Improves strength
- Helps attain healthy weight
- Helps manage stress
- Boosts mood and self-esteem
- Improves sleep

LITERATURE REVIEW

1. **Wenbing Zhao,Hai Feng ,Roanna Lun , Deborah D. Espy , M. Ann Reinthal, "A Kinect-based rehabilitation exercise monitoring and guidance system",IEEE 5th International Conference on Software Engineering and Service Science, 2014**

   - Realtime exercise quality assessment and feedback

- Provide a detailed, realistic visual guide on the correct movements for each exercise
- Capture the actual movements of the patient for real time visual display as well as for post-exercise review by the patient or the clinician
- Provide intuitive feedback to the patient regarding the quality and quantity of the exercises
- The system should not display images of the demonstrator or the patient, to conform to

the privacy policy

Technology: - Microsoft Kinect

Unity framework

Differences:

- Follows rule based approach
- Not specific to cardiac rehab
- Does not use cloud interface or web page
- Targets joint movements and angles

2. **Param Uttarwar, Deepak Mishra, "Development of a kinect-based Physical rehabilitation system",IEEE, 2015**

   - Medical Rehabilitation using Kinect, gesture recognition and skeletal tracking

- A game-based interactive rehabilitation program used Kinect which consisted of a set of balance training exercises suggested by the therapists based on the kind and severity of the injuries
- Microsoft Kinect sensor is used to obtain 3D coordinates of human joints
- Important features are extracted from the skeletal coordinates
- Assigns an accuracy score for each exercise carried out in a session
- Maintains records for doctor to access
- The accuracy of exercise performed by the patient is analyzed
- Random poses are not part of the exercise routine

Differences:

- Use of an HMM-based method
- Rehabilitation of patients recovering from shoulder

3. **R.K.Y.Chang, S.H.Lau, K.S.Sim, M.S.M Too, "Kinect-based framework for motor rehabilitation", IEEE, 2016**

- Combine Kinect with an application to produce an individually customized home based rehabilitation system

- Kinect comes with a depth sensor that is capable to track the movements of the patient in 3 dimensions
- Using the Kinect SDK, an application can assess the skeletal structure of a fully clothed patient
- Kinect is a viable solution to home based therapy due to its low cost and relatively good motion sensing accuracy
- The application will also provide feedback to the patient so that the patient can know if the exercises are done properly
- By use of technologies such as the Microsoft Kinect application, it can motivate the patient to continuously engage in the therapy while diverting the patient's attention away from the pain
- By monitoring and recording the patient's exercises, the physical therapist can be more accurately informed of the patient's progress as well
- An evaluation framework is also proposed to ensure the home based therapy program using Microsoft Kinect application is actually well received by the patient and is useful in aiding a more conducive home based rehabilitation

4. **Intan Irnanda, Achmad Basuki, Fadilah Fahrul Hardiansyah, "Physical Exercise for The Elderly People using Kinect Technology", 2018 International Electronics Symposium on Knowledge Creation and Intelligent Computing (IES-KCIC)**

- Using the game concept in rehabilitation process to provide the patient with a fun,

motivating, and challenging therapy

- To create a home-based physical therapy tool that can assist the patient in the correct execution of movements through stimulation from interactive elements of digital games based on the procedures of the physiotherapist

Downsides:

- There is no patient-doctor interaction and therefore the progress of patient is left majorly unmonitored
- The system is focussed on elderly patients

Interaction with Cardiologist

Cardiologist : Dr Narayana Murthy N

Dr Narayana Murthy N is an interventional cardiologist working full time at Sagar Hospitals - DSI, Kumaraswamy Layout and was previously the Director of CATH. Lab and Chief of Cardiology at PES Narayana Hrudayalaya. Dr Murthy has acquired his MBBS from Bangalore Medical College,India and his MD from Rostov State Medical University, Russia.

1. Is exercise important for patients suffering from CVDs?

   Yes! Exercise is very important for a healthy heart. There are basically even exercise tests to evaluate cardiac fitness. So yes exercise is very important. Exercise shows how much improvement the heart has made based on your exercise capacity.First standard tests are carried out are to measure the capability-various exercise tests like treadmill test,6 minute test, walk test,6 minute stair climbing test. These tests measure the heart capacity and then basic set of exercises are prescribed for the patient to do himself based on the capacity.

