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STUDY AND DEVELOPMENT OF PROTOTYPE FOR PROTECTION AGAINST LIGHTNING (ATMOSPHERIC DISCHARGE) IN ELECTRONIC, HOUSEHOLD APPLIANCES AND TELEPHONE DEVICES IN HOMES

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Abstract: This research project aimed to design and build a prototype of a lightning protection device (atmospheric discharges) in electronic devices, household appliances and telephones in homes so that every home owner can, from their work or anywhere else, turn off the electrical grid. and telephone from your home remotely without having to travel to the site to unplug the devices from the sockets, preventing them from being damaged in a storm.
Keywords: Protection. Automation. Atmospheric discharges (lightning). Prototype.

INTRODUCTION

The objective of this project was to study, design and build a prototype of protection against lightning (atmospheric discharges) in electronic devices, household appliances and telephones in homes using a system capable of activating remotely, via GPRS (General Packet Radio Service - messages SMS normally carried out by cell phone devices), the residence using an integrated hardware and software system capable of turning off both the electrical network and the telephone network of a residence at the same time. After the remote activation is performed, the system installed in the residence inhibits any electronic, computer, household appliance or telephone device from receiving an atmospheric discharge, which damages or burns any of the components. Another requirement of this project is that it must work with low cost in conventional equipment already present. Low-cost hardware components such as the servo motors, H-bridges and Arduino control boards are readily available.

As it is an innovative prototype that until then had never been created, the concepts acquired during the research process were used to create a device that works based on the principle of reducing the distance between the conductive poles between the ground using cylindrical steel rods. In these fixed rods, a mechanical lifting mechanism was developed that could carry out the connection and disconnection and also that could be activated remotely.

MATERIALS AND METHODS

The project started with a bibliographic and field research related to methods and systems of protection against atmospheric discharges (lightning) along with damages caused to the entire population. Several researches were carried out at the beginning of the project development, with the purpose of protecting the device and the people involved. In the research on electrical discharge power, it was found that when one occurs, it can travel through the air, in the form of an arc, 1 cm every 1000 Volts, which in this case could damage both the prototype and affect the internal equipment. Lightning is strongly attracted to the electrical network due to its magnitude, and when they strike it, an electromagnetic field is formed that impinges on the telephone network. The discharge, therefore, reaches the residences by both means, both through the electrical network and the telephone network, damaging both electrical and electronic devices in general.

The research carried out had as a principle to reduce the distance between the conductor pole and the ground in order to redirect the electromagnetic field formed by the discharge. In the device, the cables of the conductor poles of the electrical network and the telephone network are close to the ground at a distance of 0.2 mm, causing the electromagnetic field formed by the passage of electric current generated by the atmospheric discharge to form the electromagnetic arc (skip in air) and energize the ground rod. When there is

an increase in voltage and electric current due to an atmospheric discharge, an increase in the electromagnetic field also occurs. Because electricity follows the path of least resistance, this will transfer the overload to the nearest point (ground) until it dissipates into the ground. In this case, only 0.2 mm are equidistant from the ground, preventing this discharge from damaging the prototype and the internal environment.

A paper sketch was carried out to adapt the metal rods that need to be well fixed so that they could sustain the impact of the connector when it is remotely activated and also the positioning of the other materials. In this drawing it was possible to make the list of materials necessary for the making of the prototype containing the following items:

Mechanical Components:

- Electric lock drive motor used in vehicles;
- MDF sheet
- Copper-plated Cylindrical Steel Bar;
- Nickel-plated Cylindrical Steel Bar;
- Screws with 3mm superb thread;
- Nuts 3mm;
- 02 copper connectors for ground rod.

Electrical Components:

- Arduino Mega;
- Arduino GSM/GPRS shield;
- 05 m cable 10.0 mm;
- Power outlet;
- Telephone socket;
- Lamp Nozzle;
- Perforated circuit board;
- 04 NPN TIP 142 transistors;
- 04 NPN TIP 147 transistors;
- 04 PNP BC 577 transistors;
- 08 IN4007 Diodes;
- 08 1K resistors;
- 04 4K7 resistors;
- 02 Circuit Breakers 10A;
- 05 m Jumper wires.

