USING INTERNET OF THINGS AND MAKER CULTURE FOR TEACHING FIRE DETECTION SYSTEMS IN HIGH SCHOOL

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Abstract

Large fires can arise suddenly and grow rapidly depending on the intensity and speed at which the fire spreads, and can become uncontrollable in a short time. The decision to control material damage and rescue people safely must be assertive. For this, alarm and fire detection systems are an important tool for making quick, safe decisions, preventing the spread of fire. In Brazil and in other parts of the world, tragic episodes have already occurred showing that the losses of not investing in preventive measures in this area can be incalculable. Non-compliance with safety standards, lack of maintenance and precariousness of fire prevention and fighting equipment are some of the factors that contribute to fires reaching dramatic proportions. In order to help and solve this problem, residential and/or business buildings, as well as industrial areas, can be made safer by combining traditional prevention methods associated with Internet of Things (IoT) devices. Aiming to guarantee an immediate and safer response, this paper proposes the development of an alarm and fire detection system associated with the use of IoT, in which there will be continuous data collection and automatic communication of sensors emitting alerts and messages indicating the conditions and measurements of the temperature sensors, helping efficiently in preventing and fighting fires. Our chosen approach also aims to teach High School students of a public school in Brazil the concepts and tools of IoT with Maker Culture, along with the application of alarm system and fire detection. The results obtained show the viability of our proposal.

Keywords: Fire Detection, Maker Culture, Internet of Things Teaching.

1 INTRODUCTION

Often, most students come from educational models that promote the passive reception of knowledge and are used to depending on the teacher as a source of fixed and definitive theoretical concepts. In addition, being the traditional method of teaching and common use in teaching practice in Brazil and in other parts of the world, it is also a challenge for teachers to develop and apply active teaching methodologies in actions that promote autonomy, research in groups and that generate an investigative learning environment [1].

Among the active teaching methodologies, Maker Culture is present in several fields, such as fashion, arts, architecture, communication, engineering, education, among others. However, according to Gershenfeld (2005) [2] the limiting factor for the diffusion of the maker movement is not located in a technical barrier, but in the lack of disclosure regarding its application potential. However, developing skills such as initiative and proactivity in students are also key elements when using the maker culture.

However, without reasonable collaborative behavior, wrong decisions can occur. A good communicative posture and clarity of ideas make up, in the context of the learning-by-doing culture, desirable principles for future professionals in a knowledge society. In addition, factors that include adaptations to context changes (problem situations), critical thinking and 'learning to learn' contribute to the profile coveted by companies, industries and corporations.

Allying with constructivist learning processes, there are the terms “low floor”, “high ceiling” and “wide walls”, which are the mantras that govern the development work of Maker Culture at the MIT Media Lab. Seymour Papert, mentor of the Lab, has always emphasized that, for a technology to be effective, it must not only offer accessible gateways for those who do not know it to be enchanted and start without difficulty (low floor), but also possibilities for evolution with increasingly challenging projects over time (high ceiling). Complementing Papert's thinking, Mitchel Resnick adds an extra dimension: wide walls. He believes that it is not enough to provide a single path – from low floor to high ceiling. It is also necessary to offer “wide walls” so that children can have different options of paths to go from “floor” to “ceiling”, each building their own learning journey [3].

Thus, this article presents an application in the Maker Culture involving Internet of Things (IoT), which consists of a fire detection system, involving High School students with a graduate and a post-graduate student in Internet of Things.

The choice of the theme of fire detection systems is due to the fact that tragic episodes continue to occur in Brazil, which show that the losses of not investing in preventive measures in this area can be incalculable. Among the most recent cases, the almost total destruction of the National Museum in Rio de Janeiro shocked the country. The flames quickly spread through the historic building, destroying a collection of almost 20 million pieces and artifacts with incalculable historical and cultural values [4].

Non-compliance with safety standards, lack of maintenance and precariousness of fire prevention and fighting equipment are some of the factors that contribute to fires reaching dramatic proportions. In order to guarantee an immediate response, with greater security and in compliance with Brazilian legislation and international standards, a proposal arises to develop an alarm and fire detection system associated with the use of IoT in which there will be continuous data collection and automatic communication of sensors issuing alerts and messages indicating the conditions and measurements of the temperature and carbon dioxide sensors, efficiently helping to prevent and fight fires.

