Research Article

Novel Design of AC Motor Powered Smart Wheel Chair

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Abstract: Ubiquitous usage of wheel chair made the primal source for the immobile persons to have locomotion. Recent advancements on wheel chair engineered on ease living and monitoring of crippled persons both in their locomotion and their bio-metric systems. These parameters can be monitored continuously using various digital electronic sensors and actuators to monitor their mobility. Advancement in this project primarily deals with the efficiency improvement towards usage of AC motor rather than DC motor and usage of capacitor start-capacitor run motor so as to obtain high amount of torque so as to enable mobility at all levels of elevation. Usage of 24V14Ah backup source enables 4-6 hours of mobility and up to 30 hrs of continuous monitor of patient and enablement of IC circuits. Usage of EEPROM to ensure the patient's parameters are recorded precisely.ESP-8266 ensures the data transmitted wirelessly are encrypted and secured through 2 level authentications. Usage of WIFI over other GSM modules addresses the administrator to stay at an audible distance from the patient.

Keywords: Ubiquitous, AC motor, Raspberry-pi-3b, ESP-8266 Wifi Module.

1. Introduction

Recent improvement enables monitoring patient's Blood pressure, heart rate, and ECG, Regular and irregular heart rhythm, amount of oxygen saturations. These parameters remotely been transferred through Internet of Things so as to transfer the data to the administrator and so to have a record of it. This project primarily concentrates on power management replacement of bevel gear mechanism which reduces the number of motors used for locomotion. This also involves power conversion from Direct Current to Alternating Current and usage of single phase ac motor so that losses are controlled and viable efficiency is involved. Raspberry pi-3 enables this wheel chair as IoT enabled which enables the proctoring career to remotely manage the controls of the wheel chair and can also have an detailed health information of the patient. Usage of single phase ac motor replaces the 3 phase Brushless-DC motors enabling at most efficiency at lower cost when compared to 3 phase Brushless-DC motors. The main approach of this project is to implement IoT enabled smart wheel chair through AC motor traction instead of DC motor. Usage of this motor enables greater efficiency and speed torque characteristics and reduces replacement of brushes in case of DC motor. Raspberry pi 3 enables smart monitor of patient's bio-vitals and can be remotely transferred and can be viewed in case of continuous assessment of patient's vitals. The heart beat sensor can access patient's blood pressure during various periods of the day. Ultrasonic sensor allows auto-tripping of motor from normal functioning when wheel chair comes against an obstacle. Due to implementation of raspberry pi board, data transfer and future scope implementation and interaction with the board by the developers will be easier than other logical mother boards. WIFI-module built-in mother board can transfer continuous patient's vitals. Other data including battery health and cycle usage to the administrator/controller for maintenance of the wheel chair as well as the patient. Usage of AC motor reduces maintenance cost such as brush replacement. Since DC motor consumes a high starting current due to (E_b=V+I_aR_a), there is no back emf during starting of a DC motor. Thus this increases the cycle usage of the battery, whereas inversion of this DC power to AC reduces such losses, which in turn increases the efficiency and cycle usage of the battery. Raspberry Pi board is also programmed to constantly monitor the voltage and current parameters of the battery as well as consumption of charge towards number of hours the battery can withstand. Using these parameters, raspberry pi can graph the usage statistics and battery cycle (charge consumed from 100% to 0% ie. Rate of drop in voltage from 14.4 volts to 9 volts) towards number of hours required for the drop to occur. Using these raspberry pi can calculate the cycle health and efficiency of the battery. These parameters and the health can also be monitored remotely and future maintenance of the battery can be predicted using these obtained parameters. Other data such as thermal losses that occur while conversion of DC to AC power is reduced using IRF 3205 based MOSFET which is specifically designed for low level conversion from DC to AC.

2. Working Principle

The overall IoT implementation of the AC motor powered smart wheel Chair is shown in Fig 1(a), the overall mechanical connection of the diagram is shown in Fig 1(b), the wiring diagram of ultrasonic sensor with Raspberry pi-3 is shown in Fig 1(c), the connection diagram for pulse sensor to Raspberry-pi through ADC, Connection diagram of inverter is shown in Fig 1(d & e) respectively.

This project efficiently converts DC power to AC power using IRF3205 power MOSFET. Specific usage of this MOSFET is due to its improved characteristics which are specially designed for inversion purposes. Hereby we use cascaded inversion technique to obtain an ac waveform.

