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# Design and Development of Mobility Aid for Physically Challenged

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**Abstract**

This paper presents a novel idea of designing a low cost, user-friendly and safe assistive device that moves with a regulated speed in a routinely used environment. It proposes an innovation which facilitates ease of motion for the physically challenged such as cerebral palsy, poliomyelitis, muscular dystrophy, osteogenesis imperfecta and deformity of the limbs. The device is powered by a rechargeable DC battery and controlled by an Arduino Mega microcontroller. An automatic obstacle detection system is installed in the device with an ultrasound sensor which is controlled by a separate Arduino MEGA microcontroller. A locomotive device with the above-mentioned features has been implemented and the device can operate in manual mode cum programmed environment.

**Keywords:** Mobility device, microcontroller, obstacle detection, physically challenged.

## INTRODUCTION

Disability is an impairment that may be physical, cognitive, intellectual, mental, sensory, and developmental or a combination of these which imposes a restriction on an individual's ability to participate in day-to-day activities. The main aim of this prototype is to enable individuals with the above-stated disabilities to commute from one place to another with ease. A physical impairment means any physiological disorder or condition, cosmetic disfigurement or anatomical loss affecting one or more of the following body systems; neurological, musculoskeletal, special sense organs, respiratory (including speech organs), cardiovascular, reproductive, digestive, genito-urinary hemic and lymphatic, skin and endocrine.

Physical disability can broadly be classified into musculoskeletal and neuro-muscular disability. The former include muscular dystrophy, osteogenesis imperfecta and deformity of the limbs. Conditions such as cerebral palsy and poliomyelitis affect the lower motor neuron system. People suffering from the above conditions will eventually require a locomotive assistive device which can enable them to perform physical actions with ease. The device is designed to serve the above purpose is known as a mobility aid. Our device serves an ease in mobility in a programmed environment. The personal transport has been incorporated with a touchpad control and a relay driver circuit which drives the motors. The circuitry is less complex and entire device has been completely made from scrap material which makes it cost-effective.

## BACKGROUND AND LITERATURE

The work was done by Dipanchali et al. (2017) on VOICE AND TOUCH SCREEN BASED DIRECTION AND SPEED CONTROL OF WHEELCHAIR FOR PHYSICALLY-CHALLENGED USING ARDUINO illustrates a wheelchair that works on voice commands and a touchpad. A mobile phone is used to transmit voice commands to the device. A Bluetooth module is used to receive the signals from the cell phone which delivers it to the Arduino. The Arduino microcontroller controls the Driver IC (L293D) based on the signals received, which in turn controls the motor. The direction of the device can be controlled with a touchpad. The device has an infrared sensor for obstacle detection and is programmed in a way that it stops automatically when an object is detected by the device.

The work done by Shubangi P Patel et al. (2014) shows a VOICE AND TOUCHPAD OPERATED CIRCUIT FOR WHEELCHAIR which was designed and implemented. A resistive touchpad is used to control the movement of the device. The ATMEGA8L microcontroller has been incorporated for the voice control and touchpad operation of the device. A microphone is used to receive voice commands and sends it to HM 2007 IC for voice recognition. The voice commands of the patient are stored using 6264 SRAM. The direction of the motors is controlled by Driver IC (L293D). The microcontroller is interfaced with the touchpad and voice recognition circuit for dual control of the device.

The work done by Vasundhara G.Posugade et al. (2012) describes a TOUCH-SCREEN BASED WHEELCHAIR SYSTEM to provide independent mobility to disabled persons. A four wired touchpad is used to control the direction of the device. An LCD screen is used as an output screen for the device. An ARM microcontroller is used to interface the touchpad with the motor control. A microcontroller, which has a storage of 512KB, is used to store predetermined paths. The device is coded with the help of C language. The obstacles are detected by an infrared sensor.