2. Is exercise prescribed for patients with CVDs especially post-surgery?

   Yes we do prescribe exercise to the patients. After the surgery, it's a graded exercise. So, we ask them to take it step by step, ask them to do one thing at a time, take it from there

and increase it as and when. So we expect them to go back home and come back with the progress.

3. Any harm in not doing the prescribed exercise?

Yes. Exercise is very, very important especially post surgery exercises. One way of determining their heart's improvement is by determining how much they're capable of walking and how much workout they can do.

4. Is rehabilitation important post-surgery?

Yes. It's very important. After 3 weeks post surgery we put them back on the treadmill test. There's nothing better than exercise to give them fitness to know if the patient is fit enough to carry on with his daily routine. We need to make sure their heart is not over exerted. That's what we call as the functional capacity.

5. What is Cardiac Rehabilitation and is it an important thing in the rest of the world?

When we were trained in the west we had a proper unit in the form of cardiac rehab which was headed by a physiotherapist and a group of dieticians and clinical psychiatrists. They were a part of a team. It's not an individual work.

Yes, I very much think so. The set of things we were trained in and I have had opportunities to work in and the current set of things I have here is absolutely different.

6. Does India have Cardiac Rehab units integrated in hospitals?

Here in india we don't have such a concept still. Of course in many of the centres we do have some facilities. Here there's no concept of cardiac rehab. It is just that we tell the patients to do the exercise and that is cardiac rehab which is not fair.

7. Why is Cardiac Rehab still not that prevalent in Indian Hospitals?

It doesn't happen down here for a simple reason, it all boils down to the cost and so many other factors.

Interaction with the physiotherapist

Physiotherapist : Shrihari Sharma

1. What are cardiovascular diseases?

   Structure of the heart. Heart has got 4 chambers which has got blood in it and it acts as a pumping mechanism where it distributes to the whole body. The heart itself has got blood supply for its functioning

   What happens in some of the lifestyle diseases we are encountering now, because of stress, the various lifestyles, food habits, cigarette smoking, alcohol consumption, diabetes and hypertension. These are called as risk factors for cardiac diseases.

2. Which are the conditions that can be benefitted from exercises?

   Which are the diseases benefitted from exercises - coronary artery diseases, blockage in artery.

   Complete blockage cuts of the supply of the blood. The severity of the disease depends on how much blockage is present, and how many arteries have been blocked. This can be managed in 2 ways.

   One is conservative medication if its in the preliminary stage and second is the surgical management. Which is called the CABG - coronary artery bypass grafting. Anyone under conservative or surgical method both are eligible for cardiac rehab.

3. When does the cardiovascular patients require rehab?

   In cardiac rehab there are phase 1,2,3,4. Phase 1 - early rehab, restricted to hospital stay of the patient for a week or 10 days of the event. The person will be under constant medication. Usual protocol- he is discharged on the 10th day. Then he has to visit the hospital for monitored exercise program. Phase 2 - monitored rehab, once in 2 days or a week depends on where he is taking the cardiac rehab under the guidance of physiotherapist,10 days - 3 months

4. How are exercises prescribed to cardiac patients?

Here we mainly prescribe exercise. But it is not only the exercise. We have to also take care of exercise, diet, psychological factors, lifestyle modifications, risk factor management. All these things can be taken care by lectures and counselling sessions. But exercise is skill oriented which the patient has to learn.

Phase3- not monitored, 3 months to 1 year and attending the hospital once a month to change the intensity of the exercise and get advice
Phase4- lifelong management/ maintenance program. If the exercises are performed regularly, reversibility does not happen.

Phase 2 and 3 are crucial and this is where the device could be useful.

Exercises - treadmill, bicycle ergometer, staircase and monitor his resting and target heart rate..
Mode Intensity Duration Frequency
Mode - type of exercise
Intensity- how much intense by monitoring heart rate.
Duration - how long the exercise has to performed
Frequency - how many times the exercises should be done a week. At least 3 to 4 times. Otherwise he is not actually targeting the heart. Tailor made program for each patient. Intensity level is calculated based on his age, gender, fitness level.