An MDF plate was used as a support base for fixing the steel rods so that they could be positioned on the lifting motors. An Arduino microcontrolled board was used to perform the general control of the system.

Arduino is a free hardware and free software platform, emerged in Italy in 2005 with the aim of creating a device to control projects and prototypes built in a less expensive way than other systems available on the market. Arduino is also called a physical computing platform, because it works essentially with digital systems connected to sensors and actuators, which allow building systems that perceive reality and respond with physical actions, based on a simple microcontrolled Input/Output board and developed on a library that simplifies writing programming in C/C++.

A microcontroller (also called an MCU) is a computer on a chip, which contains a processor, memory, and input/output peripherals. It is a microprocessor that can be programmed for specific functions, in contrast to other general purpose microprocessors (such as those used in PCs). They are embedded inside some other device, in our case the Arduino, so that they can control their functions or actions. It is a development kit capable of interpreting variables in the environment and transforming them into a corresponding electrical signal, through sensors connected to their input terminals, and acting on the control or activation of some other electronic element connected to the output terminal. In other words, it is a data input and output control tool, which can be activated by a sensor (for example a light dependent resistor - LDR) and which, soon after going through a processing step, the microcontroller can trigger an actuator (a motor for example):

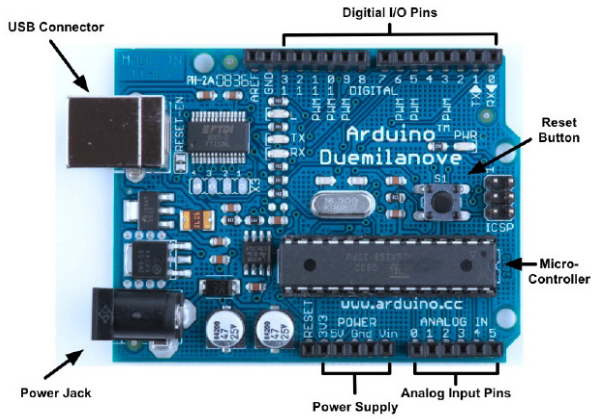

Figure 1 - Arduino board.

Using the electronic components, transistors, diodes, resistors, a connection scheme was used to make the H Bridge as shown in the following image. (Figure 2).

The Ponte H board was made by joining the electronic components following the wiring diagram, the components were adapted and positioned on a perforated printed circuit board, which was used to control the clockwise or counterclockwise rotation of the elevator motor. mechanical.

(Figure 3).

Made H Bridge using printed circuit board and electronic components to adapt to Arduino.

(Figure 4).

This mechanical lifting mechanism was used to move the contact conductors vertically or diagonally. In the electrical network, the protection device was connected only to the positive pole (+phase) of the alternating current and in the telephone network, as it is continuous, it was connected to both conductors. The protection device maintains contact in the cables of the conductor poles, allowing the normal use of energy and the telephone network without generating any interference to both and, when activated, through the mechanical mechanism it will disconnect the cables from the transmitting poles, turning off both points of contact moving them to a distance five times greater than the cables connected to the ground, in this case generating protection against an atmospheric discharge.

(Figure 5).

An atmospheric discharge was simulated using a tazer (electric shock device) generating high voltage in the conductor poles, in which it was possible to prove the effectiveness of the protection of the prototype, allowing the visualization of the formation of the electromagnetic arc in the conductor cables to the ground, since, when we distanced the cables that remain connected to the interior of the house, they were not affected by the electrical discharge. It is possible to notice in the image (figure 02) that the discharge occurred towards the ground and not towards the contact connector connected to the inner part of the house, which is further down.

(Figure 6).