## METHODOLOGY

### *A.* Block Diagram

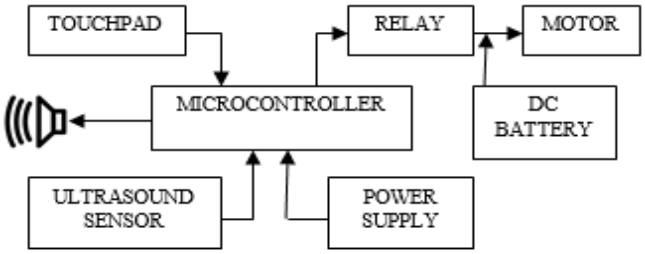


**Figure 1:** Schematic block diagram of control unit

### *B.* Block Description

1. Capacitive Touchpad: The device is incorporated with a 4x4 capacitive touchpad. The use of the above eliminated the conventional method of using a mechanical switch or an IR sensor for control. Mechanical switches are restricted to two or three inputs only and IR sensors are limited to a certain range of distance. Hence a capacitive touchpad overcomes the disadvantages of the above-mentioned components. The first five keys of the capacitive touchpad are preset to control the directions: FORWARD, REVERSE LEFT, RIGHT and STOP. A set of three keys are custom programmed according to the requirements of the user's environment.
2. Ultrasound sensor: Transducers that convert ultrasound waves into electrical signals and vice versa are known as Ultrasound sensors. Active ultrasonic sensors generate high-frequency sound waves. In order to determine the distance between the source and the object, the echo time is evaluated by measuring the time interval between sending and receiving the signal. Ultrasonic ranging module HC-SR04 provides 2cm to 400cm non-contact measurement function, ranging accuracy can reach up to 3mm. The module includes an ultrasonic transmitter, receiver and control circuit. Test distance = (high level time*velocity of sound (340m/s))/2.
3. Arduino: Arduino is a single board microcontroller designed to be useful in multi-disciplinary projects. The hardware consists of a simple open source hardware board designed around an eight-bit microcontroller. A 32-bit is also available. The software consists of a standard a programming language, compiler, and bootloader that executes on the microcontroller. The Arduino MEGA is a microcontroller board based on the AT_MEGA 328. It has 53 digital I/O pins, 15 analog inputs, crystal oscillators, USB connection, a power jack, ICSP header and reset button.
4. Power Supply: The Arduino can be powered via the USB connection or with an external power supply. The external power can come either from an AC to DC adapter or battery. The adapter can be connected by plugging a 2.1mm centree-positive plug into the board's power jacket. Leads from a battery can be inserted in the GND and Vin pin headers of the power connector. The board can operate an external supply of 6-20V. In order to operate with a supply of less than 7V, the 5V pin should be used. A DC rechargeable battery of 12A, &V is used as a supply to drive the motor.
5. DC Motor: An electric motor is a machine to convert electrical energy into mechanical energy. The motor used for the device is a 12V DC motor. Based on the current supply given to the motor, the shaft of the motor rotates which enables the motor to drive the wheels and hence moving the device.

