

# Wheelchair with Auto Navigation for Adults with Physio and Cognitive impairments

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*Abstract: Nowadays most of the family members are engaged in some job or outside activity. This has led to less attention towards the aged adults and provides necessary attention for their physical, mental and social activities. The proposed work provides assistance to the aging adults to take up their work independently with physical activities without any assistance and support of family members. The implementation is carried out using electro-mechanical devices and incorporating current technology to develop a Durable Medical Equipment (DME) embedded with few physiotherapy modules to take up self-dependent activities such as physical exercise home necessities and medicine reminders and so on. At present, there is no such system deployed with such facilities to aged adults. The system developed will assist to monitor DME dependent patients with minimum infrastructure, monitored automatically from the workplace. It automatically reminds of information about the time-based requirements such as taking of Medicine and Food by incorporating (RTC) Real Time Clock. The navigation of wheelchair is provided using ARM processor to interface i2c protocol with MEMS sensor. Vibrating motors and mechanical accessories are fixed onto the wheelchair that assists in taking care of physiotherapy exercises, for muscles and bones strengthening. Cognitive impairments can be developed by setting some images on screen and asking them to identify. Based on the response obtained from them we are able to identify the mental status also. All these activities can be monitored by the family member from their work places besides keeping a watch for any emergency needs.*

**Keywords:** Wheel chair with geared motors, Physiotherapy operation, Cognitive operation, MEMS, DME, simulation.

## I. INTRODUCTION

In present days, ubiquitous devices have become a need in the life of elderly people to meet their independent living. These devices not only provide support to aged people but also become necessary for those who are physically challenged. For independent living there is a need for the mobility of aged adults and physically challenged people to maintain their health and maintain their cognitive abilities. The limitation of the physically disabled effect the living quality of the person to a great extent. The impairments are of different types which are visual, auditory, mobility and cognitive [1]. According to the causes of impairments they are classified as prenatal, postnatal and prenatal disabilities. To resolve the problems a smart wheel chair with an affordable cost was created [2]. The Wheel-Chair was controlled by application program running with Microcontroller. The system is semi-autonomous for

Navigation. The proposed work incorporates ARM7 Embedded processor and the Activation module as MEMS to control the chair. The method and design is chosen based upon the persons disability. The whole work was partitioned into sub sections to assist movement of wheel chair, Physio movement of hands with vibration motors for muscular movement. Medicine reminder through RTC. The interaction with aged people is made by incorporating such functions with the aim to make them operate automatically without depending on others and at the same time provide interaction with others like normal persons[4]. In other words they become," self reliant to interact and perform their tasks independently"

## II. EXISTING SYSTEM

Aged adults and disabled people find it difficult to move independently because of their physical deficiency or due to mental distraction that doesn't make them to move like a normal person. An electro mechanical wheel chair incorporated help for the mobility of the disable people within their surroundings [3]. Moving on wheel chair in domestic places is difficult even for normal persons but this is still more difficult for physically disabled. In the existing wheel chair control is carried out using Infrared Radiation (IR), joystick, eye tracking and voice reorganization system. Attempt was made to transmit low intensity infrared rays on eyes. This causes voltage level variations in IR receiver depending on the eye lid movement [4]. The drawback of present system is the use of IR rays, which are applied on eyes. But this will cause effect on eyes on a long run and cause harm to the people. It may also lead to blindness which may stop the movements during night thereby leading to physical deterioration and later to mental disorders. On the other hand Handicap persons were not able to operate joystick based wheelchair, the eye tracking wheelchair operator is not able to visualize the adjacent surroundings when system is active and voice recognition based wheelchair cannot be operated effectively in a noisy environment [7].The block diagram of existing system is shown in Fig.1.

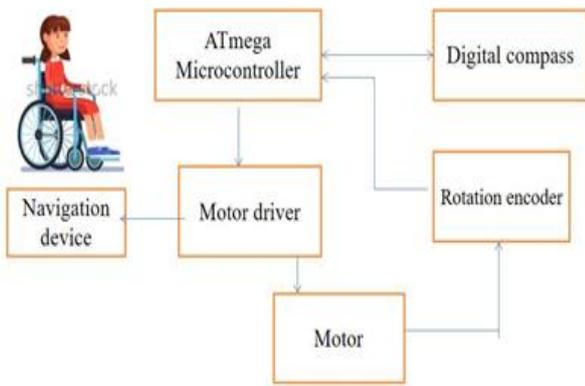
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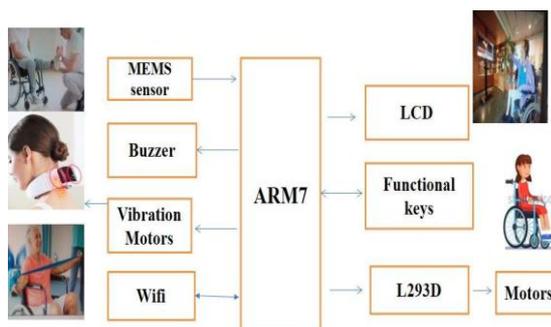
# Wheelchair with Auto Navigation for Adults with Physio and Cognitive impairments



