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HAND THERAPIST: A REHABILITATION APPROACH BASED ON WEARABLE TECHNOLOGY AND VIDEO GAMING

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Abstract— Hand impairment after stroke is quite debilitating. Present hand rehabilitation approaches, although useful, are still limited as they often require the constant help of a technician or caregiver and also because they are based on repetitive training which may be demotivating [1]. More advanced approaches are in development including the use of robotized systems [2]. Nonetheless, these systems are still expensive and require expert support. Here, we show the proof-of-concept of a hand rehabilitation system, dubbed "hand therapist", inspired in video gaming devices and software which is comprised of the Myo armband, a home-built robotic glove and Unity3D, a video game development engine. With this approach we aim at a solution that combines performance, low-cost and engagement/motivation in hand therapy.

Keywords— Hand rehabilitation, Electromyography, Robotic glove

INTRODUCTION

The Myo armband is a ~200 euros wearable device comprised of a 9-axis inertial measurement unit (IMU) and 8 electromyography(EMG) sensors [3]. The device thus provides two kinds of data, spatial and gestural data, respectively. Spatial data informs about the orientation and movement of the user's arm whilst gestural data informs what the user is doing with his/her hand in the form of one of several pre-set poses. All data is communicated via Bluetooth with Unity3D. A ~100 euros robotic glove was built based on a sports glove, nylon wiring, two stepper motors for hand opening/closing, and an Arduino Uno board for control and communication with Unity3D. Touch buttons were also used to detect a fully opened/closed hand. A game was built in Unity 3D for hand training in which the user must grab, hold, transport and drop a cube in several increasingly difficult puzzle levels. In the game the user sees virtual hands/arms that replicates the user's movements such that the user can feel more immersed in the game.

Presently, the game works as follows: the user wears the Myo armband in the healthy forearm and executes the required movements, which are translated into the movement of the virtual hand/arm. Hand movements are then replicated into the movement of the robotic glove the user wears in the impaired hand. These movements are also simultaneous translated into the movement of a corresponding virtual hand/arm. So far the system was tested only with healthy subjects, but tests with stroke patients are planned. In the future, we also plan to combine the system with an additional Myo armband unit such that is possible to monitor both hand/arms simultaneously for an improved interaction of the user with the game.

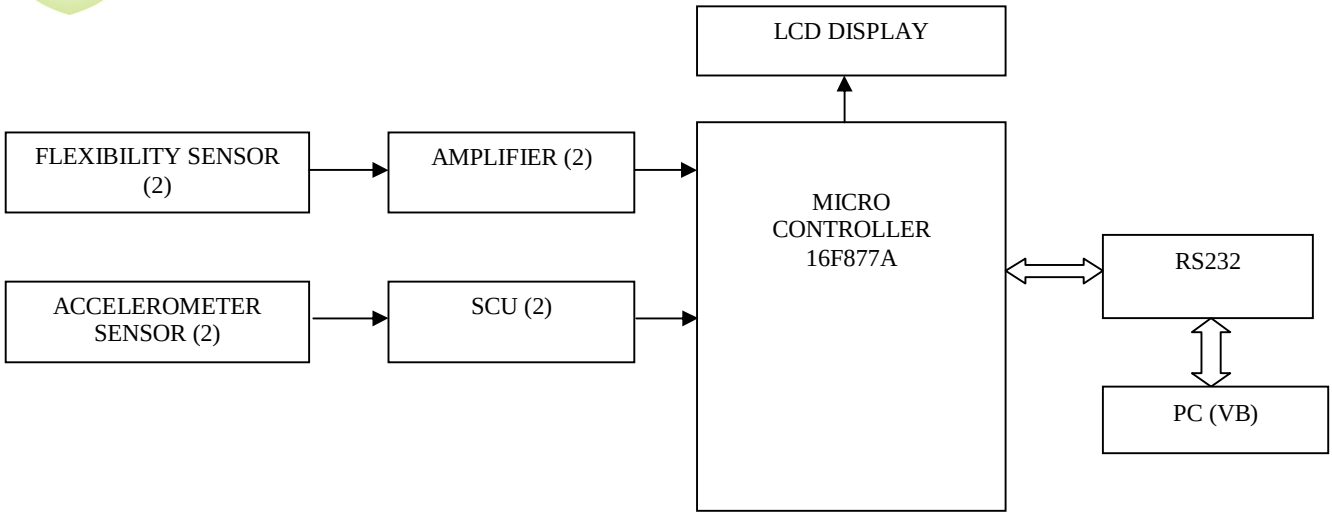
In this work we proposed a low-cost (<500 euros) and engaging solution for hand rehabilitation is possible based on gaming devices and software. Future studies with patients are still required.

