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By Lucas Herrmann, Luiz Antônio Pereira Machado, Luiz Otávio Victória, Arthur Barcellos Galli & Rafael Galli

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Abstract- In this work, we present the electro-electronic project of an articulated electric vehicle developed, initially for a user, with electric steering and an articulated center that allows the vehicle and user to enter elevators. The purpose is to allow older adults or people with special needs to obtain greater mobility and comfort on urban and residential roads. The main part of the electronic system is a complete bridge inverter controlled by a microcontroller system. The vehicle features two battery banks, monitored by a control system that defines the best bank to be used, placing the other bank under load through a solar panel. The mechanical structure was constructed from materials that are easily accessible on the market, and materials for reuse to recycle them.

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I. Introduction

Each year, there is an increase in earth temperature attributed, in large part, to human action. One of the factors that contribute to this increase is the emission of greenhouse gases into the atmosphere, for example, carbon dioxide. This problem causes public and private agencies to seek to research and develop new forms of transport to reduce C02 emission, making great use of renewable energies.

Electric vehicles are not an innovation since they appeared in 1830, and at the turn of the 20th century, about 90% of the taxi fleet that ran in New York was powered by batteries (SUPERINTERESSANTE, 2007).

The evolution of oil refining and the consequent reduction in the cost of gasoline, combined with problems with batteries and chargers for electric vehicles, made combustion vehicles more economical, thus causing the "end" of electric vehicles.

With the resumption of research, to develop new batteries and solar panels for the American space program, as well as the evolution of electric motors, new hybrid vehicles - electric and combustion - or simply electric, as efficient as current combustion vehicles, now having the advantage of reducing pollution and the possibility of using energy from the sun, looking forward to reaching a new market place for, to serve a more conscious and demanding consumer about to environmental issues.

Thus, the challenge of the project is to develop a low-cost Electric Vehicle (E.V.) prototype, using the maximum of components on the market, such as motorcycle parts for the chassis, brakes, and bicycle parts. These mechanical components, in conjunction with electronic control boards.

Based on the data previously exposed and seeking to provide people with mobility difficulties, an ally to improve their day-to-day lives, the project has the objective to develop a vehicle for individual transportation that moves around urban centers and indoor environments such as public offices, restaurants, and hospitals. Therefore, it seeks to bring greater mobility and freedom to the user and also contribute to the reduction of CO2 emissions.

II. Motivation

The purpose of the work is to promote a spirit of research among students, seeking interaction between practice and theory, building a didactic transposition that seeks to make the pedagogical methods more attractive to the student body.

There is also a concern to develop ecological and social awareness in students, seeking to show the importance of reusing materials in developing their projects, searching for alternative solutions.

The challenge proposed here is teaching-learning based on the principles of education theorists, which knowledge is developed during the construction of the object (Maria Montessori, 2014).

We must highlightthat the development of this project has been done by students from the Technical Course in Electronics and Bachelor of Design, enabling the exchange of knowledge acquired during the courses, with the support of employees, students, and colleagues of the Bachelor of Electrical Engineering Course, among others.

III. Desenvolvimentodo Projeto

The first step of the project consisted by disigning a chassis using tubes existing in the locksmiths of the Federal Institute of Rio Grande do Sul - Câmpus Pelotas, and some bicycle components, according to figures 1 and 2, together with two 24V

Author α ρ: Department of Electrical Engineering, IFSUL Câmpus Pelotas, 55740-000, Pelotas, Brazil.
Author σ: Department of Bachelor of Design, IFSUL Câmpus Pelotas, 55740-000, Pelotas, Brazil.
Author Ѡ ¥: Department of Technical Electronics Course, IFSUL Câmpus Pelotas, 55740-000, Pelotas, Brazil.
e-mail: rgalli@pelotas.ifsul.edu.br

750W GPA DC motors that generate the power needed to drive it.

Figure 1: Chassis designed by the students

Figure 2: Chassis designed by the students

Figure 3 shows A block diagram of the vehicle control system. The Control Board is responsible for generating the PWM - "Pulse Width Modulation"- for the Power Stage and generating the signals for the Protection Board. When the Protection Board receives signals from the Control Board, it releases power to the Power Stage. The Bank Control Board analyzes which battery bank has the highest load and releases it to the Power Stage through the Protection Board.