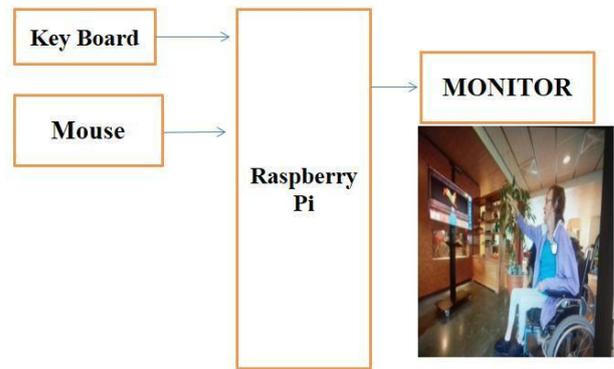
**Fig.1:Block diagram of Existing Auto-navigation with digital compass and rotation encoder**

### III. PROPOSED WORK

In the proposed work, we developed an electrically powered wheel chair that is customizable, economical and is user friendly [6]. In the proposed work we included the current technology (MEMS) that causes the wheel chair movement. It is specially designed for deployment to make it cost effective so that people can afford to buy thereby eliminating high cost. It incorporates wireless system which helps to navigate for the physically handicapped or the quadriplegic patients. As the wheel chair is atomized no arm power is required to drive as such it can be easily driven by those who do not have power in their arms[5].The motors we are using can move even though we will be using it Backbone massage will also be done by using the vibration motor which will make the person active. It will be like a physiotherapy treatment for backbone. Proposed system will also do the physio activities like movement of hands up and down directions by using DC motors which will do the operations like clockwise and anticlockwise. The movement of hands can be done by giving the commands from anywhere by the guardian using web server or switches. The guardian can be operating the physio devices that are connected to wheel chair which made the patient to do some exercises. Cognitive activities are done by observations through few images stored in a device and check the response of the disabled person. The responses will be sent via wireless transmission to the guardian. The response will be recorded using mice and converted into text by using raspberry pi processor. By looking into the response of a patient we can predict the cognitive level and later adopt such techniques which will increase the memory power of disabled person.



**Fig.2:Block diagram of Auto-navigation wheel chair (physio and cognitive operations)**



**Fig.3:Block diagram of Wheel chair (for cognitive operations)**

### IV. METHODOLOGY

Here in this we are using two different processors for different applications. The proposed system uses ARM7, LPC2148 Processor that can process the instructions according to our requirements such as wheel chair movement using MEMS sensor, Physio operations of hands and back massage is carried out using Switches controlled by Motors[10]. Physio operations can also be carried out through web links. Medicine reminder with time gap could be done using RTC. The control signals generated by the microcontroller will drive the motors of the wheelchair. Cognitive impairments can be done by using an image that can be transmitted by a processor and patient need to identify the image by giving voice output to that figure. If the patient is unable to identify the figure or put figures in order indicates the power of mind. This is indicated by a buzzer sound. Such patient mental condition has to be improved by proper training. The whole arrangement provides an effortless, convenient, quick and smooth navigation experiences. The hardware implementation of this projected wheel chair consists of wheel chair, an ARM7 microcontroller, MEMS Sensor, DC Motors, switches and vibrating Motors. Several sensors are used most of them are electrical or electronic. Wi-Fi communication is used for sending the information about the status of activity like whether the person is moving, in which direction he/she is moving, physiotherapy and/or cognitive activity carried out by them[8].

The step by step implementation and execution of the implemented work is depicted below.

Step1: Initialize the hardware according to the requirements. Program the controller according to the requirements and collect information from input devices and operate the output devices according to the instructions.

Step2: Initialize Wi-Fi in the hardware.

Step3: Categorize the input and output devices. Here inputs to the controller are MEMS sensor, switches and web links. Outputs are DC geared motors for wheel chair, DC motors for Massage Operations and vibration motors for back massage.

