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STUDY OF THE HUMAN KINAMETICS USING ARM 7 AND WEARABLE SENSORS

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Abstract: – This paper presents a system which gives the idea of human kinematics, human pathological joints and giant analysis by using a wearable sensor accelerometer and electromyography. There are many causes that can affect the functioning of human locomotors system. ARM7 is interfaced with this sensor to study the human walking and arm movements. Wired data communication is used between LCD and wearable sensors. It can detect muscle injury after accident. This system is used in emergency where muscle specialist is not available and treatment to the patient is priority. This system is a smart device for a giant analysis by using accelerometer and electromyography.

Keyword: - Gait analysis, Wearable System, Accelerometer, Electromyograph**.**

I. INTRODUCTION

Gait analysis is a systematic study of human walking [1]. It is conducted through observation and instrumentation for measuring body movement, body mechanics and muscles activities. This system is used to assess, plan and give treatment for individual with conditions influencing their ability to walk as well as hand movements. It is frequently used in sport, such as athletics to help the athletes run more efficiently and to identify problem in posture or movement of the patient. Instrumentation on gait analysis is used to trace movement of the patient through analysis based on kinetics or kinematics. Fig. 1 showed different gait cycle phases according

Gait analysis systems which are commercially available, generally uses camera (motion capture system). This camera- based system cost a lot of money .This system need time for its calibration and set-up. It also needs a special room. This camera-based system is precise but impractical for regular use [2].

The more accurate system for gait analysis comprises a camera-based system and ground plates mounted on the floor. The cameras record the positions of markers placed on a subject’s body and these records can later be used to reconstruct the motion or determine desired parameters such as gait phases, angles, gait speed, step length sole acceleration, etc. Force platform records the ground reaction forces and torques about the center of pressure.

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Force plate/platform is also an expensive system, but this system is very precise. These camera and force plate/platform systems widely used in modern in modern gait laboratories.

The gait instrumentation developed in this research is an alternative to commercially available camera and force plate system. The system is based on accelerometer & electromyograph sensors which are cheaper than the camera-based system. This system also requires no special room so it can be used under regular condition according. To Dr. Perry [3].

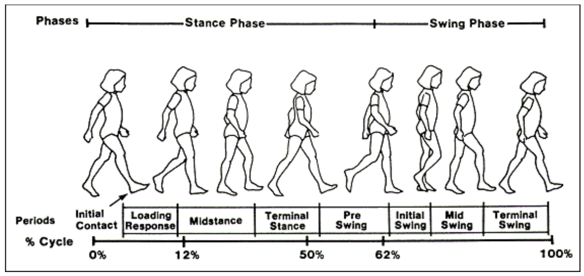

Fig. 1 Division of the gait cycle phases according to Dr. Perry [3]

Typical limb kinesiotherapy exercises that can be performed during a rehabilitation/recovery process.

Arm-Activiy 1	The arm was oscillating from straight down (parallel to body) to Horizontal straight ahead.	**Leg-Activit y1**	The leg was oscillatin g Ahead.
Arm-Activity 2	The arm was oscillating from straight down to horizontal (open arm).	**Leg-Activity 2**	The leg was Oscillating behind.
Arm-Activity 3	The forearm moved from straight down to horizontal straight ahead .c	**Leg-Activity 3**	The leg was performing a complete oscillation ahead-Behind.
Leg-Activity 4	The leg was Oscillating on side.	**Leg-Activity 5**	Lifting the Knee.

Fig 2: Arm and leg activity during different positions [4]

II. LITRATURE SURVEY

There are numerous causes that can affect the functioning of the human locomotors system, leading to the appearance of joint disorders in the lower limb and generating atypical gait patterns. The importance of research and development in assistance technologies to compensate pathological gait have been recognized since the beginning of the twentieth century and numerous challenges still lie ahead to make their clinical application a reality. In this section, GAIT, the lower-limb Wearable exoskeleton is presented, conceived as a compensation and evaluation system of pathological gait, for application in real conditions as a combined assistance and assessment methodology of the problems affecting mobility in individuals with neuromotor disorders.[2]

The main technological challenges are discussed with respect to sensing, actuation and control subsystems. Special emphasis is placed on advances in robotic lower-limborthoses, and biomechanical requirements, structural design considerations and the approaches existing to develop robust real-time controllers for portable solutions with a common aim, human motor control, are analysed.[3]