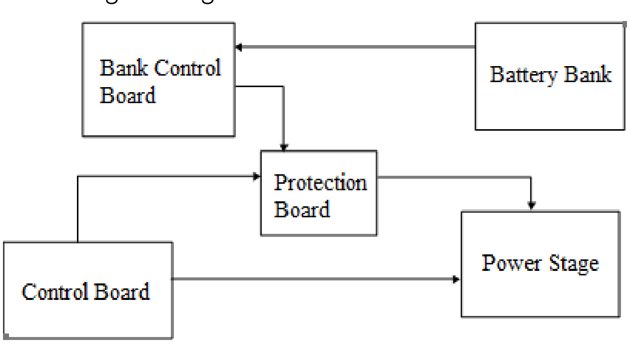

Figure 3: Block diagram

a) Control Board

In the control circuit, Figure 4, is located the PIC 18F4550 Microcontroller that has amid its functions, the generation of the PWM, and analysis of the vehicle's basic system, that is, to analyze the initial conditions of the vehicle, such as battery voltage and condition of the accelerator, and after, if everything is in order, it releases the same to transit.

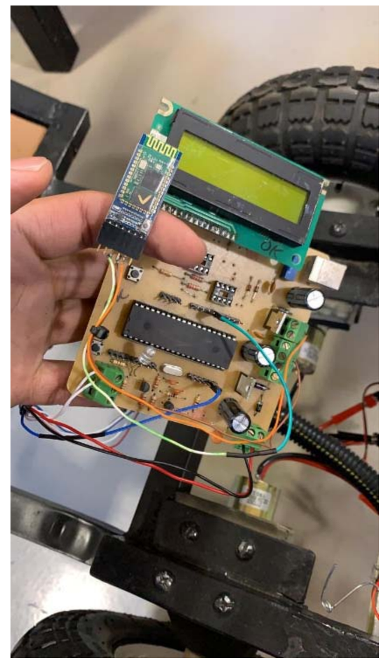

Figure 4: Control circuit

In addition to the digital protection circuit, there is an analog circuit, Figure 5, that prevents the inversion of the batteries and controls the vehicle lights.

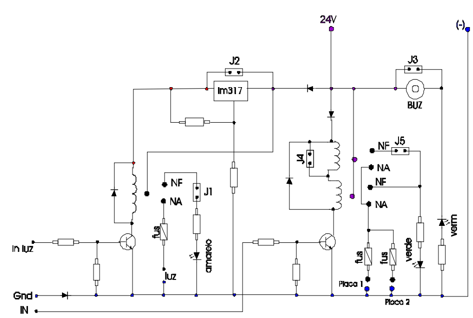

Figure 5: Analog protection circuit

b) Battery Reading Circuit

The battery analysis or reading circuit, shown in Figure 6, has the function to select the battery bank. The vehicle has two battery banks. The control board analyzes the bank with the highest load and switches it to use, keeping the other in charge, through solar panels.

When the bank reaches a certain value, the circuit analyzes the banks again and automatically switches over to the one with the highest load.

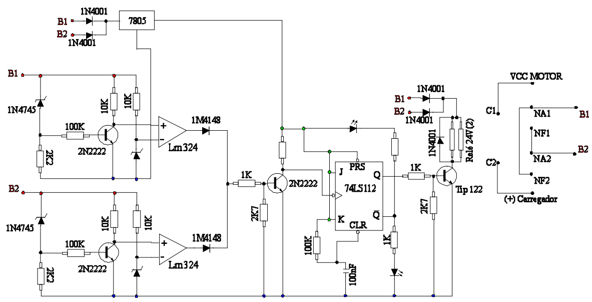

Figure 6: Battery comparator circuit

c) *Power Stage*

The vehicle has two identical power stages:Controlling electric steering, another for controlling fuze, responsible for opening and closing the car, and a more powerful one for propelling.

The full-bridge inverter, implemented with IR2184 and IR 2110, wasbased on a full-bridge. Such integrated circuits are a trigger drive for half a bridge; the complete schematic circuit is shown in Figure 7 and the PCB in Figure 8 end Figure 9, the prototype board Mosfets.

In the case of the main engine's power plate, these CI's control two IGBT's modules and, in the others, power MOSFET.