2 METHODOLOGY

The fire detection system was developed through the integration of knowledge in the areas of Programming, IoT and Electronics. We used the Telecommunications Laboratory of the Federal Institute of Amazonas Campus Manaus Distrito Industrial (IFAM CMDI), with the following materials:

- ESP32 [5] DEVKIT V1;
- MQ-135 Gas Sensor (polluting gases, for example, carbon dioxide);
- DHT11 humidity and temperature sensor;
- Breadboard;
- Jumpers (for electronic circuit connections);
- Resistors;
- Identification LEDs (green for safe environment and red for fire detection).

Fig. 1 shows High School, Higher and Graduate students interacting to assemble the circuit and program the ESP32 using the Arduino IDE. In turn, Fig. 2 presents the schematic diagram of the circuit realized in the Fritzing software. It is important to point out that in the schematic diagram of Fig. 2 only one other type of gas sensor appears, just the alcohol detection one (MQ-3), while in the physical circuit the polluting gas sensor (MQ-135) appears. And Fig. 3 presents the circuit physically assembled. In this system, with the values obtained from the temperature and gas sensors, the data, when processed by the ESP32, are sent via Wi-Fi to a web page that shows whether or not there is a fire (fire alert).

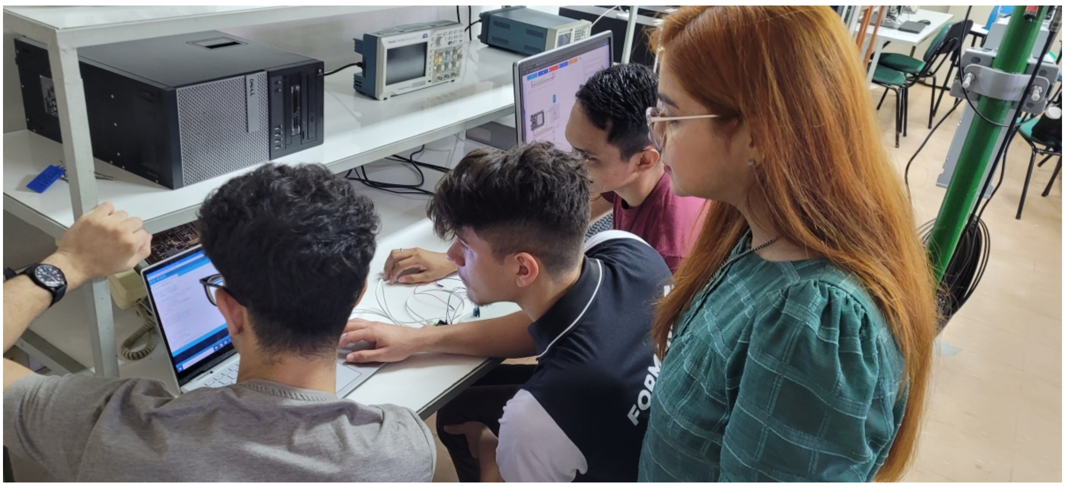

Figure 1. Students interacting in the development of the system.

