AMAXTUS : PRESSURE SENSITIVE WHEEL CHAIR

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ABSTRACT

Mobility is an important aspect for a physically disabled person to be independent. AMAXTUS is developed aiming to eliminate the immobilities of the needy, as well as to fit it into the Indian economy with ease. The concept of "*press to drive"* implemented in the wheel chair, sets it apart from all the existing mechanically steered drives. The basic driving system of AMAXTUS can be later coupled with other innumerous electric vehicles as well to make them touch driven.

This paper provides an approach of using pressure drives as a replacement for steering and gear systems in conventional vehicles. This paper explains how AMAXTUS works and its applications in the domain of automobiles for the disabled. The project is still under development stage.

INTRODUCTION

AMAXTUS (*Latin origin: amaxi-vehicle ; tactus-touch*) is a wheel chair which is driven by pressure. The automotive unit has force sensitive panels under the armrests, upon which the driver needs to apply pressure to bring the vehicle into motion. The unit's driving mechanism is a differential one, allowing the person driving it, to go forward, backward, or rotate about its central axis with a zero degree radius. Its speed can be varied in accordance with the amount of pressure applied on the panels. AMAXTUS will be powered up by a 35 Amp-Hr 12V car battery, which will be powering up the two motors connected to each side wheel. The wheel chair is designed as a mobility aid for the old people, pregnant ladies, people with walking disability and hence its speed varies from stand still to 10kmph (max).

Figure 1: The conventional wheel chair

I. THE BASIC STRUCTURE

The exo-sceleton of AMAXTUS is a usual wheel chair (**Figure 1**); only the space beneath the seat and the base of the chair is maximised to fit a 12V car battery and the control unit.

The Force Sensors are installed beneath the armrests where the rider is supposed to rest his hands on. Similar Force Sensors are present at the handle of the wheel chair just beside the back rest. This is provided so that if a person has to carry a person sitting in the wheelchair, not capable of driving it on his own; then a slight hold is enough to make the wheel chair move instead of pushing it.

Figure 2: Concept 3D model of AMAXTUS

Two steps are provided at the footboard which are coupled to switches and are supposed to be turned on/off by momentary movement of the feet on the paddle by the rider.

The function of the two foot-rests are as follows :

i) To reverse the motor rotation direction in the wheel chair.
ii) To lock the current speed of the wheel chair instead of continuosly pressing the armrests.

The foot-rests can be configured out according to the rider's convenience.

Even the maximum and minimum speed of AMAXTUS can be configured separately, provided that the maximum speed remains below the permissible speed (10 kmph).

II. THE FUNCTIONAL UNITS

A. The Force Sensors

The force sensors that are going to be used are Force Sensitive Resistors (FSRs) whose value of resistance changes according to the amount of force they receive on their sensing area.

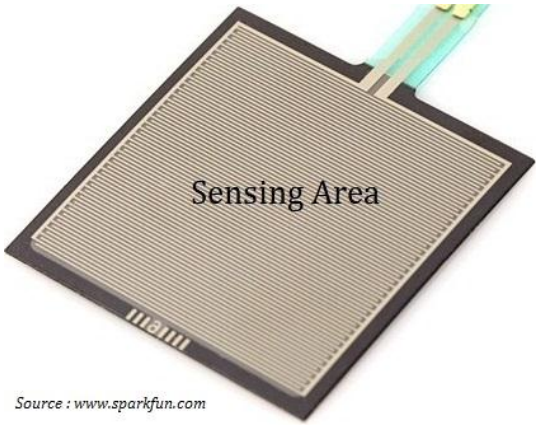


Figure 3: Force Sensing Resistor (FSR)

These sensors are installed under the two armrests.