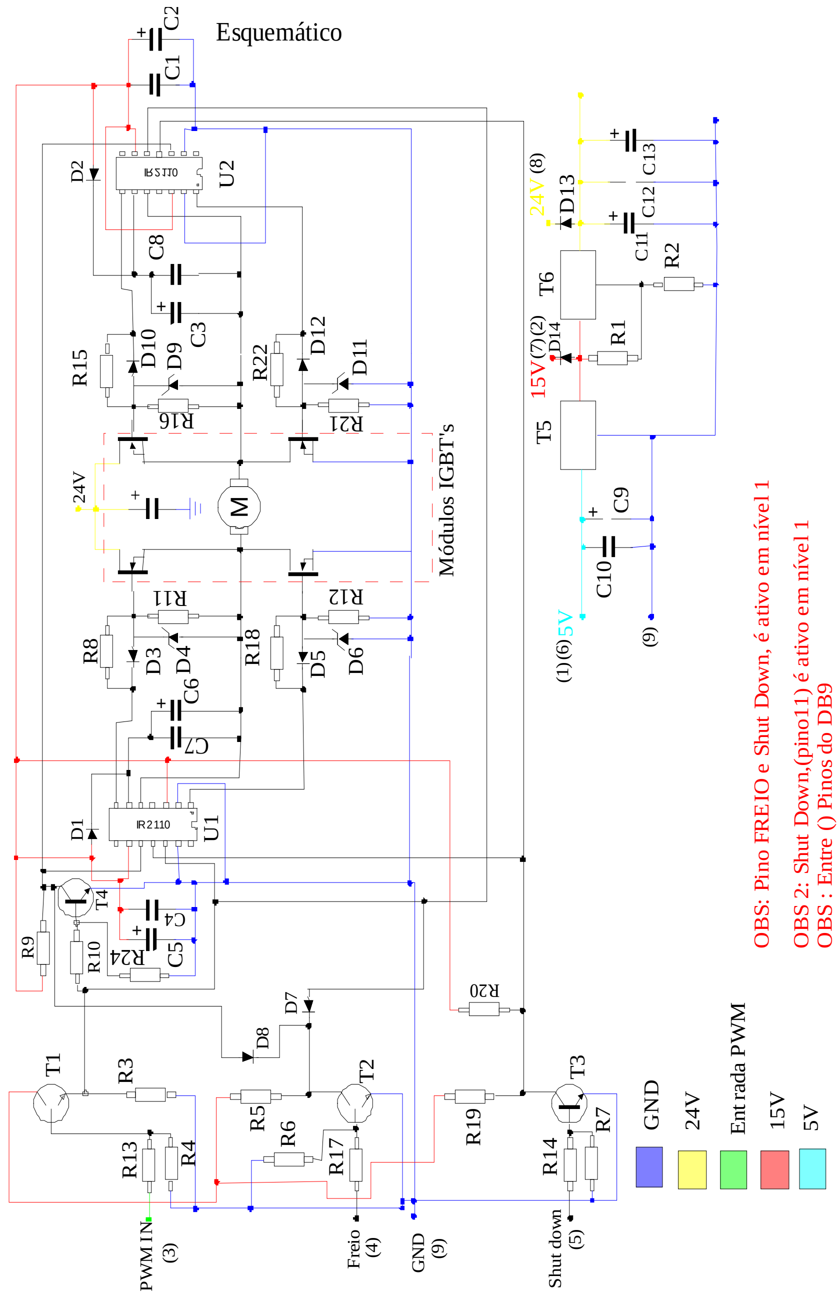

Figure 7: Power stage

The circuits power with IGBT's can be seen in figures 10 and 11.