Several sending and SMS tests were carried out using Arduino Quadband GSM/GPRS with a SIM chip (cell phone chip) together with an Arduino board, which worked as expected. The SIM board is coupled to the Arduino Mega board which, through programming, carries out the activation and control commands, sending them to the H bridge, which in turn manages the motors.

(Figure 7).

The Quadband board (called a shield) allows the inclusion of a cell phone chip which uses the telephone line to receive voice and text calls. The application carried out in the prototype was to receive a text (SMS message), which when receiving the message through the shield programming recognizes and sends commands to the Arduino platform, sending a signal to the motors that are connected to the H Bridge performing the movement to up and down as requested.

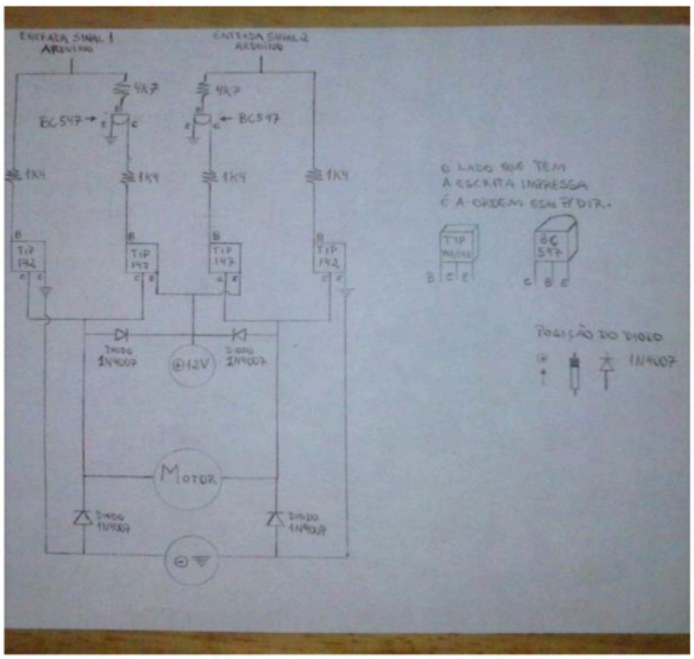

Figure 2 – H-bridge electronic schematic.

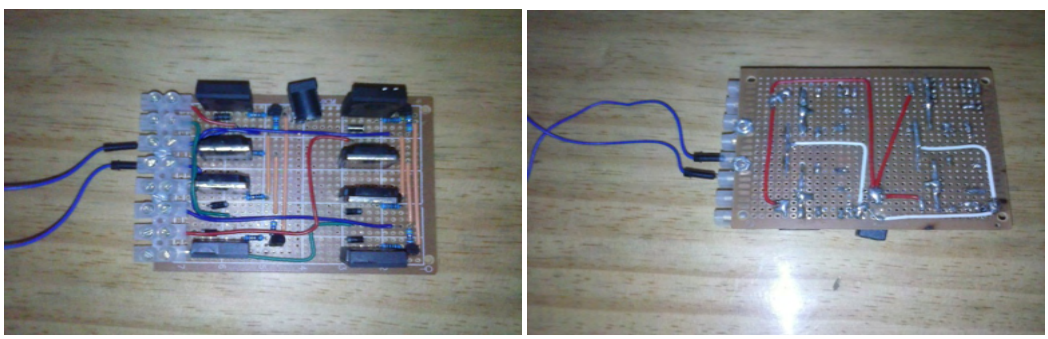

Figure 3 – Test H bridge (front and back).

