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RESEARCH ARTICLE

A COMPUTER - BASED VIRTUAL REHABILITATION PLATFORM USING KINECT SENSOR FOR CEREBRAL PALSY: FIZIO

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Manuscript Info   Abstract

In this paper: FIZIO, a computer based virtual rehabilitation was developed using Microsoft's Kinect Sensor to treat the Cerebral Palsy. Cerebral Palsy is a neurological disorder caused by a non-progressive brain injury or malformation that occurs while the child's brain is under development. Cerebral Palsy primarily affects body movement and muscle coordination. This could be treated with physiotherapy. Normally People with cerebral palsy don't want to visit rehabilitation centres regularly as the sessions are too costly as equipments used in the rehabilitation process are very expensive to be used at homes or the clinics are far away from their homes. Conventional therapy doesn't engage and motivate people. The exercises are too monotonous and repetitive. Also there exists no medium through which the patients and doctors can track each patient's progress. To overcome these problems FIZIO was developed (an easy-to-use virtual rehabilitation platform designed to aid the rehabilitation process, and track patients' progress). It aims to make physiotherapy fun and convenient by transforming existing physical therapy exercises into3D-full body motion sensing video-games using Microsoft's Kinect sensor to track and assess patient's compliance. Designed with physical and occupational therapists, each exercise and activity is programmed to maximize recovery in a safe environment. The cognitive and motor activity required in 3D-full body motion sensing games will make the entire process engaging and hence keep patients fit, active and feeling lively. This will lead to (1) a reduction of rehab session costs, (2) flexibility of time of use, (3) reduce added injuries during transportation, (4)allow for live chat access to medical assistance anytime. In addition, Fizio can also be used as a networking tool to share experiences. The physicians and therapists can follow-up the patient's improvement online via. Fizio. Fizio brings the rehabilitation process out of the confines of hospitals and a patient may use it in 'whenever-wherever' way.

Background:-

Over a billion people are estimated to live with some form of disability. This corresponds to about 15% of the world's population. Between 110 million (2.2%) and 190 million (3.8%) people have significant difficulties in functioning. Furthermore, the rates of disability are increasing in part due to ageing populations and an increase in chronic health conditions.[1]

Disability is extremely diverse. While some health conditions associated with disability result in poor health and extensive health care needs, others do not. People with disabilities report seeking more health care than people without disabilities and have greater unmet needs.One of the disability is Cerebral Palsy is [1].

Cerebral Palsy (CP) is considered a neurological disorder caused by a non-progressive brain injury or malformation that occurs while the child's brain is under development. Cerebral Palsy primarily affects body movement and muscle coordination. [2]

People with CP experience limitations in fine motor control, strength, and range of motion. These deficits can dramatically limit their ability to perform daily tasks, such as dressing, hair combing, and bathing, independently. In addition, these deficits can reduce participation in community and leisure activities, and even negatively impact occupational perspectives[5,6,7].

CP have been developed for physical therapy across numerous settings. These innovative technologies provide a selection of differing platforms and contribute to the user sensory experience. In particular, virtual reality (VR) and motion-based games have been used for rehabilitation recently. Virtual reality systems demand focus and attention, can motivate the user to move, and provide the user with a sense of achievement, even if they cannot perform that task in the real world. Burdea,Deshpande, Liu, Langrana, and Gomez (1997) werethe first to incorporate VR technology for hand rehabilitation therapy. Byusing sensors installed in gloves, users were provided with VR-based force feedback, and the system provided data records regarding the grip forces achieved for every activity, and grip forces and bending angles of fingers

To treat children suffering from cerebral palsy we have proposed FIZIO (an easy-to-use virtual rehabilitation platform designed to aid the rehabilitation process, and track patients' progress) by using Kinect sensor to track and assess patient compliance.
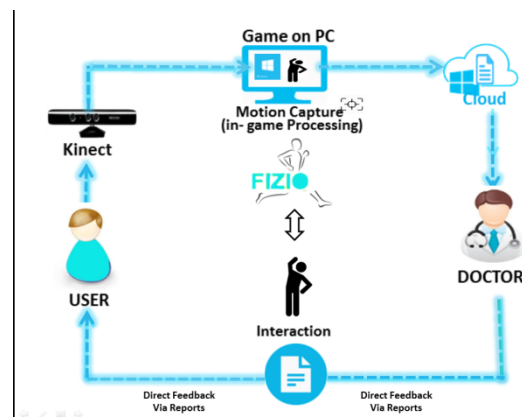
Fig.1:- Architectural Design of FIZIO.

Fizio is an easy-to-use virtual rehabilitation platform designed to aid the rehabilitation process, and track patients' progress. It aims to make physiotherapy fun and convenient by transforming existing physical therapy exercises into video-games, and uses Microsoft's Kinect sensor to track and assess patient compliance. Designed with physical and occupational therapists, each exercise and activity is programmed to maximize recovery in a safe environment. The cognitive and motor activity required in these 3D-full body motion sensing games will make the entire process engaging and hence keep patients fit, active and feeling lively. This will lead to a reduction of rehab session costs, flexibility of times, reduce added injuries during transportation, allow for live chat access to medical assistance anytime. In addition, Fizio can also be used as a networking tool to share experiences. The physicians and therapists can follow-up the patient's improvement online via. Fizio. Fizio brings the rehabilitation process out of the confines of hospitals and a patient may use it in 'whenever-wherever' way.