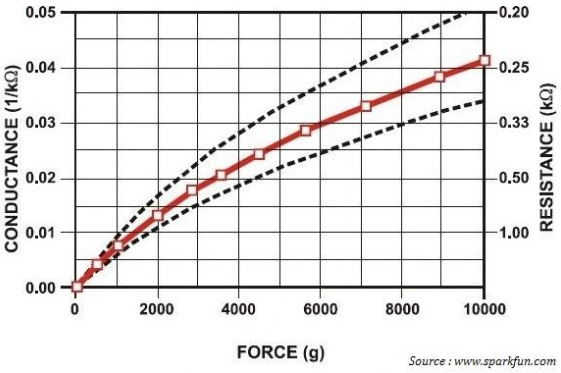


Figure 4: Conductance and Resistance Vs. Pressure Applied per unit area (0-10kgs)

The pressure sensors have a resistance of 1MΩ when not under pressure. Upon application of force the resistance across the sensors varies. The working values are graphically plotted above in **Figure 4**.

B. The Locomotive Unit

The two wheels of AMAXTUS are coupled with two separate 12V DC motors. The motors take in power from the battery that is going to be installed just beneath the rider's seat. The motors are connected to the ESC (*Electronic Speed Controllers*) which are fed by a PWM (*Pulse Width Modulation*) signal generated by the micro-controller in response to the input received by the force sensitive sensors. The motors are coupled to the wheels by suitable gear chain system as present in the existing cheap hand-driven wheel chairs which is commonly used by the disabled hawkers.

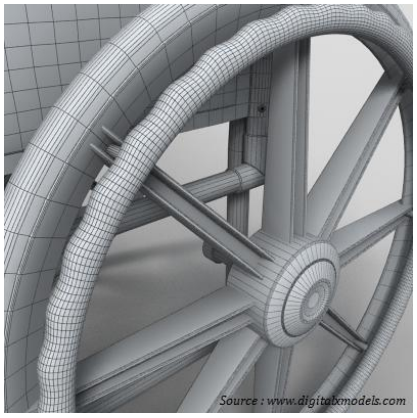


Figure 5 : The Wheel Coupling

B. The Steering Mechanism

Amaxtus has a differential drive consisting of the pressure sensitive sensors supplied with the 12V car battery and connected to the micro-controller that measures the amount of pressure applied. A difference in pressure upon the left and the right armrest makes the vehicle steer left or right.

If the pressure on the left armrest is more than the right one, a difference in the pressure values makes the vehicle steer to right; the radius of turning varying directly with respect to the value of pressure difference. For a zero radius turn in the right direction, only pressure is to be applied to the left armrest.
This is how the steering mechanism works.

C. The Control Unit

The whole project is developed on Arduino platform for the sake and simplicity with coding. Java as the backend platform and lucidity of C++ makes interfacing algorithms with the hardware very easy. Amaxtus runs on ATmega328 based Arduino Mega Micro-controller.

Figure 6: The Arduino Mega

The sensed values from the sensors (pressure sensors as well as the obstacle sensors at the foorboard) are inputted via the analog sensor pins on the micro-controller. These

analog pins are also used for supplying PWM to the ESCs.

The digital pins are used for reading digital HIGH and LOW from the paddle switches.

The control unit contains the algorithm that processes the pressure values from the Force sensors installed under the armrests. The algorithm distinguishes between the difference in values of the force sensors to assess the difference being a turn or to drive the vehicle straight. Since humans cant have exactly the same amount of pressure at both the palm ends hence it is required to determine the difference is slightly (while trying to apply same pressre with both palms) or actual a willful difference created by self for turnig the vehicle differentially. Once the program is able to recognize the difference, it locomtes the vehicle accordingly. This is one of the very important function of the Micro-controller which isnt possible otherwise.

The main reason for using Arduino was to provide the consumers of AMAXTUS with Open Source support. The AMAXTUS codes will be available to the user to tween the vehicle according to his own will and hack the normal functioning of the vehicle. This is to support improvement and incoming of better designs into the market.

The Control Unit reduces the error in the incoming digital values of the pressure applied, processes the signals and then determines how to trigger the ESCs in the last stage.

1. Phase 1 : Error Reduction

The incoming signals are converted into decimal values and are processed for error check. The algorithm checks the difference in the incoming signals. Since pressure applied by our both hands may not be exact. It is required to detect whether the difference in the pressure values is hardware error or actually the rider demanding to turn the vehicle.