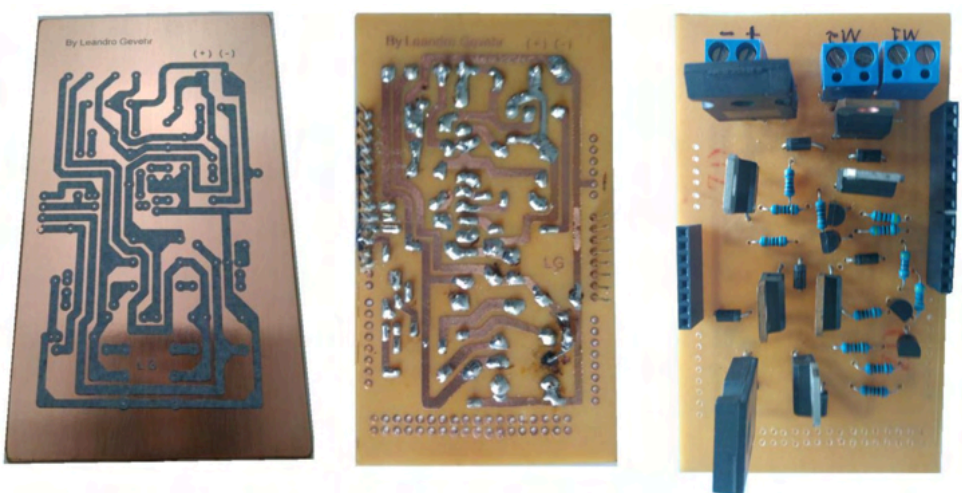

Figure 4 – H Bridge (front and back).

