RADIO FREQUENCY SAFETY DEVICE APPLIED TO CHAIR CHILDREN IN CARS

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ABSTRACT
The article aims to present a prototype device able to identify and warn those responsible when there is a possibility of forgetting of a child inside the car, thus avoiding an injury to the health of the child or even death. To this effect electronic sensors able to detecting the presence of the child on the chair have been used, microcontrollers (Arduino Uno, Arduino Nano) programmed to perform the data processing, wireless communication module (XBee) to perform the transfer of data between the chair, and a specific key chain, and ultimately actuators responsible for a possible warning against forgetting a child inside the car. Generally speaking, this article comprises concepts involving instrumentation and programming. This paper has the effect of academic results, nowadays there are not many studies concerning the proposed theme and its application is highly viable because of the relatively low cost, making it accessible to all social classes.

Keywords: Instrumentation, programming, Microcontrollers, XBee, child care

1. INTRODUCTION

Rush of day-to-day marks society and the constant change of scenery happens especially in large cities. These changes occur constantly and it is necessary to one adapt itself in real time, since the change of routine can give rise irreparable accidents such as the forgetting of a child in a closed car, damaging the child's health or taking this child death.
In recent years, news emerged of several cases of forgotten children inside vehicles, facts that shocked society. For this reason, the idea of creating a device that detects this possible occurrence arises. To design the device, the use of two microcontrollers was necessary, as well as two wireless communication modules, sensors and child safety car seats.
Is it worth it? In Brazil, there are no official statistics on such occurrences. However, in the United States, KidsandCars NGO which deals in all types of accidents involving children and cars, has counted 550 cases have been counted since 1998 (Buzzinaro 2016).
One must consider that the issue concerns children who are not able to care for themselves, and would have had a whole life ahead. There is only one life, there are many lives that have to deal with this loss, a father, a mother, a brother who will always miss the child who was in the car. So, this mistake is unacceptable.

2. OVERVIEW

Thinking about the safety of children, a control prototype with a baby chair was developed by adapting Arduino boards, XBee modules, two pressure sensors, one for the seat and one for the locking of the chair seat belt actuators as LEDs, buzzers and vibration motor.
The following is the operation of the two parts of the system, the first chair and the second key chain.

2.1. Chair Operation

The chair system is composed of: 1 Wireless communication module (XBee Series 2 Pro); 1 USB adapter for XBee Explorer; 1 Arduino Uno Rev 3; 1 Buzzer; Leds; 2 Pressure sensors (buttons Normally Open); 1 Key ON / OFF; 9 V battery.
The process starts with the positioning of the chair in the car without the need for car modification for installation of the device. It will just a need to connect the battery charger in the car's cigarette lighter.
After correctly position and connect the chair is then triggered the ON / OFF switch which in turn activates the chair system. Therefore, the control variables responsible for managing communication between the chair and the keychain are initialized.
The system will check if there is "Child in the car," if there are not triggered the alarm and return to the state sends signal. If there is a new check will be performed to determine if the child has been forgotten or not.
However, if the child has been not forgotten, the alarms will not be triggered and the system returns to step "send signal", otherwise the alarm will be triggered.

2.1.1. Operation Diagram - Chair

Following it is shown the operating diagram of the chair and its respective steps.

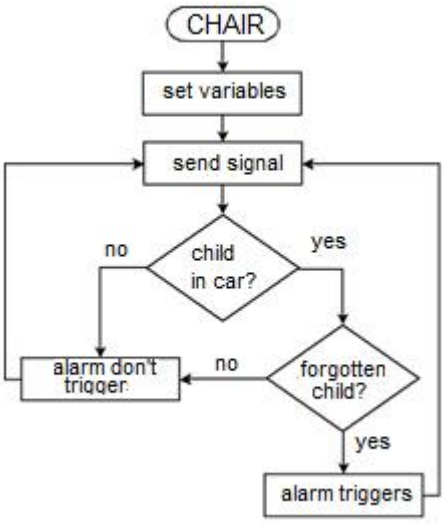

Figure 1: Chair - Operating Diagram

- Set variables: Step responsible for setting the initial conditions of the system;
- Send Signal: Step responsible for reading the signals obtained from the chair sensors and sending signals to the keychain module;
- Child in car: Step comparative data obtained from pressure sensors;
- No Triggers Alarm: Failing a child forgetting, not the actuators will be triggered;
- Forgotten Child: Step comparative where sensors identify if the child has or has not forgotten;
- Alarm triggers: Identifying a possible forgetting, all actuators will be triggered;

2.2. Keychain Operation

The keychain system is composed of: 1 Wireless communication module (XBee Series 2 Pro); 1 USB Explorer Adapts pain for XBee; 1 Arduino Nano, 1 Buzzer; Motor Vibratory; Leds; 1 Key ON / OFF; 1 9v battery; 4 buttons.