You should basically concentrate whether he is doing the exercise daily, because motivation is very important. If you don't have motivation you don't do it. Especially when patients have comorbidities they don't do it regularly. So it has to be monitored. If he knows he’s being

monitored probably he will do it regularly. And his diet has to be strictly monitored. So if these things are there in your device which can be accessed by the doctor it will be useful.

OBJECTIVES

Research and deliver Home-based Rehabilitation system for patients in rehabilitation of cardiovascular diseases with a user-friendly interface and also a doctor-patient interaction system for doctors to diagnose and examine patients without face-to-face interaction.

1. Research if project feasible
2. Research similar technologies to determine user requirements for this project
3. Research technologies to determine the most appropriate implementation of this project
4. Implement exercise tracking in patient system
5. Implement serious games in patient system
6. Implement doctor system
7. Implement Heart-rate tracking in patient system

Doctors will not be the main users of Doctor-Patient system. Physiotherapists will most be in charge of patient checkups. Doctors will refer to the group of physiotherapists, psychiatrist,dietitian.

PROBLEM IDENTIFICATION

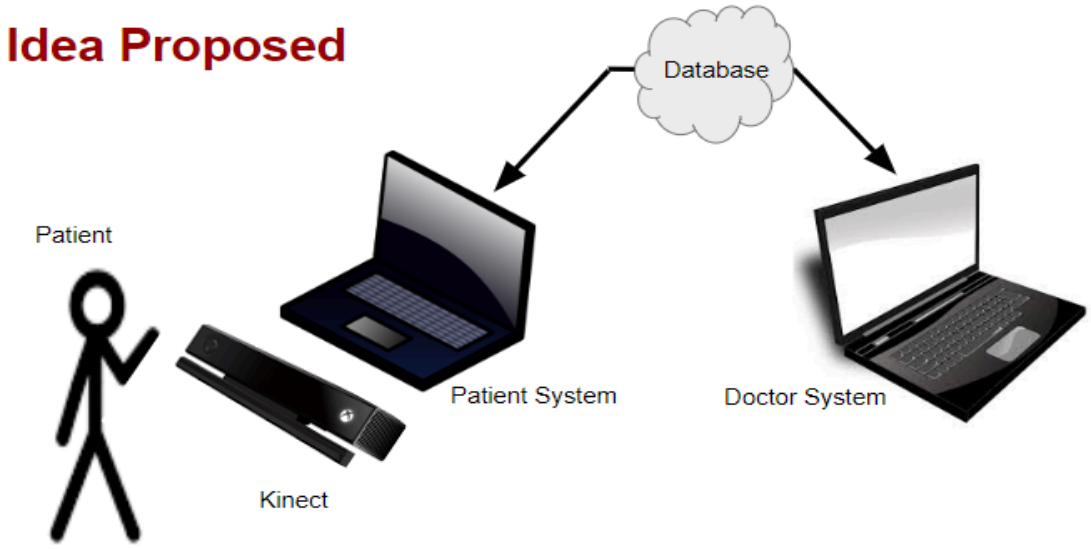
Communication between doctor and patient is a key success factor in medical treatment. And as such the doctor–patient relationship is central to the practice of healthcare and is essential for the delivery of high-quality health care in the diagnosis and treatment of disease or rehabilitation. Doctors must maintain a professional rapport with patients, uphold patients' dignity, and respect their privacy.

In terms of online medical systems between doctors and patients, there has been an emergence of websites set up for booking appointments, order repeat prescriptions and view your medical

record with certain Doctors/General Practitioners depending on if they choose to use the website.

The planned system will be in some ways similar to these online medical systems between doctors and patients except that results taken from patient's exercises will be sent straight to the doctor without the need for direct communication and check-ups and to allow for their exercise and rehabilitation to be performed from home.