Normal and pathological human gait:

Regarding gait disabilities due to neurological, orthopedic or traumatic conditions, there are different robotic approaches, and a classification of lower-limb robotic exoskeletons is presented in Rehabilitating robots, evaluation and tracking systems, and functional recovery wearable systems.[3]

The cyclical process of events during gait is known as the gait cycle, and it starts and ends the moment when one of the feet comes into contact with the ground, and the stance phase begins. While one leg displaces moving the body, the other leg acts as a support; thus, the state of the lower extremity is divided into two phases depending on its situation with regard to the ground: swing phase and stance phase. During gait at normal speeds there is a short period of simultaneous support of both legs. As speed increases a cycle is reached where there are no bipodal supports. Gait can be characterized by a set of parameters: stride length, step length, rhythm and speed. The complexity of the human locomotion process implies studying the cyclical movements that are executed, considering the kinematics and kinetics (forces and moments) and also the work, energy and power engaged in the process. Moreover, to understand all the phenomenon, it is necessary to have knowledge of the principles and neurological movements that control movement, the periphery input or sensory systems that intervene and the mechanisms that command the musculoskeletal system.[3]

Limb joint classification:

1) Upper limb joint: This joint is again divided into three sub joints

a) Shoulder joint

b) Elbow joint &

c) Wrist joint

Shoulder joint can work in 6 modes and it work for different angels from this angles we decide the normal human and abnormal or injured person's movement and we come to know the tear of muscle or fracture in the arm .Arm joints is known as upper limb joints.

Sr no	Position name	Normal angle
1	Flextion	0 -180
2	Extention	0-60
3	Abduction	0-180
4	Adduction	0-60
5	Exterior rotation	0-90
6	Interior Rotation	0-90

Fig 3: Table for shoulder joint

Elbow joint: It works for two different positions

Sr no	Position name	Normal angle
1	Flextion	0 -120
2	Extention	120-0

Fig 4 : Table for elbow joint

Wrist joint: : It works for two different positions

Sr no	Position name	Normal angle
1	Flextion	0-60
2	Extention	0 -40

Fig 5: Table for wrist joint

2) Lower limb joint: Leg joints are known as lower limb joints. These joints again divided into 3 different joints. a) Hip joint b) Knee joint & c) ankle joint

a) Hip joint:

Sr no	Position name	Normal angle
1	Flextion	0-180
2	Extention	0-40
3	Abduction	0-40
4	Adduction	0-30
5	Exterior rotation	0-15
6	Interior Rotation	0-20

Fig 6: Table for hip joint

b) Knee joint

Sr no	Position name	Normal angle
1	Flextion	0-140
2	Extention	140 -0

Fig 7: Table for knee joint

c) Ankle joint

Sr no	Position name	Normal angle
1	Flextion	0-40
2	Extention	0-30

Fig 8: Table for ankle joint

III. SYSTEM BLOCK DIAGRAM

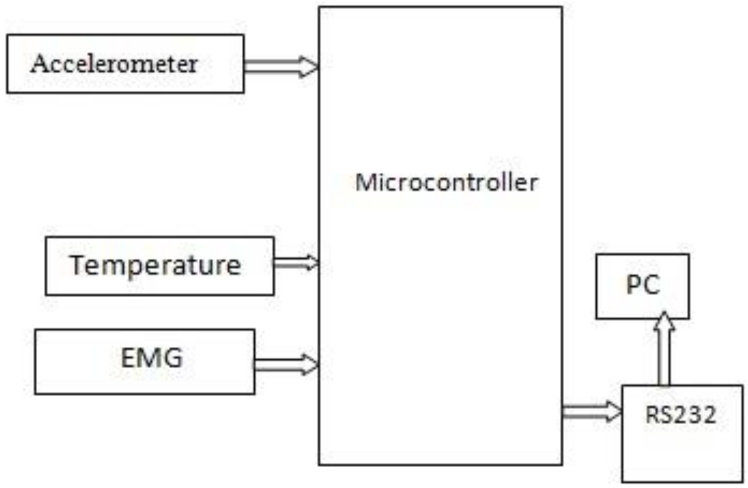

Fig 9: Basic system block diagram

Axis Accelerometer:

An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer .By measuring the amount of static acceleration due to gravity, you can find out the angle the device is tilted at with respect to the earth. By sensing the amount of dynamic acceleration, you can analyze the way the device is moving.

