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SAFETOUCH: ELECTRICAL PROTECTION FOR THE VISUALLY IMPAIRED

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ABSTRACT
The first step in creating a prototype is to identify the needs and requirements of users. This can be done through research, interviews, and use case analysis. Based on this research, it is possible to define the functionalities and characteristics of the prototype. Given the occurrence of accidents involving electricians, the prototype was developed to increase the safety of these workers in their work activities to mitigate the possibility of these possible accidents occurring, as well as to be a product that is easy for the user to handle. Thus, the prototype consists of a glove made of insulating material that, through a system for detecting the passage of electric current in conductive wires, will alert the user via the Arduino Uno board and output modules of the dangers detected by the tool. The aim is to obtain positive results at the end of the project development, so that this objective can be achieved through the methodological process implemented and, in parallel, we seek to meet the demand and expectations of our client in a way that provides greater safety and versatility with the use of the tool at a low cost.

Keywords: Electricians. Arduino. Glove. Safety. Visually impaired.

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INTRODUCTION

In modern Brazilian society, the development of technological mechanisms that facilitate people's daily actions is constant. However, problems related to the improper handling of electrical energy still exist throughout the country. Many professionals who work in activities associated with electricity are exposed to the dangers of accidents that can occur when working with this physical phenomenon. What motivated us to choose this project was the need for greater safety for people with visual impairments when working with electrical energy. However, we saw through news channels in Brazil and in our region of the lower Tocantins, in addition to participating in classes related to the neglect suffered by people/professionals who handle electrical energy. For this reason, I proposed to my students/team the possibility of researching the topic, where they realized that it is important to think of possible ways to mitigate these accidents. From this perspective, it is known that working with electrical energy is dangerous, and people often prefer to speed up the activities related to electricity that they need to perform in their homes. In this process, the prevention of turning off the main circuit breaker in the house is generally ignored, even by negligent people/workers in the area, which is a major problem.

In addition, there are similar products on the market today that refer to the issue of checking the presence of electrical energy in the wiring, however, these products in operation are not entirely satisfactory in ensuring good warnings to users, especially those who are visually impaired. In addition, many people also do not have adequate knowledge about devices that perform these functions; sometimes not even electricians are aware of the existence of such products.

In this way, the proposed project will reduce the dangers that electric shocks pose to electricians and non-professionals in the area, especially for the visually impaired, who often perform such services in their homes. Thus, the social importance of this project lies in being able to prevent accidents for those who work with electricity or not, or who simply want to carry out repairs in their homes, and the economic relevance concerns the accessibility that the tool will provide to users, so that excessive expenses with other more expensive and less versatile equipment can be avoided.

Thus, the project consists of the development of a glove for checking electricity in wiring, which, upon identifying the communication of electrical energy in the conductive wires, activates an audible alarm and a vibration motor to alert users of the product, especially those who are visually impaired. To do this, we will use ready-made circuits in

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the verification part; we will use conductive materials in the shape of the fingers of the glove so that when the tips of the user's fingers come together, creating a closure, it will be possible to check whether energy is passing through. In short, depending on the response given by the verification of the circuits, the Arduino warning sensors will be activated and the user will receive them.

There has been a broad discussion about the importance of introducing concepts of logic and computer programming from the most basic levels of education. Corroborating the themes about the application of robotics in the educational context, a theme defended many decades ago by researcher Seymour Papert, it is understood that computing is so present in our lives that we should approach it in the same way we do with learning biology, geography, physics, and other fundamental subjects for the basic education of students. This view of education has even been debated at the government level, as reported by the British government's education department, which, after a public consultation, approved important curricular revisions to be implemented in 2014, emphasizing the teaching of programming and computing concepts from the age of 5. Logical thinking is valid for numerous areas of knowledge and learning to program is essential when we consider that the development of algorithms is one of the most used tasks in areas related to computing. Many of the difficulties related to programming are related to the capacity for abstraction, as well as problems in understanding the syntax and structure of programming languages, especially when there is no basic understanding of the English language.