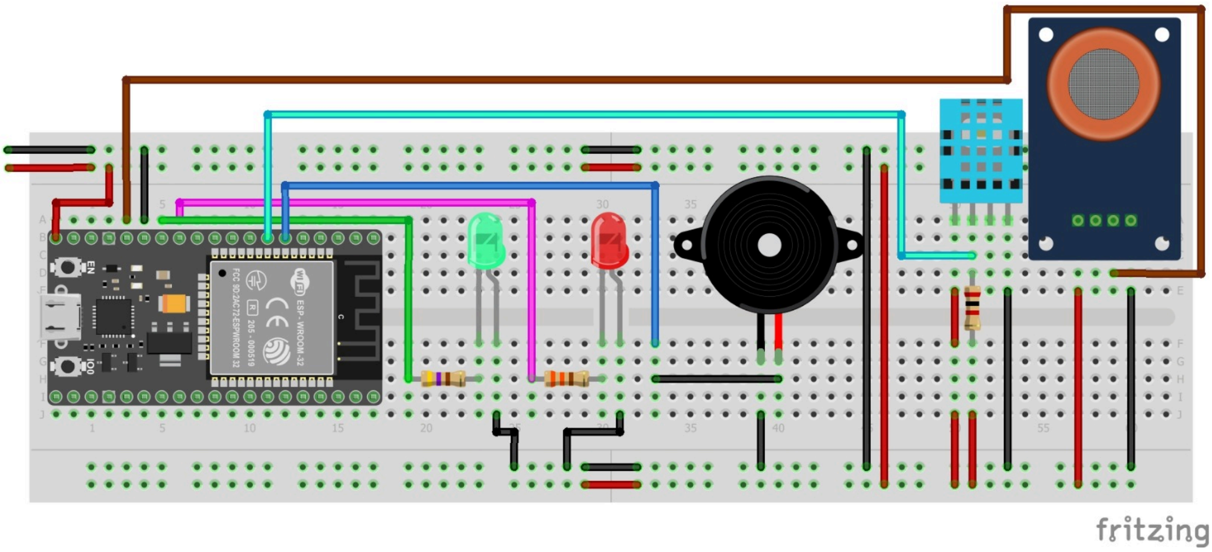

Figure 2. Schematic diagram of the assembled circuit.

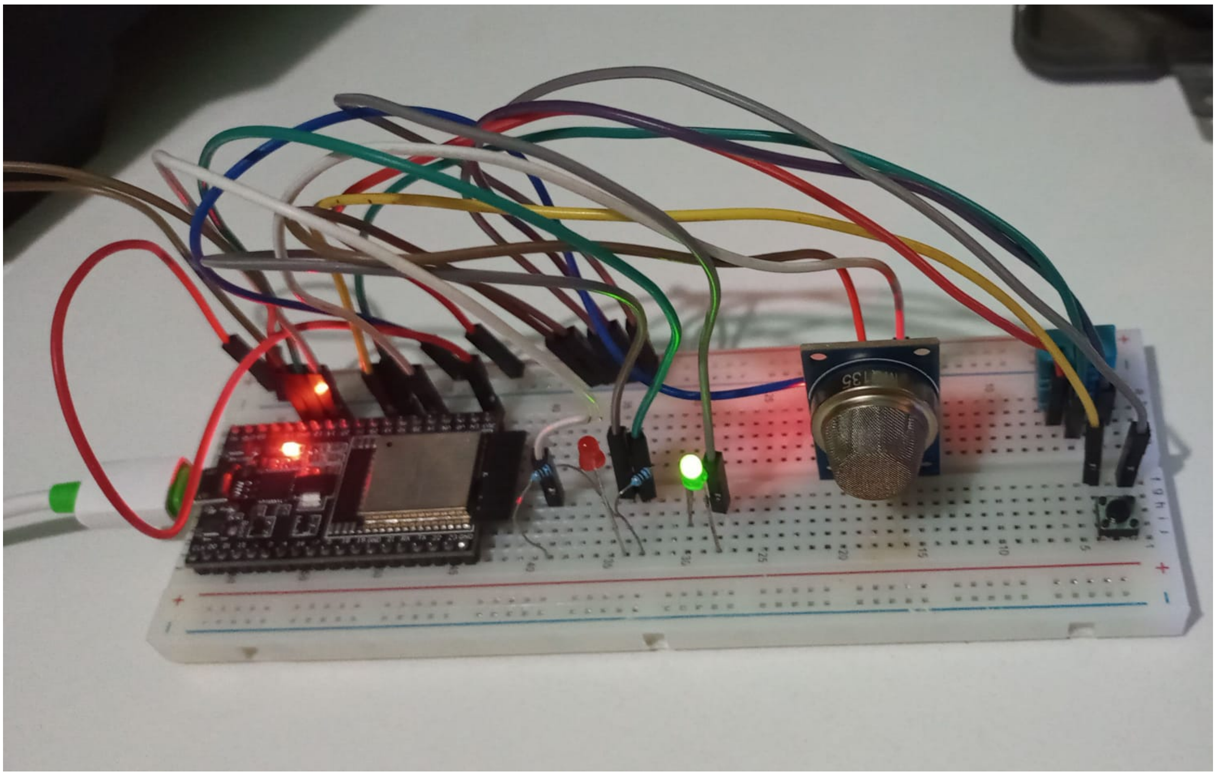

Figure 3. Circuit assembled physically.

After the circuit was assembled, the programming was elaborated after identifying the data input, processing and output procedures, as shown in the flowchart of Fig. 4 below. The temperature and gas sensors identify the possible fire data (Read Values), where, through processing (Process), it is verified whether or not there is a risk of fire and if so, it issues an alert (Action).