Accelerometers use the piezoelectric effect - they contain microscopic crystal structures that get stressed by accelerative forces, which cause a voltage to be generated. Another way to do it is by sensing changes in capacitance. If you have two microstructures next to each other, they have a certain capacitance between them. If an accelerative force moves one of the structures, then the capacitance will change. Add some circuitry to convert from capacitance to voltage, and you will get an accelerometer.

The three axis accelerometer are basically used to identify the movements across the three axis i.e. x-axis, y-axis, z-axis. Accelerometer is an electronic device which is interfaced using I2C protocol and provides the reading after every 1msec. According to the requirement of the application, the microcontroller will take the reading from the accelerometer within a fixed interval of time and do the necessary operation according to the requirement of the application.

Liquid Crystal Display:

LCD is used in a project to visualize the output of the application. We have used 16x2 lcd which indicates 16 columns and 2 rows. So, we can write 16 characters in each line. So, total 32 characters we can display on 16x2 LCD.

LCD can also use in a project to check the output of different modules interfaced with the microcontroller. Thus LCD plays a vital role in a project to see the output and to debug the system module wise in case of system failure in order to rectify the problem.

PC:

PC is used to analysis the various body muscles critical injuries using visual basic software developed window. Using pc we can analysis the intensity of injury happened and the necessary treatment can be started well on time.

RS232:

RS 232 IC is a driver IC to convert the µC TTL logic (0-5) to the RS 232 logic (+-9v).Many device today work on RS 232 logic such as PC, GSM modem , GPS etc. so in order to communicate with such devices we have to bring the logic levels to the 232 logic (+/-9v).

Today, RS-232 has mostly been replaced in personal computers by USB for local communications. Compared with RS-232, USB is faster, uses lower voltages, and has connectors that are simpler to connect and use. However, USB is limited by standard to no more than 5 meters of cable, thus favoring RS-232 when longer

EMG Sensor:

EMG stands for Electromyography. This sensor is used to detect the muscles movements in the body. This sensor is very useful in detecting the muscles tear able issues like limb problems etc.

There are generally two types of EMG

1. Fine Wire electrode EMG &
2. Surface Electrode.

Surface electrodes are having different advantages like Quick, easy to apply, No medical supervision, required certification ,Minimal discomfort etc.

Some factors may effect on EMG so care must be taken at the time of handling. Factors which may affect are causative factors, extrinsic electrode structure and placement, physical & physiological phenomena influenced by one or more causative factors.