2. Phase 2 : Processing the signals

When the processed input is error free, a simple if-else check runs which supplies the left/right/both ESC, a PWM pulse who's Duty Cycle is directly proportional to the magnitude of pressure applied. For no pressure the ESC is given a pulse of 0% duty cycle. For full pressure (that is meant to achieve 1kmph speed) the pulse is of 100% duty cycle; the intermediate values being linear to the max and min values.

III. VEHICLE ACCESSORIES

A. The Footboard

The Amaxtus has a footboard with two padels. The padels are conventional rocker switches which activate on being toggled at the ends. The function of the toggle paddles are :

i) **Motor rotation direction reversal in the wheel chair :** This paddle will serve as a Dual Pole Dual Throw switch which changes the motor supply polarity reversing all the control directions of the actuators.

ii) **Lock the current speed of the wheel chair instead of continuosly pressing the armrests :** This feature is to reduce the labour of applying continuous pressure to maintain a steady speed. The paddle sends a signal to the control unit which records the instant speed value and continues supplying the ESCs as the way it was supplying at the instant of pressing the paddle.

The footboard are also embedded with obstacle sensors which detect if the footboard is approaching any obstacle unexpectedly and brings the vehicle to rest. This is a Safety First feature.

B. 3 Pin AC charger

AMAXTUS comes in with a 3 pin single phase AC charger which just has to be plugged in into a usual 220V supply wall socket for charging the car battery.

C. Battery Level Indicator

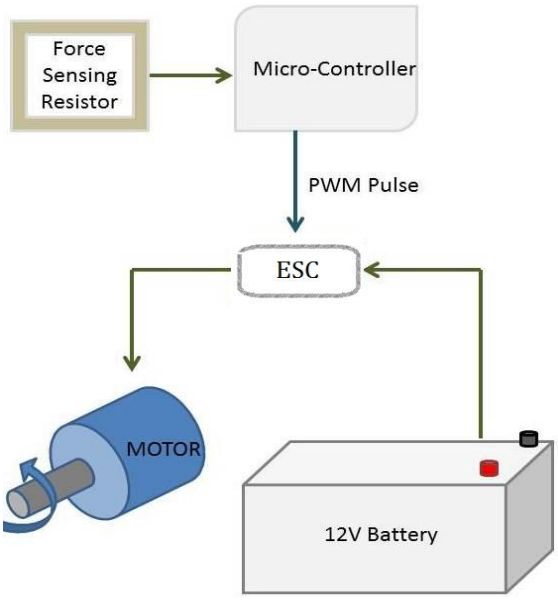
This setup shows the current value of the vehicle battery digitally. So the consumer is able to plan out how much to use the vehicle and approximately for how long.

The indicator circuit is of very high resistance (above 1MΩ) hence power dissipation is low from the battery to the indicator.

B. Battery Overcharge Alarm

Over charge alarm consists of a 5V buzzer which fires on when the battery is fully charged. This setup is provided to maintain the healthy state of battery by avoiding overcharging it.

IV. WORKING BLOCK DIAGRAM



V. POSSIBLE FUTURE UPGRADES

The entire project being re-developed with Brushless Hub Motors instead of usual usual brushless motors will be the first possible upgrade. The space will have to be maximised for that case to accommodate more than one car battery inside the vehicle.

Safety features will be improved such as auto parking during major system failure.

Currently Vehicle Security is being developed to incorporate features such as GPS tracking of the vahicle's location and starting of the vehicle with voice command.

ACKNOWLEDGEMENT

The idea of AMAXTUS was presented in NIRMAN (model presentation at B.P.P.I.M.T Techstorm 2.0) for the first time. The complete documented project is solely the work of the author without any other inspirations behind the idea of the project.

The project is neither a re-modification of any existing project nor a re-improvement of the existing technology in the market.

But I would like to throw a focus on companies that produce Handicap Aid automated vehicles for the improvement in mobility of the disabled. Their innovations and dedication was a key factor behind my interest to focus into this particular domain.

REFERENCES

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