I. PROPOSED METHOD

In this paper the wired process has been made with the interfacing module. So that data flow cannot lose due to the connectivity problem. Here two flexibility sensors are fixed in the two hand fingers to identify the force associated with it and accelerometer sensor is fixed in the hand to detect the movement of it. All the sensors are interfaced with the microcontroller through the amplifier and interfacing circuit.

Microcontroller is already programmed for the task needed for the proposed work. From where PC is interfaced with it through the RS232 serial communication. In PC we can easily monitor the whole hand movements and force associated with it. And also in PC video game is created in Unity 3D for hand training in which the user must grab, hold, transport and drops a cube in several increasingly difficult puzzle levels. In the game the user sees virtual hands/arms that replicate the user's movements such that the user can feel more immersed in the game.

In the pre-processing stage bilateral filter is used, because it is an edge preserving nonlinear filter. The preprocessed image is decomposed to one level using 2D DWT and the detail subband coefficients are denoised using bivariate shrinkage. Finally the despeckled image is reconstructed from the modified wavelet coefficients using 2D IDWT.



II. PERFORMANCE METRICS

FLEXI FORCE SENSOR:

This manual describes how to use Tekscan's Flexi Force Sensors. These sensors are ideal for designers, researchers, or anyone who needs to measure forces without disturbing the dynamics of their tests. The Flexi Force sensors can be used to measure both static and dynamic forces (up to 1000 lbf.), and are thin enough to enable non-intrusive measurement.

The Flexi Force sensors use a resistive-based technology. The application of a force to the active sensing area of the sensor results in a change in the resistance of the sensing element in inverse proportion to the force applied.

The Flexi Force sensor is an ultra-thin and flexible printed circuit, which can be easily integrated into most applications. With its paper-thin construction, flexibility and force measurement ability, the Flexi Force force sensor can measure force between almost any two surfaces and is durable enough to stand up to most environments. Flexi Force has better force sensing properties, linearity, hysteresis, drift, and temperature sensitivity than any other thin-film force sensors. The "active sensing area" is a 0.375” diameter circle at the end of the sensor.

Accelerometer sensor

Accelerometer sensor have been developed to measure acceleration in a variety of application,a three dimensional accelerometer sensor has been created for measuring involuntary human hand motion.the sensor uses three single axis accelerometer fabricated at MIT Microsystems technology laboratory. the size and mass of the sensor werelimited to avoid altering hand motion being measured. To measure the three dimensional acceleration of human hand motion with adequate accuracy and precision ,the necessary bandwidth for normal human motion, and the amplitude range required for the highest normal acceleration. At the same time ,the physical presence of the sensor should not alter the hand motion .the application of measuring something sensitive to external mass like human hand requires the accelerometer sensor to be extremely small and lightweight.

CALIBRATION:

Calibration is the method by which the sensor’s electrical output is related to an actual engineering unit, such as pounds or Newtons. To calibrate, apply a known force to the sensor, and equate the sensor resistance output to this force. Repeat this step with a number of known forces that approximate the load range to be used in testing. Plot Force versus Conductance (1/R). A linear interpolation can then be done between zero load and the known calibration loads, to determine the actual force range that matches the sensor output range.

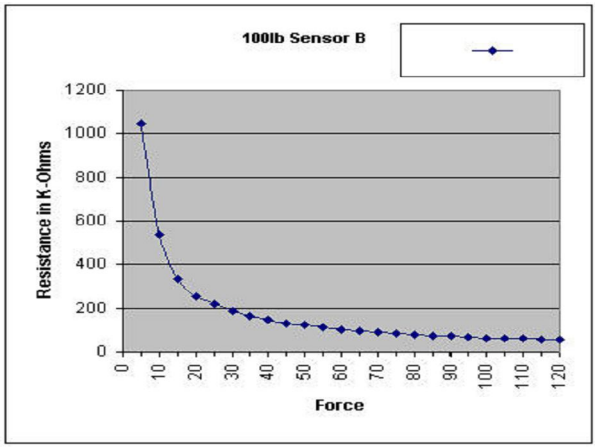
Amplifier:

Generally, an amplifier is any device that will convert a signal with a small amount of energy into a similar signal with a larger amount of energy. In popular use, the term today usually refers to an electronic amplifier, often as in audio applications. The relationship of the input to the output of an amplifier — usually expressed as a function of the input frequency — is called the transfer function of the amplifier, and the magnitude of the transfer function is termed the gain

LCD DISPLAY

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. An LCD consists of two glass panels, with the liquid crystal material sand witched in between them.