There are currently not many studies supporting and reporting the use of programming as a teaching tool for understanding logic, but rather emphasizing its product, that is, the software generated. Even with the existence of technologies such as Lego Mindstorms, the vast majority of students do not have experience and deeper contact with aspects of robotics. Thus, it is seen that This topic should be directly linked to everyday situations or problem-solving (problem-based learning) that motivate students to have a greater interest and also improve their reasoning about abstractions of complex content.

Arduino is a free platform, both in hardware and software, with its striking attribute being its flexibility. It is seen as a quick and practical way for people with different backgrounds to get in touch with the development of electronic circuits. Technically, it is a printed circuit board that has a programmable microcontroller via USB and a set of tools that facilitate its programming. In this way, it is possible to create prototypes of circuits that

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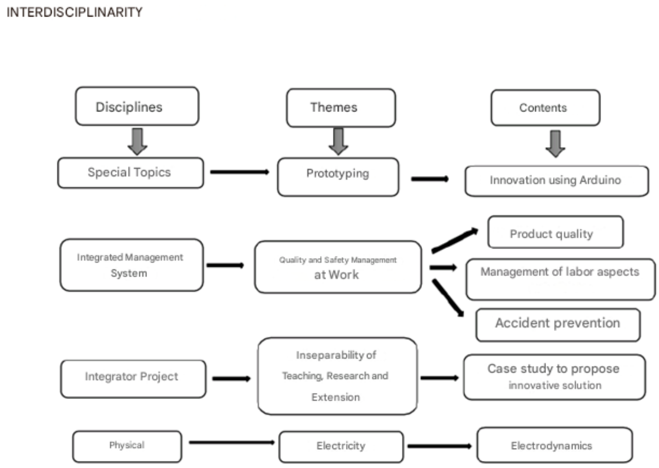
receive and send analog/digital signals to components such as sensors, actuators, LEDs, and stepper motors, among others. This platform has shown important didactic potential and can be applied in education at its most diverse levels, helping in the creation of several projects that require hardware technology in some aspect. Because it is a simple and expandable tool, its use can vary from practical school activities to more complex projects. This platform emerged as a research project at the Ivrea Institute in Italy but was designed by people from different parts of the world who collaborated directly and indirectly in its development. The circuit's source code is open, so much so that anyone can develop it, improve it, and even commercialize new products based on the current project. In this way, the lack of free and low-cost hardware platforms on the market was satisfactorily met.

In this perspective, the concept of interdisciplinarity between disciplinary contents described in the National Common Curricular Base (BNCC) of the Ministry of Education (MEC) was worked on. In the figure below, we make the proper relationship between the disciplines.

Figure 01 – Umbrella of the Interdisciplinarity of the Theme



Source: Own Authorship (2024).

The Arduino system is widely used in the contemporary job market and has been researched by authors such as Warley Monteiro Araújo, Maxwell Machado Cavalcante, and Rogério Oliveira da Silva (2019):

Arduino emerged as a development and prototyping solution, with possibilities ranging from a simple system to turn a light on and off, to sophisticated and professional projects, which depend only on the Arduino user's knowledge of programming and electronics. (Revista Tecnologias em Projeção, v10, n°1, year 2019. p.41).

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In the text above, the author talks about the functionality of Arduino, which is also easily extensible, which means that you do not need to change the motherboard if you want to extend the functionality of your project. Simply add sensors, modules, and shields to integrate new functions. Furthermore, once programmed, Arduino can be used without a computer, since the program installed on the board remains in a loop, repeating itself non-stop, requiring only power for the board to work. Therefore, the use of Arduino in electronic research and projects is one of the most advantageous in terms of ease, low error rate, and excellent functionality, as discussed in the magazine Tecnologias em Projeto (2019).

For the development of this project, along with the study of the Arduino architecture, studies of electricity and, especially in this case, electrodynamics are also considered. "Electricity is the name given to a broad set of phenomena that in one way or another underlie almost everything that surrounds us" (HEWITT, 2011, p. 387). Electrodynamics, in turn, concerns the study of phenomena associated with moving electric charge carriers (Roberta, 1985).