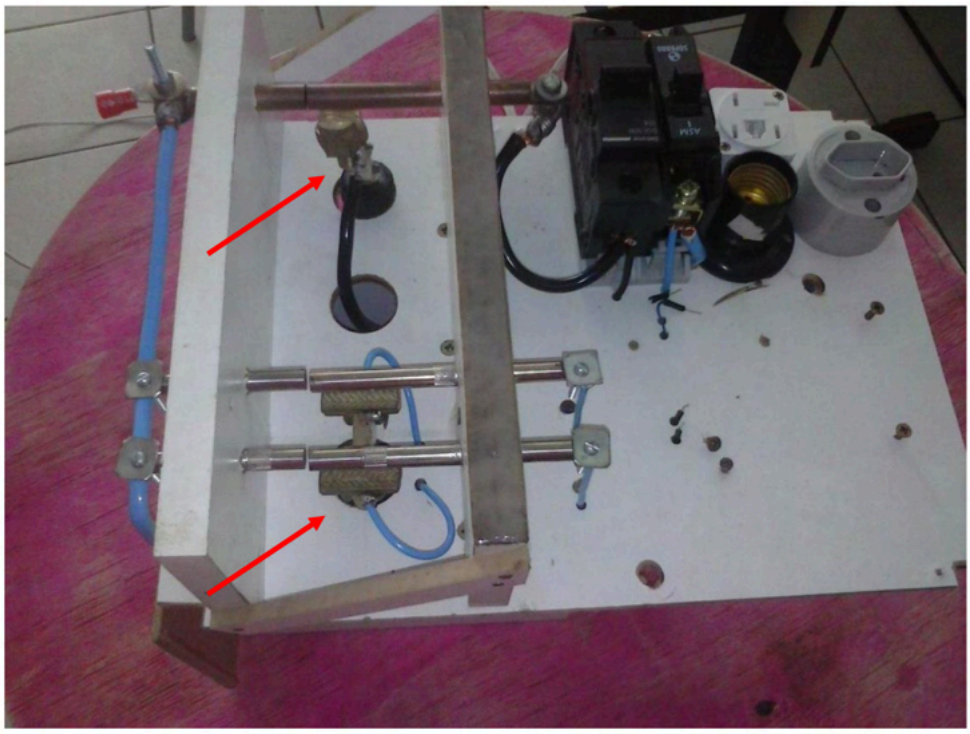

Figure 5 – Prototype Image

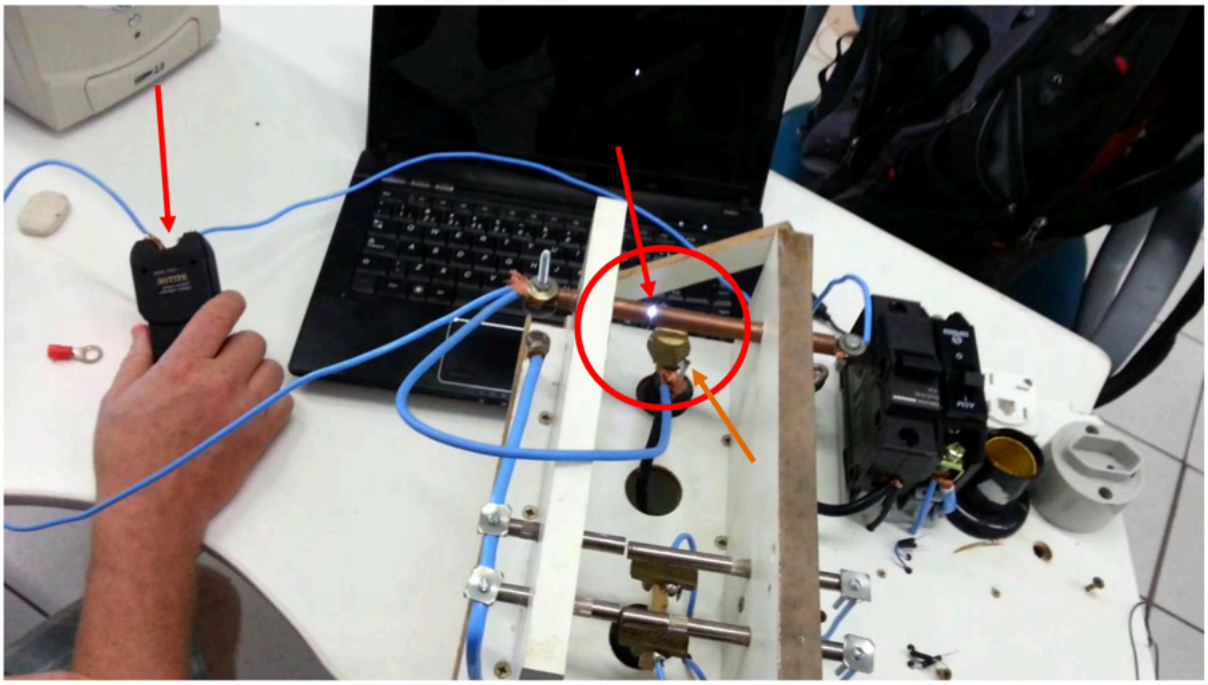

Figure 6 – Atmospheric Discharge Simulation.

Figure 7 - Quadband Arduino Shield.

RESULTS

As results of the project can be cited:

- Research carried out on the approximation of the positive pole of the electrical network to grounding as a way of protecting and dissipating excess electrical load without the short occurring;
- The lightning protection prototype.

The development of the prototype for protection against lightning (atmospheric discharges) in electronic devices, appliances and telephones in homes, the general objective of this project, was successfully completed. As expected from the beginning of the project, adjustments are necessary regarding the design of the prototype, regarding the replacement and modification of the lifting mechanism, regarding the installation of a rechargeable battery to keep the circuit active during the disconnection of the power and the installation of another mechanical mechanism to perform manual activation in case of prototype failure. This way, the prototype will have its correct functioning and can be patented and commercialized.

FINAL CONSIDERATIONS

The study on lightning (atmospheric discharges) was carried out. The prototype for protection against lightning (atmospheric discharges) in electronic devices, household appliances and telephones in homes was designed and built. An Arduino shield Quadband board was used to: a) receive calls and b) receive SMS. An Arduino Mega board was used to: a) receive information from the shield and b) activate the lift motors. Created an H Bridge. Softwares were created for joint use of the Arduino Mega platform with the Arduino shield Quadband. Although the prototype as a whole needs adjustments, improvements can be made in these aspects so that it can be patented and commercialized, the proposed objectives were successfully achieved.

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