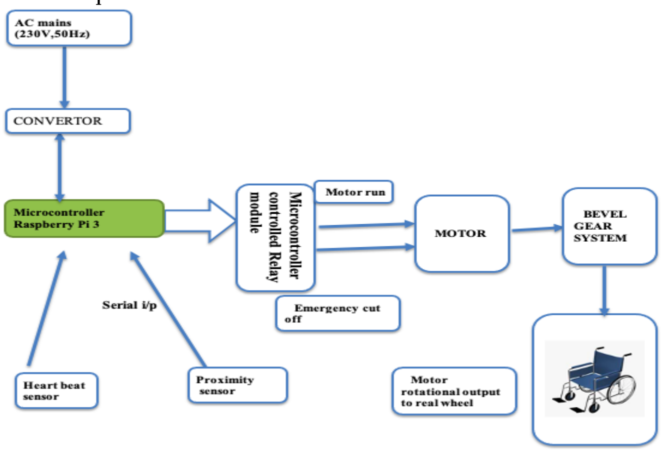

Fig (a)

First the DC power is obtained through parallel connection of 2 batteries (12 V/7.5Ah) each. This enables 15Ah of DC current which is then inverted using IRF3205 MOSFET. Output of 24 volts (peak-to-peak) 5 amps are nominal output considering all possible losses occurred during inversion. This is then fed to secondary part of 12-0-12V/10 Amps transformer which steps-up to 400VA of apparent power.

IRF 3205 is specifically used as it can handle a voltage of 55V and a maximum current of 110 Amps at 88 degree Celsius.

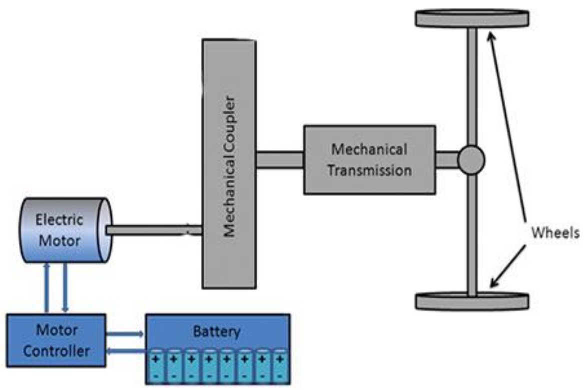

Fig (b)

Thermal loss, inversion losses are considerably low when compared to other MOSFET and also its current parameter.

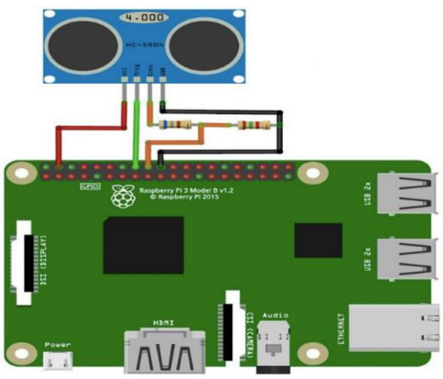

Fig (c)

Microcontroller Raspberry Pi-3b allows multiple monitor of serial and analog inputs from various different sensors interconnected with it. This microcontroller is pre-equipped with ethernet port, Universal Serial Bus port which allows data monitoring and easy access to the data and storage of data.

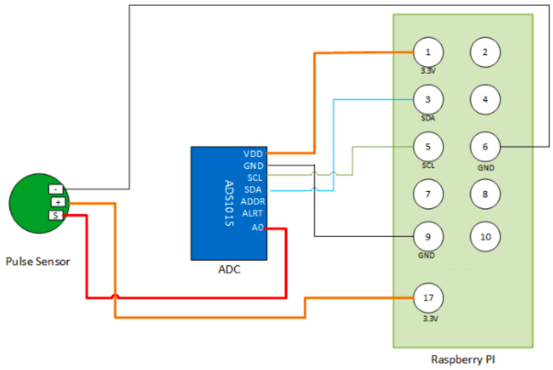

Fig (d)

Here this is directly connected with heart beat and proximity sensor that is further processed and decisions on controlling the ac motor were programmed in microcontroller can is achieved through relay modules due to large power supply. These relay modules allow different parameters to run successfully such as slow run, continuous run, and emergency stop.