From this perspective, it is essential to emphasize that what is of utmost importance for the development of this project are the studies of the electrical quantities of electrodynamics, namely: electric current, voltage, and electrical resistance. From this perspective, it is worth noting that, according to Hewitt (2011, p. 408), electric current is the flow of charge, set in motion by a voltage and hindered by electrical resistance. Voltage, electrical tension, or potential difference (DDP), in turn, refers to the difference in electrical potential that conductive materials, batteries, and others present, that is, the difference in the accumulation of electrical charge quantity between one end and the other of a given conductor or source of electrical energy. Finally, according to Robortella (1985, p. 112), the difficulty that carriers of electrical charge encounter in moving within a given body is called electrical resistance.

From this perspective, most people have heard about the risks of electricity, but it only takes one oversight for the situation to change completely, get out of control, and even cause death. Unfortunately, the number of incidents of this nature remains high in Brazil, as indicated in the Abracopel 2022 Yearbook, recently published by the Brazilian Association for Awareness of the Dangers of Electricity (Abracopel). According to the publication, there were 1,585 electrical accidents in Brazil in 2021, resulting in 761 deaths. In 2020, there were 1,502 incidents, resulting in 764 deaths.

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Also according to the document, the cases are varied and many occurred in everyday situations, most of them inside the home. Last year alone, the Association recorded 215 accidents that caused 190 deaths inside homes across the country. Our project, considering the aforementioned factors, seeks to develop a technological glove that can prevent and/or avoid accidents related to electrical energy, mainly by acting as a tool to check the presence of electrical energy in the conductors, to improve the safety of people who need to work with electrical energy, such as residential electricians.

In addition, taking into account that many accidents can happen due to not turning off the home's main circuit breaker or not knowing whether energy is being transferred through the home's wiring, the Luvolt product aims to check the electrical transfer from one point to another, using a circuit with sensor modules to check and alert the user about the presence of electricity. It is worth noting, however, that our glove does not eliminate the need to be careful when using electrical energy, because, even if there is a tool that can help, it is by no means dispensable that people are responsible when handling electricity.

METHODOLOGY

The construction of the Arduino glove to provide greater safety and versatility to the individual who performs activities involving electrical energy can follow an iterative methodology, such as the Agile Development Cycle. Below, we describe a possible approach to building the project:

1. Team formation: the project begins with the formation of the participating team members in order to form a harmonious and proactive group.
2. Problem identification: with the team formed, seek to identify a problem in society that requires a project to mitigate it. This involves understanding the risks of accidents that electricity poses to formal or informal workers, and especially to the visually impaired, and mitigating them through a tool that provides greater safety in carrying out the activity.
3. Questionnaire: conduct a questionnaire to obtain legitimate and accurate information to support the project under development.
4. Meeting with the professional in the area: Meet with the supervising professor together with the physics teacher to have a framework of information about the phenomenon of electricity, its concepts, and practical examples.

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5. Project construction: develop the prototype of the glove using an insulating material. Apply the electrodynamic measurement system to the finger part of the glove, so that it does not pose a risk to the user.
6. System development: implement the Arduino platform to receive the system verification signal and alert the user through sound and vibration modules.
7. Testing and validation: perform system tests to verify whether the electrical current detection and alert to the user are being performed correctly. Put the system in real-life usage situations to validate its effectiveness and identify possible failures or improvements.
8. Feedback collection: obtain feedback from users, professionals in the electrical field, and the visually impaired involved, in this case, only one student from the team who participated in the project. They evaluated whether the system meets the users' needs, whether it is easy to use, and whether it prevents possible accidents. Use these insights to improve the system.
9. Continuous improvement: based on the feedback received, iterate and improve the system, adding additional features or adjusting existing functionalities. Maintain a continuous cycle of feedback, testing, and improvement to ensure the quality and effectiveness of the system.
10. Implementation and evaluation: after improving the system based on the feedback received, proceed with large-scale implementation (if it is of interest to investors). Monitoring and evaluating its performance, observing user adherence, and increasing worker safety. So that additional adjustments can be made, if necessary.

It is important to note that the methodology may vary depending on the resources available, the development team, and the project constraints. Adapting the methodology to the specific needs of the project is essential to obtain effective results...