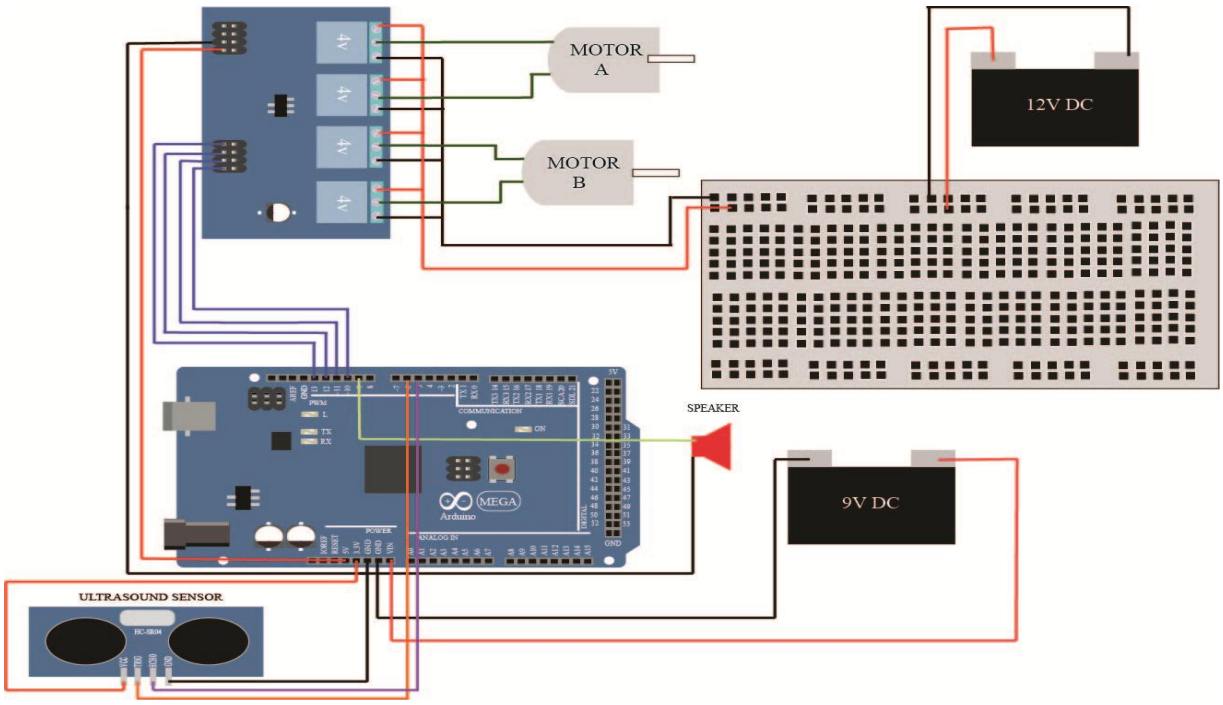


**Figure 2:** Circuit diagram of the control unit

### *C.* Software Implementation

The software part of the prototype is implemented using Arduino. The ultrasound sensor is connected to the Arduino and programmed to detect obstacles in the path of the prototype. On detection of the obstacles at a distance of 1m, the alarm is set to beep. When the distance between the device and the obstacle is less than 20cm, the device stops automatically. The touchpad is encoded with five operations: forward, reverse, left, right, and stop functions. The touchpad also has two keys which can be customized to navigate in the pre-programmed environment.

### *D.* Working Principle

The assist device has a capacitive touchpad, microcontroller, relay system and the motor unit. The signal from the touchpad initiated by the user acts as the input to facilitate the movement of the device. The input signal activates the motor to rotate until a further command is given to the motor. The basic commands are forward, reverse, left, right and stop. The device has two DC motors which are controlled by a relay in a microcontroller. A four module relay circuit is used like a simple switch for ON/OFF function of the motor. The relay unit is further interfaced to the Arduino microcontroller for the movement of the device in a specific direction. The use of relay unit decreases the complexity of the circuit as they are easily interfaced with the microcontroller. The relay unit is of high importance as they cut off the power to the DC motor, as it produces a lot of unwanted heat which deteriorates the motor. The relay unit is programmed in a way to control the motor for each specific command as given below.

**Table 1:** Logic table for commands

| | MOTOR 1 | | MOTOR 2 | |
|---|---|---|---|---|
| COMMAND | + | - | + | - |
| FORWARD | HIGH | LOW | HIGH | LOW |
| REVERSE | LOW | HIGH | LOW | HIGH |
| RIGHT | LOW | LOW | HIGH | LOW |
| LEFT | HIGH | LOW | LOW | LOW |

The capacitive touch screen is interfaced with the Arduino microcontroller to control the DC motor. The buttons on the capacitive touch screen have been programmed to serve the above commands. An additional feature of the device is that it can be moved to a specified location given by the user in a programmed environment, such as laboratories and hospitals.

## IMPLEMENTATION AND RESULTS

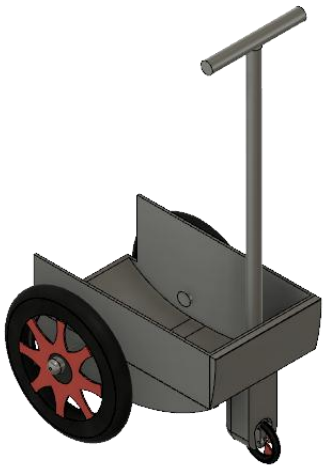

**Figure 3:** Initial design of the device

The initial design of the device was done using Autodesk Fusion 360. The device is made entirely out of scrap material which makes it cost-effective in nature. It is made up of steel, which makes the device sturdy. It is also consists of a handle bar to provide support for the physically challenged during movement. The amount of current required for the motor is calculated based on the load that the device can handle. The connections are given to the DC motor without the microcontroller for analysing the efficiency of the motor for the given load. After this procedure, the relay is interfaced between the microcontroller and is programmed to run the motor in the above-specified directions. The output from the touchpad is given as the input to the microcontroller. The device was basically operated for commands, FORWARD, REVERSE, LEFT, RIGHT and STOP.

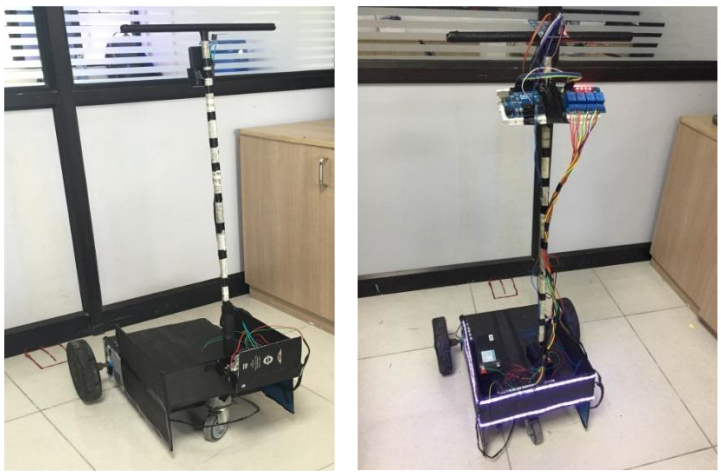

**Figure 4:** Side and Front view of the device

The device is also capable of detecting obstacles. The above mechanism is implemented through the use of an ultrasound sensor. The user is alerted of the obstacle by the sound of a buzzer. The following image shows the ultrasound sensor detecting obstacles at various distances.