The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. One each polarizer's are pasted outside the two glass panels. These polarizer's would rotate the light rays passing through them to a definite angle, in a particular direction



When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters.The LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD's don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range.Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications

Signal conditioning unit:

The signal conditioning unit accepts input signals from the analog sensors and gives a conditioned output of 0-5V DC corresponding to the entire range of each parameter. This unit also accepts the digital sensor inputs and gives outputs in 10 bit binary with a positive logic level of +5V. The calibration voltages* (0, 2.5 and 5V) and the health bits are also generated in this unit. Microcontrollers are widely used for control in power electronics. They provide real time control by processing analog signals obtained from the system. A suitable isolation interface needs to be designed for interaction between the control circuit and high voltage hardware. A signal conditioning unit is which provides necessary interface between a high power grid inverter and a low voltage controller unit.

RS232 COMMUNICATION:

In telecommunications, **RS-232** is a standard for serial binary data interconnection between a *DTE* (Data terminal equipment) and a *DCE* (Data Circuit-terminating Equipment). It is commonly used in computer serial ports.

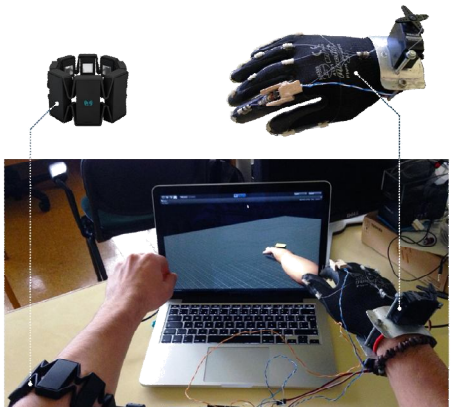
Scope of the Standard:

The Electronic Industries Alliance (EIA) standard RS-232-C [3] as of 1969 defines:

- Electrical signal characteristics such as voltage levels, signaling rate, timing and slew-rate of signals, voltage withstand level, short-circuit behavior, maximum stray capacitance and cable length
- Interface mechanical characteristics, pluggable connectors and pin identification
- Functions of each circuit in the interface connector
- Standard subsets of interface circuits for selected telecom applications

The standard does not define such elements as character encoding (for example, ASCII, Baudot or EBCDIC), or the framing of characters in the data stream (bits per character, start/stop bits, parity). The standard does not define protocols for error detection or algorithms for data compression. The standard does not define bit rates for transmission, although the standard says it is intended for bit rates lower than 20,000 bits per second. Many modern devices can exceed this speed (38,400 and 57,600 bit/s being common, and 115,200 and 230,400 bit/s making occasional appearances) while still using RS-232 compatible signal levels.

III. EXPERIMENTAL RESULTS AND DISCUSSION



Visual basic:

Visual Basic is a third-generation event-driven programming language and integrated development environment(IDE) from Microsoft for its COM programming model first released in 1991. Microsoft intended Visual Basic to be relatively easy to learn and use. Visual Basic was derived from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using Data Access Objects, Remote Data Objects, or ActiveX Data Objects, and creation of ActiveX controls and objects. A programmer can create an application using the components provided by the Visual Basic program itself. Over time the community of programmers has developed new third party components, keeping this programming language to modern standards. Programs written in Visual Basic can also use the Windows API, which requires external function declarations .The final release was version 6 in 1998 (now known simply as Visual Basic). Though Visual Basic 6.0 IDE is unsupported as of April 8, 2008, the Visual Basic team is committed to "It Just Works" compatibility for Visual Basic 6.0 applications on Windows Vista, Windows Server 2008 including R2, Windows 7, and Windows 8. In 2014 there are tens of thousands of developers who still prefer Visual Basic 6.0 over Visual Basic .NET. Moreover, in recent years some developers lobbied aggressively for a new version of Visual Basic 6.0. A dialect of Visual Basic, Visual Basic for Applications (VBA), is used as a macro or scripting language within several Microsoft applications, including Microsoft Office

IV. CONCLUSION

The progress in science & technology is a non-stop process. New things and new technology are being invented. As the technology grows day by day, we can imagine about the future in which thing we may occupy every place. The proposed system based on PIC microcontroller is found to be more compact, user friendly and less complex, which can readily be used in order to perform. Several tedious and repetitive tasks. Though it is designed keeping in mind about the need for industry, it can extended for other purposes such as commercial & research applications. due to the probability of high technology (pic microcontroller) used this" a rehabilitation approach based on wearable technology and video gaming" is fully software controlled with less hardware circuit. the feature makes this system is the base for future systems. The principle of the development of science is that "nothing is impossible". So we shall look forward to a bright & sophisticated world

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