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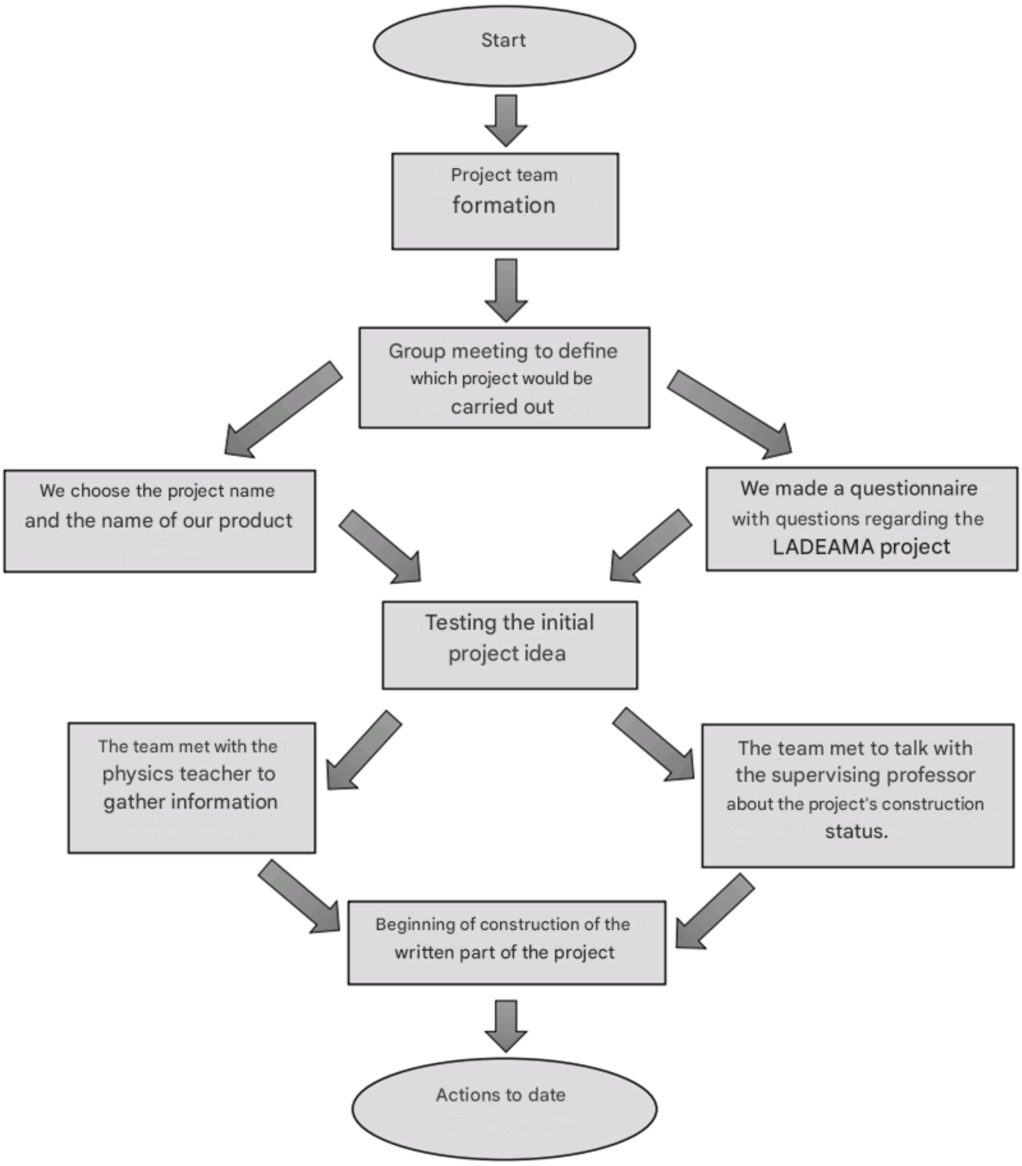
Figure 02 – Methodology divided into Phases



Source: Authors

RESULTS

RESULTS/DISCUSSIONS

Increased safety: by alerting the user to the possible risks of the presence of electrical energy in conductive wires, the project contributes to increasing the safety of workers who perform activities in this line of work. This is especially important for those professionals who perform these activities in hostile work environments, such as tasks that require the use of ladders.