Step4: Response to the MEMS state according to the movement of wheel chair is done.

Step5: Physiotherapy operations can be done through



switches or through web links that are designed through web server.

Step6: Cognitive operations can be done through web server. It is transmitted wirelessly as the processor is connected with internal Wi-Fi.

Step7: Real Time clock was initialized for the purpose of medicinal reminder using buzzer

## V. HARDWARE IMPLEMENTATION

Raspberry Pi is incorporated to handle cognitive operations, ARM7 LPC2148 for movement of PMDC brushed and geared motors for the wheel chair which can carry weight of 60kg person using MEMS sensor. 100rpm DC geared Motors along with drivers IC L293D for movement of hands i.e. up and down using switches. Vibration motors were used for stimulating operations for back (ribs). The project divided into 3 categories they are Wheel chair movement, Physiotherapy operations and Cognitive operations.

### a. Wheel chair movement:

Permanent Magnet DC motors (Fig.4) offer output power up to 300 watts with a range of voltage from 12V to 48V. The motor is of ruggedized die cast aluminum or composite material (high strength plastic) worm wheel gearboxes, making it the most competitive DC Geared motor on the market with a maximum torque of 40kg each motor[11]. The working Principle of motor is shown in Fig.5. In our Project we are connected the motors as shown in Fig.6



Fig.4:PMDC Motor

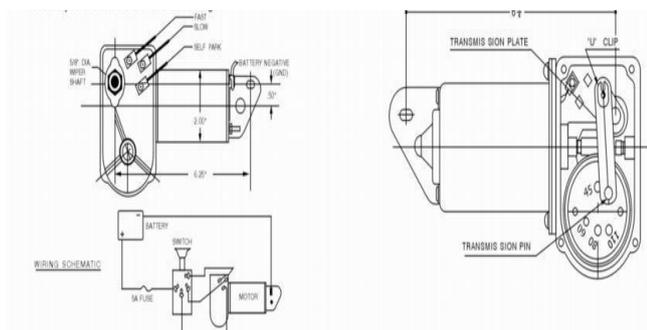


Fig.5:Working Principle of Motor



Fig.6:Arrangement of motors to the wheel chair

### b. MEMS Sensor:

The MEMS sensor is a small, thin, low power, 3-axis accelerometer with high resolution. But in our work we are using only 2-axis for movement. Digital output data will be calculated based on the I2C digital interface [12]. MEMS sensors sense the movement and provides the directions for wheel chair i.e. forward, left, right and back. It works in low power mode with intelligent motion-based power management along with threshold sensing. The movement will be displayed in LCD according to MEMS action as shown in Fig.7.

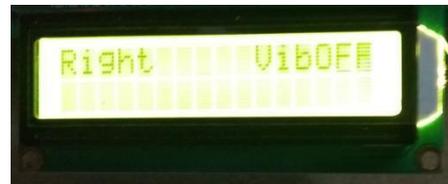


Fig.7:Display about wheel chair action according to MEMS

### c. DC Geared motors:

Physiotherapy operations are assisted by DC geared motors. A DC motor uses direct electrical current (DC) as the source of its energy. Here in our application we are using switches to operate the dc motors which can run the motors in clock wise and anti-clock wise directions used to lift hands and legs movement exercise. We could also operate these motors through Wi-Fi also which made the elderly care people will make them to exercise even though no person will be in home to operate the motors. We will control the motors anywhere from the world through web links that are programmed in controller which is connected to wheel chair. These DC motors are connected to controller through motor driver IC (L293D) which will works with H-Bridge operation. These DC motors are connected to wheel chair through a steel rod and a pulley. DC motor and Hands of aged person are connected with a rope through pulley. When DC motor rotates in clockwise direction, the rope will be and it lifts the hand up. When DC motor rotates in anticlockwise direction rope will be released and the hands will move down. This clockwise and anticlockwise rotation of motor causes the hands to move up and down thereby strengthening the hands. The display seen on the LCD screen is shown in Fig.8.



Fig.8:Sample DC motor, pulley and sample display information about movement of hands

### d. Vibration Motors:

This is also meant for Physiotherapy operation for stimulating purpose. Vibration motor is a dense size coreless DC motor. It vibrates when signal is receiving.

So users get the information about the signal. Vibration motors are used in various applications such as handsets, pagers, cell phones, etc. There are two main features of vibrating motor. They are (1) The magnet of coreless DC motor are permanent (2) Size of the motor is small and light weight. Motor consume less power and produces less noise. Because of these features, the performance of the motor is immensely reliable. In our project we are using this motor for the purpose of stimulation operations. It is operated through a relay along with a switch. When the switch is pressed the relay closes and correspondingly vibration motor starts functioning. The Schematic of such motor is shown in figure 9.