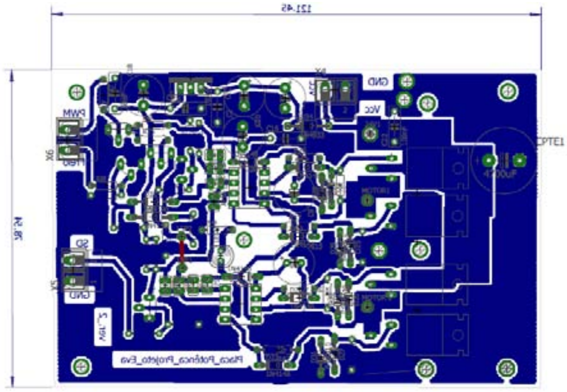

Figure 8: Power PCB board with MOSFETs

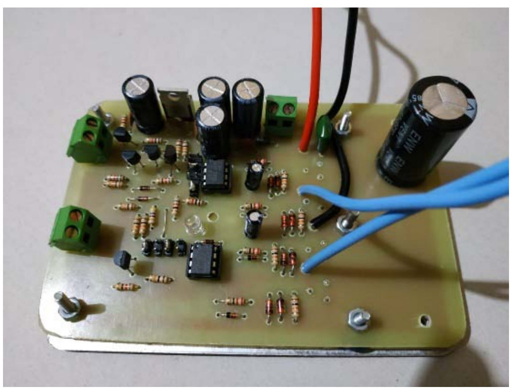

Figure 9: IR 2184 control circuit to mosfets

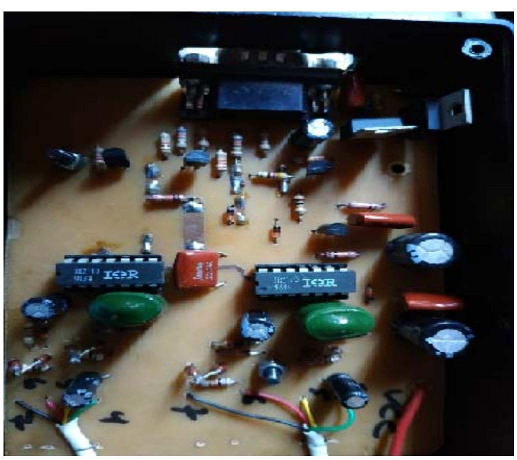

Figure 10: IR 2110 control circuit

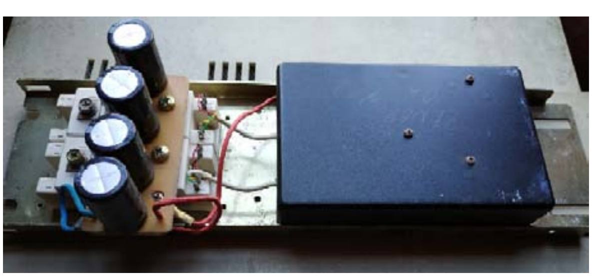

Figure 11: IR2110 circuit assembled with IGBT's.

IV. Results and Discussion

During the development of the prototype, built with recycled materials (Figures 1 and 2), some problems arrived in the mechanical and in the circuits. The shock absorbers were badly damaged hindering cornering vehicle stability. To solve this problem, a new structure with four wheels, shown in Figures 12 and 13, was built.

Figure 12: New open structure

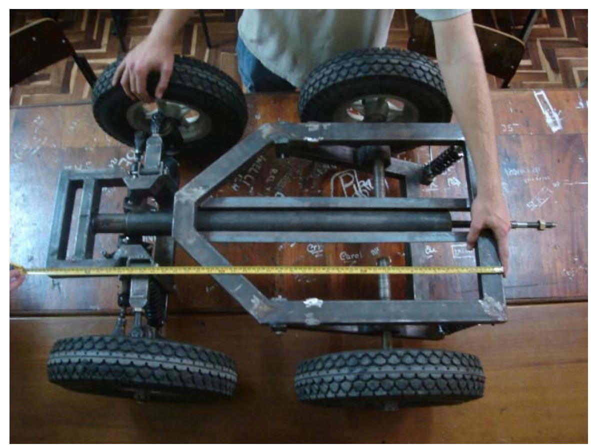

Figure 13: New closed structure

In the electronics part, the battery comparator circuit showed instability. The solution found was the addition of a Schmitt Trigger between the transistor and the flip-flop that stabilized the input pulses.

In preliminary tests, observations in the new structure, showed that the vehicle reached a speed of 35 km / h and reached a distance of 5 km in uneven terrain.

The tests with the charge of the battery banks presented satisfactory results, being in the implantation phase in the prototype.

With the addition of a Bachelor of Design student, it was possible to implement a new chassis, as seen in figures 14 and 15, in partnership with the Universidad Autónoma de Ciudad Juárez, Mexico, which allowed a considerable reduction in the vehicle's weight, allowing the replacement of 750W motors by 350W motors, and the replacement of IGBT's with power MOSFETs, reducing the number of plates, significantly reducing the cost of the vehicle.