Ease of use: the project seeks to provide a comfortable and easy-to-use glove, meeting customer expectations in a useful and inclusive way for the various occasions that the work demands. This contributes to a positive user experience and facilitates the integration of the system into the worker's daily work activity.

Cost-benefit: based on the prices of similar tools, the aim is to develop an affordable product so that it is not economically expensive for the customer to purchase the tool. Therefore, the project can have a positive impact on reducing expenses in the purchase of PPE and improving the efficiency of the activity.

In short, the expected results of this project are to provide greater safety for workers in this area, efficient audible and vibration alerts, a useful and inclusive tool, versatility and easy handling in an affordable way. With the success of the finalized prototype, these results can contribute to better workplace safety for electricity professionals in today's society.

FINAL CONSIDERATIONS OR CONCLUSION

When developing this project, it is essential to consider the needs of users, ensuring a cohesive, easy-to-use tool that is accessible to different profiles. Continuously collecting feedback from users and professionals in the electricity sector will help identify opportunities for improvement and ensure that the system meets expectations and requirements. Finally, the success of this project will depend not only on the construction of the functional prototype but also on its adoption and effective use by users. Therefore, it is essential to ensure safety for professionals and efficiency in the field of electricity work by providing support through effective tools for the itinerary work of these workers.

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the electricity sector who collaborated with us on the practical effects of the theory based on.

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ANEXO: CÓDIGO FONTE PROPOSTO

```
#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_ADXL345_U.h>

// Defina os pinos do Arduino
const int vibrationMotorPin = 9; // Pino para o motor de vibração
const int sensorPin = A0; // Pino para o sensor de eletricidade

// Inicialize o sensor de vibração
Adafruit_ADXL345_Unified accel = Adafruit_ADXL345_Unified(12345);

void setup() {
  Serial.begin(9600);
  pinMode(vibrationMotorPin, OUTPUT);
  pinMode(sensorPin, INPUT);

  // Inicialize o sensor de aceleração
  if(!accel.begin()) {
    Serial.println("Não foi possível iniciar o sensor de aceleração!");
    while(1);
  }
}

void loop() {
  // Leia o valor do sensor de eletricidade
  int sensorValue = analogRead(sensorPin);

  // Defina um limite para ativação do motor de vibração
  int threshold = 500;

  if(sensorValue > threshold) {
    // Ative o motor de vibração se o valor lido for maior que o limite
    digitalWrite(vibrationMotorPin, HIGH);
    Serial.println("Eletricidade detectada! Motor de vibração ativado.");
  } else {
    // Desative o motor de vibração se o valor lido for menor que o limite
    digitalWrite(vibrationMotorPin, LOW);
    Serial.println("Nenhuma eletricidade detectada.");
  }

  // Aguarde um pouco antes de fazer uma nova leitura
  delay(500);
}
```

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Figura 03: Tela de Programação

```
#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_ADXL345_U.h>

// Defina os pinos do Arduino
const int vibrationMotorPin = 9; // Pino para o motor de vibração
const int sensorPin = A0; // Pino para o sensor de eletricidade

// Inicialize o sensor de vibração
Adafruit_ADXL345_Unified accel = Adafruit_ADXL345_Unified(12345);

void setup() {
  Serial.begin(9600);
  pinMode(vibrationMotorPin, OUTPUT);
  pinMode(sensorPin, INPUT);

  // Inicialize o sensor de aceleração
  if(!accel.begin()) {
    Serial.println("Não foi possível iniciar o sensor de aceleração!");
    while(1);
  }
}

void loop() {
  // Leia o valor do sensor de eletricidade
  int sensorValue = analogRead(sensorPin);

  // Defina um limite para ativação do motor de vibração
  int threshold = 500;

  if(sensorValue > threshold) {
    // Ative o motor de vibração se o valor lido for maior que o limite
    digitalWrite(vibrationMotorPin, HIGH);
    Serial.println("Eletricidade detectada! Motor de vibração ativado.");
  } else {
    // Desative o motor de vibração se o valor lido for menor que o limite
    digitalWrite(vibrationMotorPin, LOW);
    Serial.println("Nenhuma eletricidade detectada.");
  }

  // Aguarde um pouco antes de fazer uma nova leitura
  delay(500);
}
```

Fonte: Autoria própria (2024)