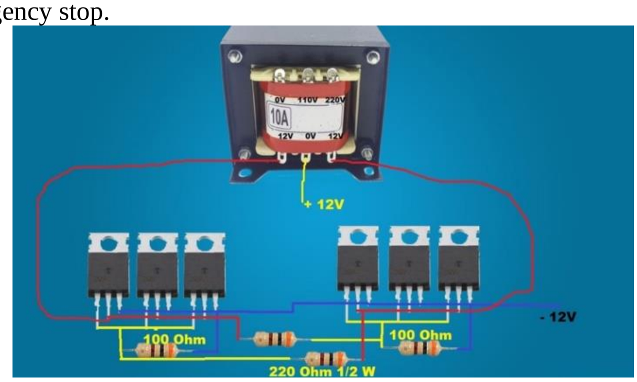

Fig (e)

3. IoT enabled Smart Operation

The IoT enabled smart wheel chair can be remotely operated and controlled using Wi-Fi and relay modules for emergency tripping. At emergent situations, the wheel chair can be controlled and can be stopped using relay operations

Fig (g)

Raspberry pi-3 with built-in Wi-Fi that actually gets connected across devices who administer the wheel chair. Various bio-metric parameters such as Blood Pressure can be remotely monitored. Basic implementation of AI involves emergent tripping of wheel chair when there is an obstacle while locomotion where-in ultrasonic sensor senses the obstacle between 5-10 meters and trips the operation of locomotion through digital pulse (binary 0/1 where 0 is considered as no obstacle and 1 as an obstacle ahead). Other data such as battery health information and cycle usage and also battery charge is remotely monitored through Wi-Fi. Raspberry-pi enables external storage of data and easy implementation of futuristic scope of the project.

4. Simulation Results

The above is the simulation of single phase inverter used to power AC motor using typical square wave inverter using IRF3205 simulated using MATLAB. The output is the square wave at 0.2 micro seconds of time delay to obtain a frequency of 50 Hz. The MOSFET is connected in a cascaded approach to reduce voltage drop. The output is fed to a single phase Capacitor Start induction run motor that runs at 1500 rpm enabling enough torque for traction of the wheel chair at 4-5 kmph.

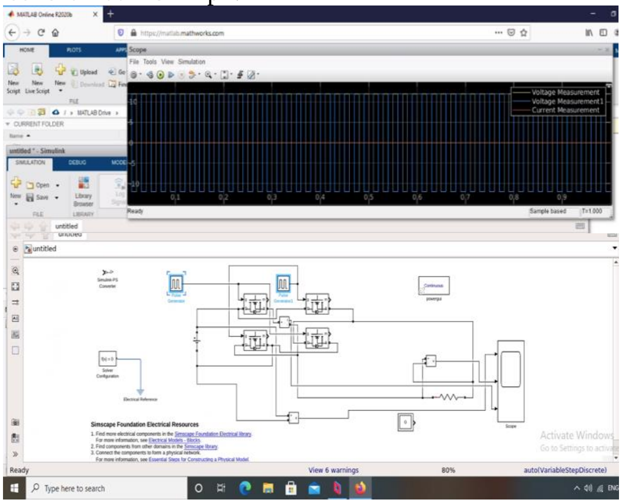

Fig (f)

5. Experiment Result

The inverter designed for AC motor traction Fig (g) and (h) for the overall wheel chair.

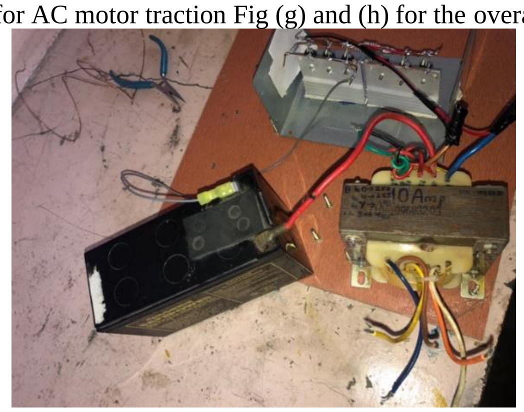

Fig (g)

6. Conclusion

Modification in the wheelchair design and biometrics could play a vital role promoting physical activity. Single phase capacitor Modifications in wheelchair design and biometrics could play a crucial role in promoting physical activity, QOL and level of participation among physically disabled individuals. Further research is necessary on co-effectiveness of advanced design features, interventions. Modifications in wheelchair design and biometrics could play a crucial role in promoting physical activity, QOL and level of participation among physically disabled individuals. Further research is necessary on co϶-effectiveness of advanced design features; interventions run induction motor offers better efficiency and controllability which replaces BLDC motors with replacing efficiency up to 90%. Enables cost efficiency as usage of single motor with replacement to 2 motors.

Fig (h)

Usage of inverter and rectifier in same board enables ease of charging by just connecting it in the plug point and no need of adapters. Advanced raspberry Pi microcontroller enables better IoT connectivity with ESP-8266 in transmitting critical data securely and exceptions (user-defined) can be remotely managed through handsets authorized by administrators. Microcontrollers equipped with USB cables can be used in storing various critical parameters and other regular monitored data of the patient for over an year as external storage devices can be easily connected and can be used as an back-up storage.

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