Figure 14: Final chassis side view

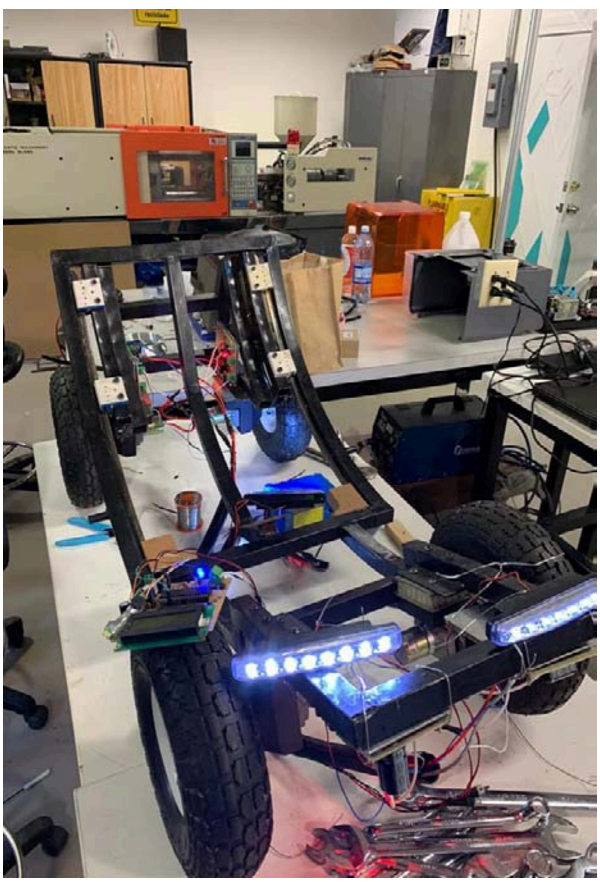

Figure 15: Final chassis front view

The power phases with MosFet's performed better than expected, showing stable signals, as shown in figures 16 and 17. The results were obtained mesuring the powers steps by using a Tektronix Oscilloscope TDS 2022B and the Open Choice PC Communication software from Tektronix.

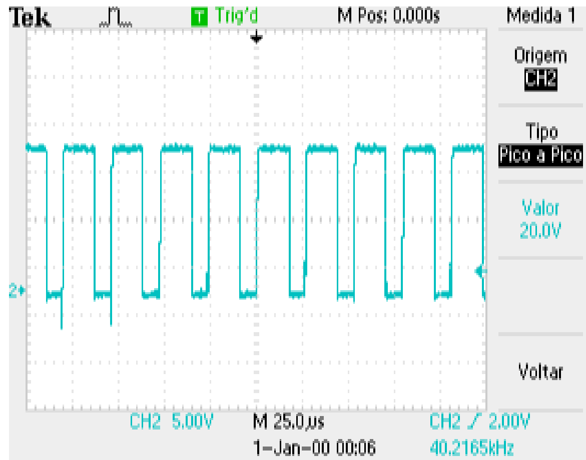

Figure 16: PWM at the entrance to IR 2184

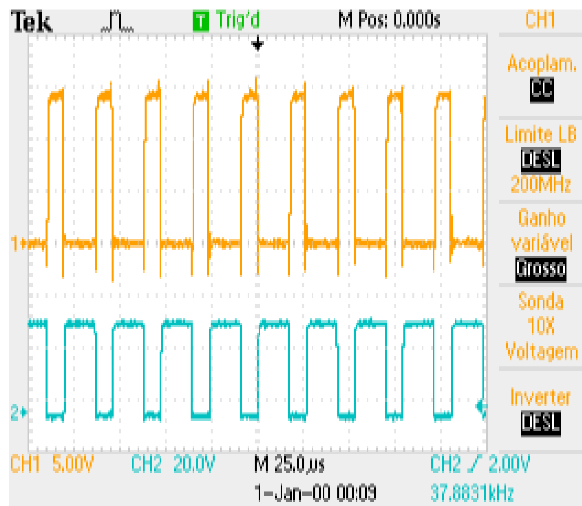

Figure 17: IR 2184 outputs

V. Conclusion

This work presented the development of a project for the creation of an ecologically correct electric vehicleto enable greater mobility for people with special needs and the elderly.

The work proved to be very useful. Given the suggested pedagogical proposal, it was the act of doing to learn, starting from the student's curiosity and desire, besides promoting interdisciplinarity.

There was great interest from those involved in the project, as the teaching methodology was motivating and differentiated in the school routine. The project proved to be a reference for the developing other projects such as Design that generated a modern and efficient chassis and a vision of the future final prototype shown in Figure 18. The design of this project in fact derived the Master's degree from student Luiz Antonio Pereira Machado Júnior, from the Bachelor of Design course at the Federal Institute of Rio Grande do Sul, at the Universidad Autónoma de Ciudad Juárez, México.

Figure 18: Conceptual drawing

And in the control stage, a telemetry system, where over long distances, we can collect and analyze the main signals of the vehicle, such as engine and inverter temperature.

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