DESIGN AND DEVELOPMENT OF EXTERNAL SUPPORT SYSTEM FOR DISABLED ARM

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Abstract : In the work presented in this paper the conceptual design and actuation of one new exoskeleton of the upper limb is presented. The device is designed for application where the motion of the human arm is supported by an external aid which runs with the help of a windshield wiper motor which is in turn controlled by a VNH2NP30 DC dual motor driver and is also capable of gauging the weight by a load cell for which an amplifier HX711 load cell amplifier is used and also connected over the internet through the node MCU ESP32 which is a Wi-Fi module. The motor is set made to rotate with a 12V battery as its source of power input. All the functionalities are controlled and programmed by Arduino UNO microcontroller. By programming the Arduino UNO microcontroller we can achieve the direction of the exoarm rotation and also the speed and torque of the movement of the exoarm.

IndexTerms - Exoskeleton, wiper motor, VNH2NP30 DC dual motor driver, node MCU ESP32, Arduino UNO, exoarm, load cell, HX711.

I. INTRODUCTION

Exoskeleton is an externally wearable robot with joints and limbs corresponding to those in the human body. Exoskeleton transmits torques to human joints by means of actuators allocated in its mechanical structure. Exoskeletons are used for four basic functions by means of different control algorithms. The design for these type of model play and important and a vital role as to keeping into consideration the stress and strain that will be imposed on the human body due to the load that is been put up on the human body. As the motion of the forearm plays an important role we should make sure that there is no higher stress or strain on the joint of the forearm. As IoT is having a huge impact on the current society collecting the data and updating to the internet can help in the maintenance and also upgradation based on the users experience and monitoring those.[1] The objective of the work presented in this paper is to create a new concept project of a soft upper-limb force-feedback exoskeleton. The device to be used is an exoskeleton with a wearable structure and anthropomorphic workspace that can cover the full range of motion of a human arm.[2] Device should enable an application of force within a wide range of human limb and reproduction of natural compliance.[3] The device to be designed can be used for application where both motion tracking and force feedback are required

II. EASE OF USE

Exoskeleton arm.

An exoarm is abbreviation used for exoskeleton arm ,so the main components to the design of an exoarm are a car windshield wiper motor, a VNH2NP30 DC dual motor driver which is used to control the wiper motor, a 12V Battery for power supply and an Arduino UNO microcontroller which is used to control the whole system combined together, a load cell which is used to gauge the weight of the object that is to be lifted and an HX711 amplifier to amplify the load cell and at last a node MCU ESP32 Wi-Fi module to fetch and update the data from the exoarm to the internet using the concept of IoT.

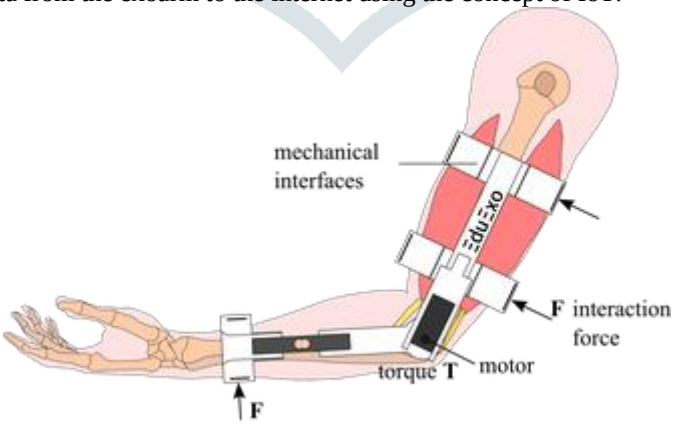

Figure1: Exoskeleton arm design

III. MOTOR WORKING FUNCTIONALITY

The VNH2SP30-E is a full bridge motor driver intended for a wide range of automotive applications. The device incorporates a dual monolithic high side driver and two low side switches. The high side driver switch is designed using STMicroelectronic's well known and proven proprietary VIPower™ M0 technology which permits efficient integration on the same die of a true Power MOSFET with an intelligent signal/protection circuitry. The low side switches are vertical MOSFETs manufactured using STMicroelectronic's proprietary EHD ('STripFET™') process. The three die are assembled in the MultiPowerSO-30 package on electrically isolated leadframes. This package, specifically designed for the harsh automotive environment offers improved thermal performance thanks to exposed die pads. Moreover, its fully symmetrical mechanical design allows superior manufacturability at board level. The input signals INA and INB can directly interface to the microcontroller to select the motor direction and the brake condition. The DIAGA/ENA or DIAGB/ENB, when connected to an external pull-up resistor, enable one leg of the bridge. They also provide a feedback digital diagnostic signal.. The motor current can be monitored with the CS pin by delivering a current proportional to its value. The speed of the motor can be controlled in all possible conditions by the PWM up to 20 kHz. In all cases, a low level state on the PWM pin will turn off both the LSA and LSB switches. When PWM rises to a high level, LSA or LSB turn on again depending on the input pin state.[4]