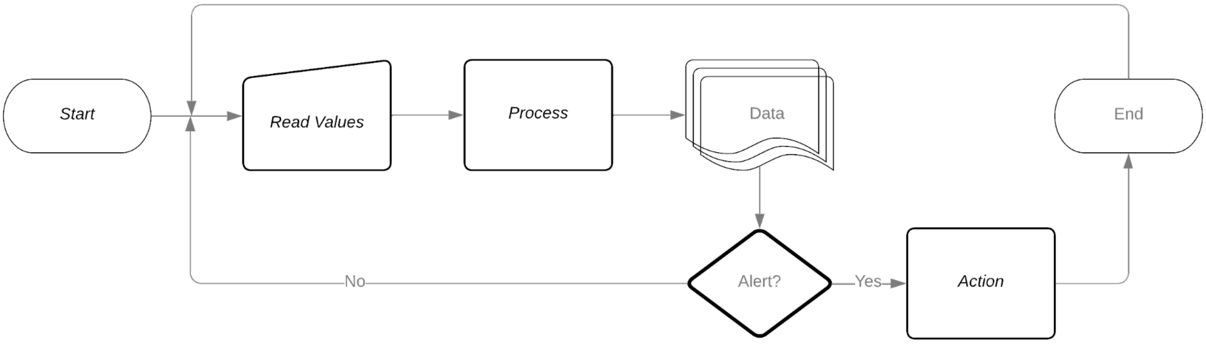

Figure 4. Project Flowchart.

After identifying the stages of data input and processing development, the data is stored and presented to the user. And through the pre-configured environmental conditions (temperature, humidity, among others), a message is issued informing the environment condition. In the event of an unsafe environment, a message is sent to the building's fire brigade/team to take immediate action. This alert message is sent via Wi-Fi by the ESP32 device, based on the reading of data from the gas and temperature sensors. System programming was developed in Arduino IDE. Fig. 5 shows a screen where there is a fire alert.

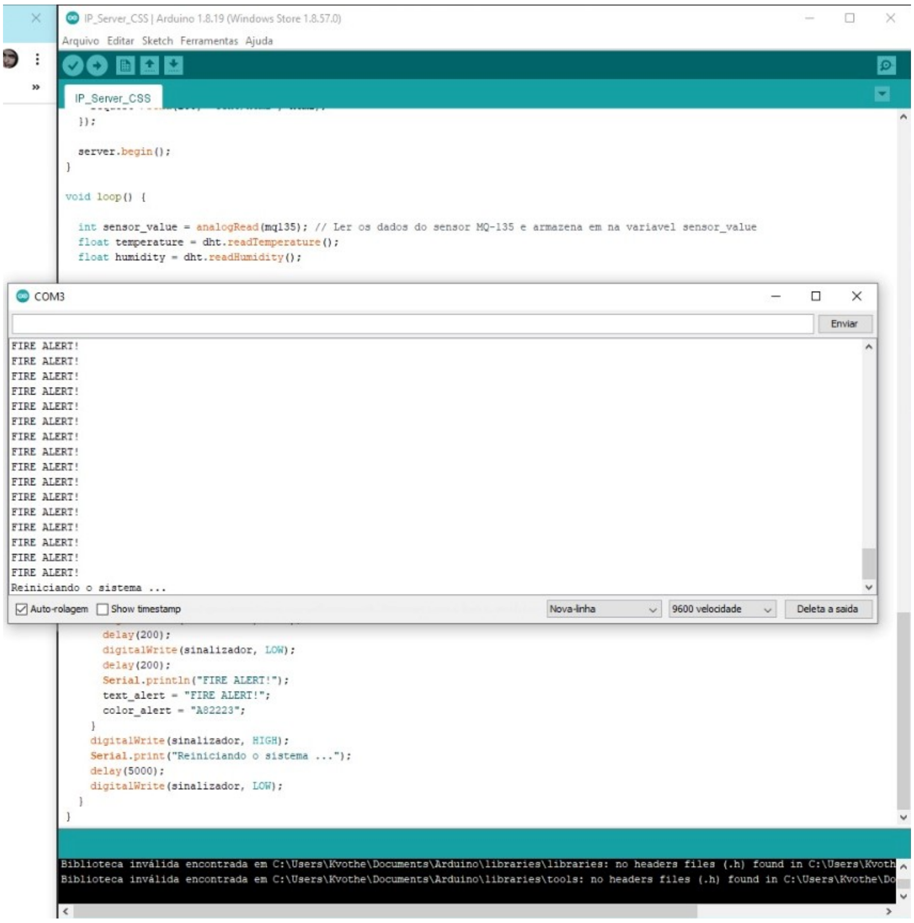

Figure 5. System programming in Arduino IDE with fire alert.