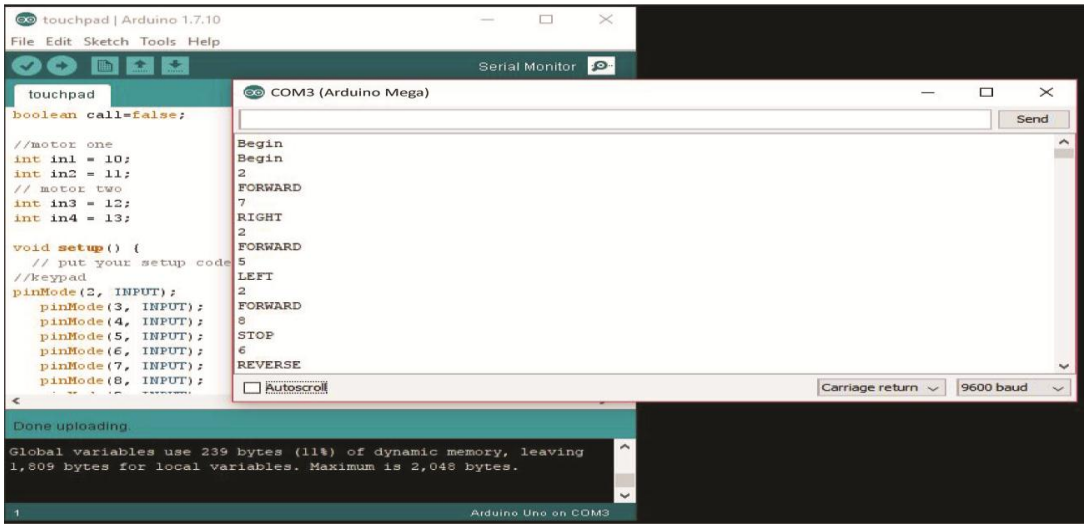


**Figure 5:** Output of relay unit

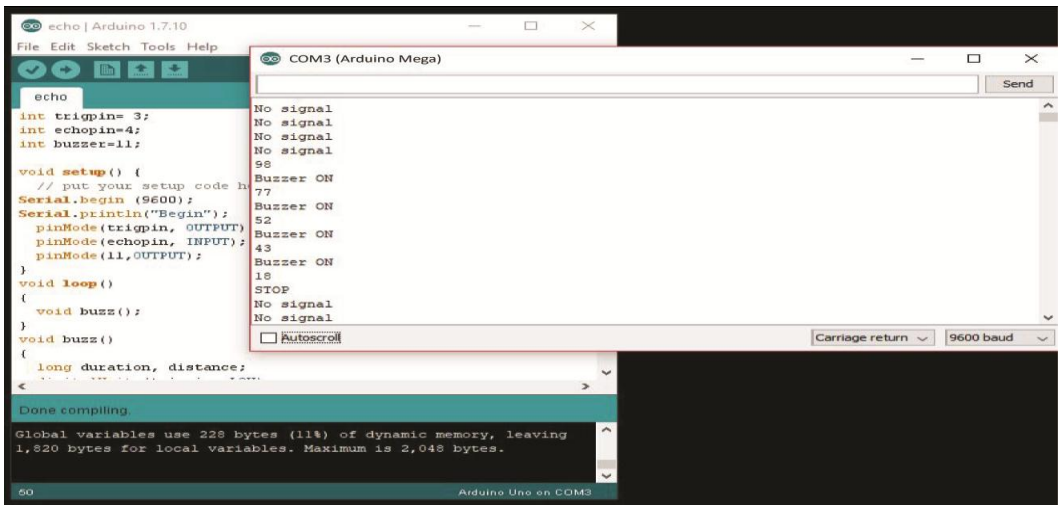


**Figure 6:** Output of ultrasound sensor

## CONCLUSION

Thus the aim to build a locomotive device for the physically challenged has been successfully implemented. One of the major advantages of this device is that it is entirely made from scrap material, which makes it economically cost-effective. The control mechanism is implemented using simple circuitry and can be used in programmed environments like laboratories, hospitals, etc. With depleting petroleum and diesel resources, the concept of electrically powered vehicles reduces the factor of pollution. The device will be of great use to physically challenged persons who are crippled, have deformed limbs, poliomyelitis, and cerebral palsy, thus enabling them to move safely and quickly in a closed environment. It can also be used to perform day-to-day activities with ease. The device works for basic commands such as forward, reverse, left, right and stop. There is wide scope for modification and additional features that can be added to enhance the device in the future. The touchpad control would be replaced with a voice recognition system so that the device can be voice controlled which would be advantageous for the blind.

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