**Fig.9:Vibration Motor for massage operations**

### e. Raspberry Pi :

This is incorporated for cognitive operation. The Raspberry Pi is a single-board computer which will be used to design many embedded applications. It has a Broadcom BCM2836 System on Chip (SoC), which includes an RASPBERRY PI1176JZF-S 700 MHz processor, Video Core IV GPU with 2GB RAM [13]. It does not have built-in hard disk or solid state drive, but for booting and persistent storage it uses an SD card. Built in Wi-Fi available for data transfer and we can also update the programming by connecting to the processor anywhere from the world. By using Wi-Fi adapter or USB Ethernet, it can be connected to any network. The operating system used in Raspberry Pi is Linux-kernel. In our project we are using this for the purpose of cognitive applications.

These operations can be performed by transmitting the data about image display through web server (Fig.10). For the purpose of cognitive Raspberry Pi board should be connected to display monitor through HDMI port, which can be used to display the image. Raspberry Pi works with Raspbian OS along with Python programming. It has an inbuilt Wi-Fi which can be connected automatically when switched on, if previously connected. It then starts responding to the image transmission and display the corresponding image on the screen. The transmission of images will be categorized differently as per requirements. In the proposed work we are reminding about medicine to be taken at different timings. Cognitive levels [14], and Cognitive development is also done by making them to identify various colors, animals, sequencing of letters/alphabets, recognizing family members etc depending on the mind power and deterioration.



**Fig.10:Information Display in web page about last received message along with transmitting web links.**

## VI. EXPERIMENTED RESULTS

The implementation was experimentally verified with the movement of wheel chair by a person weighting 65kg.MEMS will provide a digital value output to the controller[6]. The digital value observed for both axis are varied. If x axis and y-axis value is more than 450 and less than 550 then the wheel chair will stop. If x axis value is more than 450 and less than 550, y axis value is more than 350 and less than 450, then the wheel chair will move in forward direction. If x axis value more than 450 and less than 550, y axis value more than 550 and less than 650 then wheel chair will move backward direction. If x axis value more than 550 and less than 650, y axis value more than 450 and less than 550 then wheel chair will move left direction. If x axis value more than 350 and less than 450, y axis value more than 450 and less than 550 then wheel chair will move right direction. The implementation and testing setup is shown in Fig.11 and Fig.12.



**Fig.11: Wheel Chair with physiotherapy and cognitive operations**

Vibrating Motor connected through relay to the microcontroller is based on Slide switch connected to port 0.20 of ARM Micro controller. Left Hand, Right hand movements will be done through DC motors connected to ARM through L293D motor driver IC using switches. If switch1 is pressed then left hand moves up using DC motor1, rotating in clockwise direction. After certain time motor releases and hand move down by DC motor1 rotating in anti-clockwise direction. Hand and DC motor1 both are connected through a pulley and a rope. If switch2 is pressed then right hand moves up using DC motor2 rotating in clockwise direction. After certain time motor releases and hand move down by DC motor2 rotating in anti-clockwise direction. Hand and DC motor both are connected through a pulley via a rope.



**Fig.12: a.Physiotherapy operation for Hand Movements  
b.Cognitive operation for memory state using auto images**

## VII. CONCLUSIONS AND FUTURE SCOPE

The proposed wheel chair control is unique and it is quite simple. Aged/Disabled person can easy operate the wheel chair by simple movement of his hand which is more convenient than the present systems. This designed system provides auto navigation of wheelchair with various movements such as left, right, front and back. It is developed with few features for physiotherapy operation and cognitive impairment development features. It is flexible to upgrade using future technologies by upgrading programming instructions. Aged/Disabled person need to operate only 2 switches for his self-physiotherapy operations with hands. Simple slide switch is given to operate for back stimulating. This reduces the effort of family members to attend for caring the aged people at home and also saving the time.

The designed system needs a battery that has to be charged regularly depending on work efficiently. In future, we need to upgrade the battery. Limited Cognitive operations are incorporated. Physiotherapy operations are implemented for hands only and but can be extended for legs also. Stimulating operations is done for back (spine and ribs).But as future scope can be extended for thigh's, lower legs also. Vibration speed is fixed in present implementation, but it can be extended for variable vibration speeds depending upon the persons withstanding ability. Incorporating these features it can be made into a

commercial product for the physically disabled with affordable cost.

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