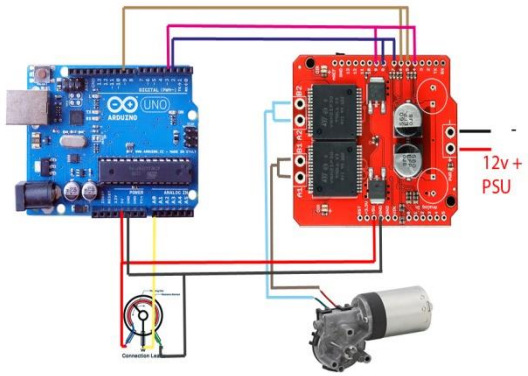

Figure 2: VNH2SP30 dual motor driver connection to Arduino and car wiper motor

IV. WEIGHT GAUGING

Load cell is transducer which transforms force or pressure into electrical output. Magnitude of this electrical output is directly proportion to the force being applied. Load cells have strain gauge, which deforms when pressure is applied on it. And then strain gauge generates electrical signal on deformation as its effective resistance changes on deformation. A load cell usually consists of four strain gauges in a Wheatstone bridge configuration. Load cell comes in various ranges like 5kg, 10kg, 100kg and more, here we have used Load cell, which can weight upto 40kg.

Now the electrical signals generated by Load cell is in few millivolts, so they need to be further amplify by some amplifier and hence HX711 Weighing Sensor comes into picture. HX711 Weighing Sensor Module has HX711 chip, which is a 24 high precision A/D converter (Analog to digital converter). HX711 has two analog input channels and we can get gain up to128 by programming these channels. So HX711 module amplifies the low electric output of Load cells and then this amplified & digitally converted signal is fed into the Arduino to derive the weight. [5]

Load cell is connected with HX711 Load cell Amplifier using four wires. These four wires are Red, Black, White and Green/Blue. There may be slight variation in colors of wires from module to module. Below the connection details and diagram:

- RED Wire is connected to E+
- BLACK Wire is connected to E-
- WHITE Wire is connected to A-
- GREEN Wire is connected to A+

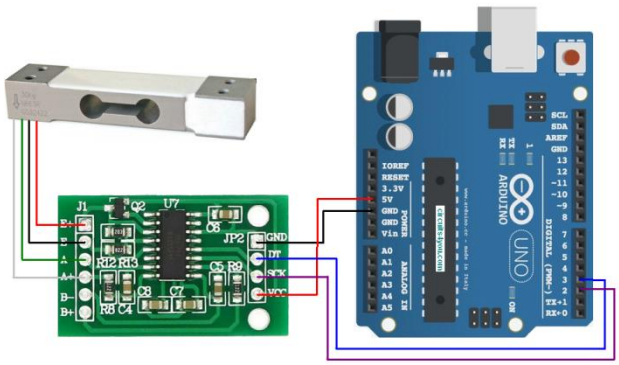

Figure 3: Load Cell with HX711 circuit diagram

as universe of the study.Non-financial firms listed at KSE-100 Index (74 companies according to the page of KSE visited on 20.5.2015) are treated as universe of the study and the study have selected sample from these companies.

V. MAINTENANCE AND MONITORING

The NodeMCU ESP-32 is one of the development board created by NodeMcu to evaluate the ESP-WROOM-32 module. It is based on the ESP32 microcontroller that boasts Wifi, Bluetooth, Ethernet and Low Power support all in a single chip. The NodeMCU ESP-32S comes with a serial-to-usb chip on board that allows programming and opening the UART of the ESP32 module. Drivers may be needed depending on your system (Mac or Windows) and can be download. In Linux systems, the NodeMCU ESP-32S should work out of the box. By using this node MCU ESP-32 the monitoring of the battery usage and also the number of rotations of the exoarm is fetched and uploaded to the net which will be helpful for documentation and the feedback of the product that is developed.[6]

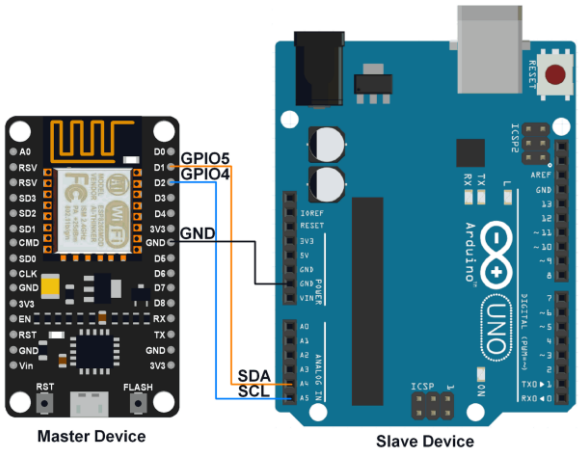

Figure 4: Node MCU ESP-32 circuit diagram

VI. CONCLUSION

In this paper the implementation of exoskeleton arm is done in such a way that all the components that are used are easily available in the market and easy to access and to use. The product is designed in such a way that it is light weighted and also the materials used for building the frame are cheap and light. It has a constraint of lifting objects weighing from 2Kg to 5Kg of load. It can also be built easily by any commoner. The data when linked to the net will help the user to also monitor the life of the product and the performance. It is cost effective and is a helpful for the people who suffer any kind of fatigue or temporary arm injuries. Production in large scale will lead to easy identification of any common fault that the product is going through and also can be solved easily. Producing this product will lead to the helping and development of the society. This product will also be helpful for disabled people and will be very helpful in lifting heavy objects.

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