Physically, the program was connected to electronic components as shown in Fig. 3 following the wiring diagram in Fig. 2.

3 RESULTS

As a result of data processing, Fig. 6 shows the interaction screen between system and user, in which one of the cases for the alert system is presented. In this situation, the environment is fire-free. In Fig. 7, there is a situation in which a fire was detected. Smoke concentration is in parts per million (ppm). Temperature is in Celsius degrees.

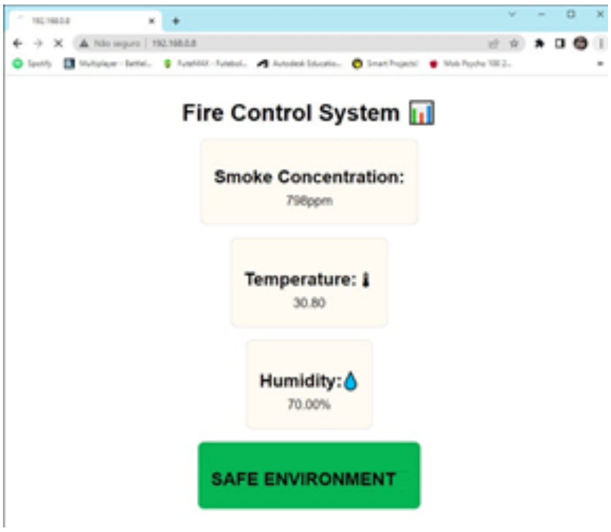

Figure 6. Safe environment, no fire.

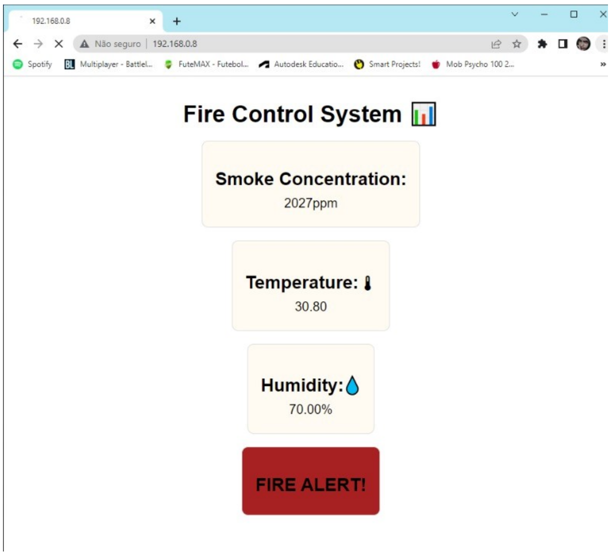

Figure 7. Fire alert.

During the execution of this project, a team of 3 levels of education worked together, whether building the system or developing software and hardware. It was possible to integrate social, professional and personal skills. The union of efforts and interaction of the team sought the most viable solution of the application and solution of a real case through integrated knowledge in the areas of Electronics, Computing and professional experiences. And this resulted in a combination and sharing of fundamental skills for any type of organization, where we noticed a development of soft skills in the team, based on their interactions, sharing knowledge. This is even one of the characteristics of the Maker Culture, seen in the hands-on activities.

The particularity of this teamwork was organized and coordinated through a common mentor who promoted networking and facilitated cohesion and decision-making to achieve the success of the shared objective.

4 CONCLUSIONS

This article presented an approach that unites Culture Maker and Internet of Things applications in order to teach fire detection systems, involving different concepts and technologies, such as sensors and actuators and an ESP32 microcontroller. In addition, this work involved a graduate student and high school and higher education students. The integration between different levels of education allowed for a dialogue for sharing knowledge, as well as obtaining results and learning that are useful for the world of work and in the training of students at all levels. With the concepts learned, students were able to develop more complex systems closer to real life. As future work, our approach should involve the participation of other students who use the system, as well as design systems that analyze other situations, such as a system with different gas sensors.

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