Methods:-
Development of FIZIO:-
FIZIO was developed by using Microsoft'sKinect sensor which was connected to a DELL laptopinstalled with Microsoft Windows 8. The computer has an audio module that we used to deliver audio feedback whereas it's 15-in. LCD screen was used for visual interaction. The software (FIZIO game) was coded in Microsoft C# using Visual Studio and Microsoft Unity as the integrated development platform for the game.
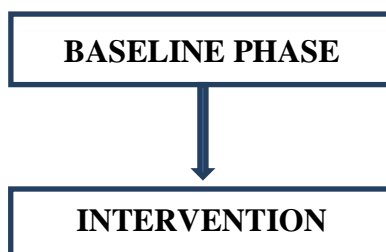
User testing:-

After the software development, a physical therapist in a special-education school invited five junior-high school students of age group between 8-16 years to test the assistive device. All of them were having cerebral palsy with inflexibility of upper and lower limb movements and insufficient muscle endurance after they were born. They have received substantial rehabilitation since they enrolled in the special education system. They were having problems in limb movements and problem in maintain balance while walking. Neither of the participants had previous experience with game through Kinect.

Setting:-
FIZIO was tested the Kinerehab system at a special education school, which receives students with special needs from kindergarten to high school. Kinect was connected to a DELL LAPTOP on which the rehabilitation system software (FIZIO GAME) developed in Lab was installed with Microsoft Windows 8. The computer has an audio module that we used to deliver audio feedback whereas it's 15-in. LCD screen was used for visual interaction. The software was coded in Microsoft C# using Visual Studio and Microsoft Unity as the integrated development platform for the game. For optimal performance of the Kinect sensor, participants were required to perform physical exercise approximately 3 feet in front of the Kinect module. The rehabilitation games used in the experiment were as follows: (1) "Balloon Bursting", which facilitate upper limb exercise,(2)"MEDICINE COLLECTION", which help child to improve their balance. Each type of movement was repeated a certain number of times in the game.

FIZIO was tested in two phases:-

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┌─────────────────────────┐
│     BASELINE PHASE      │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│      INTERVENTION       │
└─────────────────────────┘
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Fig. 1:-Phases of FIZIO testing

Baseline phase:-
In the baseline phase, all the instructions were given to the participants about the game. Before they started the therapy demonstration was given to them. Then the participants started to perform physical exercise on the wheelchair or while standing. The numbers of correct and incorrect movements were recorded in the game by the system in each session. The participants then repeated what they heard. If there was any inaccuracy in movement types or numbers of exercise, the therapist corrected the participant until the content of the prescribed program was understood without errors. During the baseline phases, the participants followed the instructions and demonstrations of the physical therapist and completed the required movements without assistance. The proposed system detected inaccuracy in performance and counted the number of correct movements in each session. However, the system did

not provide any visual cues and any feedback to the participant. The therapist did not interfere with any inaccuracy in performance that the participant might have.

Intervention phase:-
In this phase, the Kinerehab system was used. Children performed physical exercise through game, three feet in front of the Kinect module and the laptop screen while sitting on the wheelchair or standing. As in the baseline phase, children repeated each type of movements for 1 minute as per the game time. The progress in exercise was evaluated on the basis of scores earned in each level of the game. The numbers of correct movements were counted automatically by the Kinerehab system using gesture recognition.

Neither of the participants had previous experience with Kinect. They were motivated to perform physical activity daily in the fun way.

Results:-
Table 1:-GameScores of baseline and intervention phase.

Phases	Sessions	Scores	
		Level 1	Level 2
Baseline Phase	6	40	30
Intervention Phase	10	70	60

The baseline phase was carried for 6 days for all the participants. The intervention phase was carried for 10 days for all participants. The baseline and intervention phases observed the number of correct movements of each type. During the baseline phase (6 sessions), the highest score for correct movements in first level of the game was 50 on the average and in the second level it was 30 on an average. During the intervention phase (10 sessions), the score in each level increased to approximately 70 in the first level of the game and 60 in the second level of the game. The difference of numbers of correct movements between the baseline and the intervention was significant.

Discussion:-
This study assessed the effectiveness of FIZIO for motivating and engaging children for physical rehabilitation. During the baseline phases, the scores in both the levels of the game were lowbecause the required movements were relatively difficult for them to perform. During the intervention phases, the score in each level of the game increased substantially compared to those obtained during the baseline phases. In addition, the absence of feedback resulted in a lack of enthusiasm for rehabilitation. The observation during the study showed that this virtual rehabilitation platform motivated children for these 3D-full body motion sensing games made the entire process engaging and motivated children for the physical therapy.

Conclusion:-
From the study we could conclude that Kinerehab system shows a positive impact of FIZIO in motivating and engaging children suffering from cerebral palsy for the physical therapy. In future we would be developing new games including exercises related to occupational therapy.

Abbrevations:-
CP- Cerebral Palsy
VR- Virtual Reality

Acknowledgement:-

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