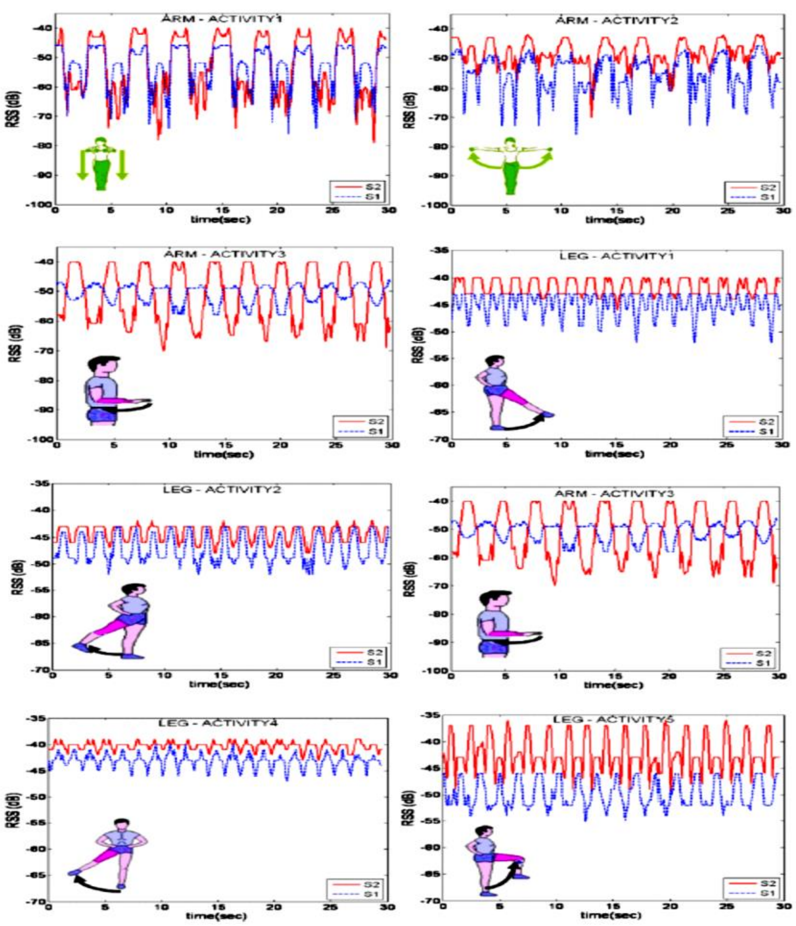

Fig 10: Sample traces of RSS for electrode s1 and s2

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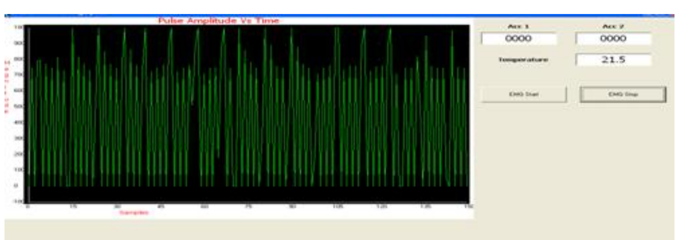
IV. SYSTEM SETUP

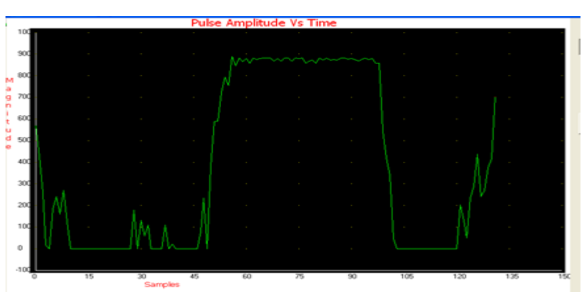
The system is interfaced with the hardware the required result is find out by connecting EMG with the patient or human body. Accelerometer is also used to find the angle while the movement. 32 bit microcontroller is used to get the best results as it can be programmed according to the needs.

Fig 11.Hardware set up

V. RESULT AND DISCUSSION

This system is monitoring tool for gait analysis. Many researchers have worked on gait analysis for different limbs they have developed different systems. I have tried and form a system which can be used for all limb joints to find the tear of muscle and fracture and give the results in terms of angle and graph. The proposed system reveals a promising monitoring tool for gait analysis. It allows measuring gait temporal features (stance, swing, single and double support) during a walking. It also measures foot plantar pressures. There are many potential clinical applications of this system such as measuring an outcome after total knee or hip replacement, prosthesis adjustment for amputees, gait disturbance analysis in neurological diseases. In paper Wearable Gait Measurement System Based On Accelerometer And pressure, Gyroscope is used for calculating Pressure on the foot and used for calculating gait temporal for walking. While in my proposed system EMG and Accelerometer is used for calculating different angles as well as wear and tear of muscles for the limbs.





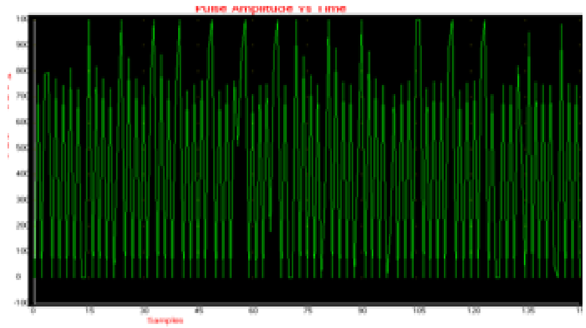


Fig 12: Result of the system with EMG and Accelerometer

VI. CONCLUSION

A wearable gait measurement system based on accelerometer and electromyograph is developed successfully. It is portable, wearable and expected not to interfere the natural gait pattern of the subject. It can measures angle of patient's leg and ground while the patient walks, and ground reaction forces (plantar pressure) data in an unrestricted environment. The wearable system can be used for studying abnormal versus normal gait. It can also be used to study cadence and plantar pressures measurement of the foot. In addition the system can be interfaced with a portable electro tactile stimulator to provide sensory feedback for the insensate foot

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