PROPOSED METHODOLOGY



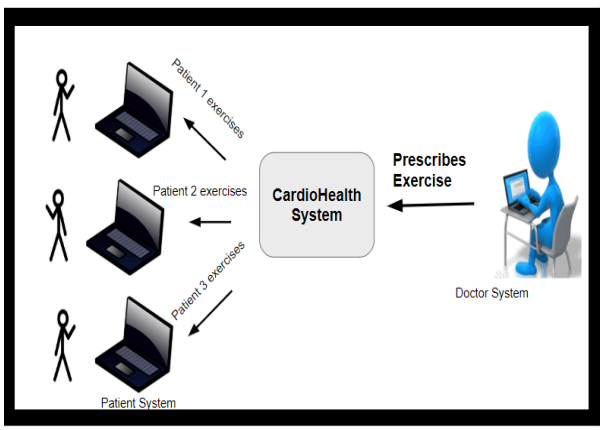
CardioHealth is a home-based rehabilitation system which uses the Xbox Kinect 2. Users of the system are usually patients in treatment of any type of Cardiovascular Disease. User must perform exercises in front of the Kinect. Exercises are played out in the form of a game. Different exercises are provided and patient's heart rate is monitored. The System is also connected online to the cloud services for patient's doctor /physiotherapist to view patient records. Doctor / physiotherapist views how well exercises are performed and also keeps up to date with the patient without the need of continuous doctor visits.

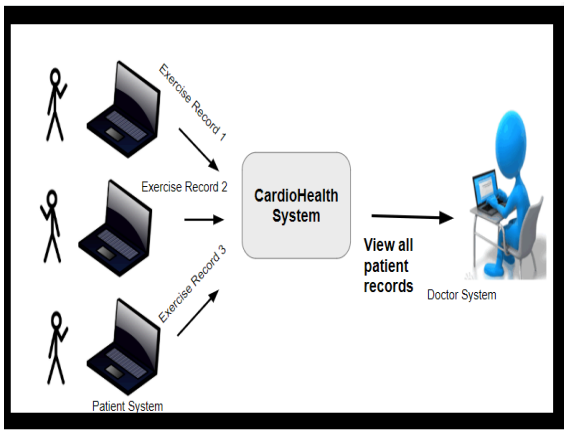
Rehabilitation is in areas of CardioVascular Diseases and Monitoring Heart-rate.

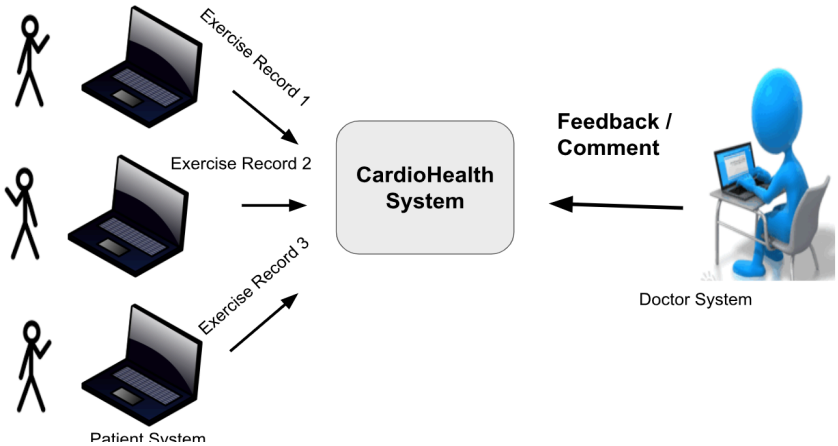
Exercises may include: Squats, Jumping Jacks, Various Stretches and Basic Body Movements, etc.

PATIENT'S SYSTEM: System will have the game and rehabilitation workout routines. Patient logs into their user-account (which is set up by Hospital / Doctor) and application commences. Patient has the ability to commence normal workouts, perform workouts in Gamified environment or view records from previous workouts as well as comments from Doctor.

ADMIN/ DOCTOR'S SYSTEM: System will be a Doctor check-up system. Doctor logs into their system- can view patients, create account for patients, can view specific patient records and send comment to patient on records to progress. There may also be an ability to view exact patient workout.







EXPECTED OUTCOMES

- To establish a customized plan to help the patient to regain strength
- To prevent the condition from worsening and reduce the risk of future heart problems
- To get regular feedback and updates on the exercises
- To improve the patient health and quality of life