The process starts with the key drive ON / OFF which in turn will activate the keychain system. Then beginning the control variables responsible for managing communication between the chair and the keychain.

The system checks whether the keychain is enabled or not. If ceste is not, the system will be redirected to step sends signal and the keychain will only be reactivated if the password is entered correctly, or if it is more than 1 minute near the chair. If enabled it will check whether there is "Child in the car," if there are not triggered the alarm and return to the state sends signal. If there is a new check will be performed to determine if the child has been forgotten or not.

If the child is not forgotten, the alarms will not be triggered and the system returns to step sends signal. If it is forgotten, the alarm will be triggered.

2.2.1. Operating Diagram - keychain

The keychain operating diagram and their steps are shown in the following figure.

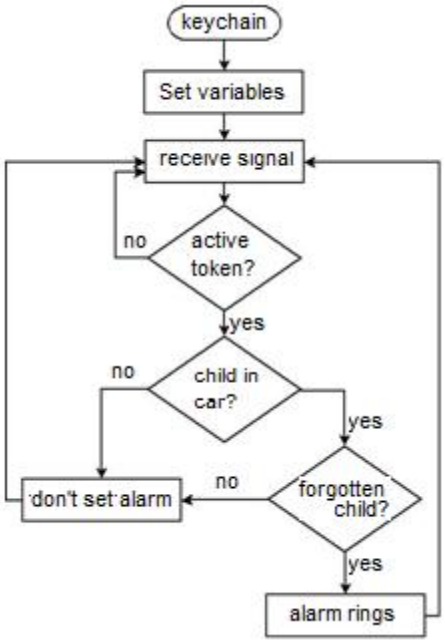

Figure 2: keychain Operation Diagram

- Starts variables: Step responsible for setting the initial conditions of the system;
- Receives signal: Step receiving the data sent by the chair and it is also responsible for the activation Keychain with the buttons;
- keychain Enabled: Checks the current state of the Keychain control variable.
- Child in the car: Step comparative data obtained from pressure sensors, via wireless communication;
- No Triggers Alarm: Actuators are not triggered if the child is not inside the car.
- Forgotten Child: Step comparative where sensors identify if the child was or was not forgotten;
- Alarm triggers: All actuators will be triggered, because there is possibility of a child have been forgotten inside the car.

2.3. Module Wireless XBee Communication

The name Xbee module refers to a family of radio frequency modules developed by Digi International. These are responsible for managing a wireless network using the IEEE 802.15.4 protocol (The Institute Electrical and Electronics Engineers).

The XBee is widely used in control systems, as aside from present reliability data transmission. It also presents low cost and low power consumption, which is important for applications in difficult remote access systems where the use is necessary of a battery.

Figure 3: XBee Series 2 module Pro

2.4. XBee USB Adapter

The adapter is used to regulate the input and output voltages in order to protect the XBee modules, once these have a supply voltage of 3.0 - 3,4V and Arduino 5V voltage.

This also offers a means of serial communication with the PC via a mini USB cable, and you can then set the XBee using X-CTU, practical and safe way.

The component has a dedicated pin called RSSI (Received Signal Strength Indicator) having an output modulated signal PWM (Pulse-Width Modulation), this in turn is read by Arduino and converted to decibels being used as a parameter to estimate distances.

Figure 4: XBee USB Adapter

2.5. X-CTU: XBee Programming Software

The X-CTU is a software developed by Digi International used to configure and test all its radio frequency products. This has compatibility with Windows operating system and has a very friendly graphical interface for handling.

This software can run in parallel, or may be open over an X-CTU a time. This feature allows the user to test and configure the communication between the radio frequency modules fast and reliably.

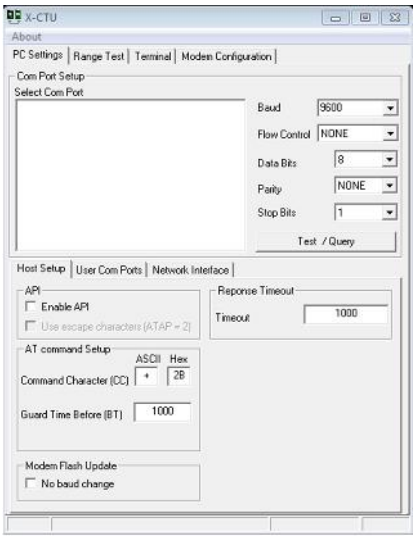

Figure 5: Programming Software and Test XBee (X-CTU)

2.6. Arduino Platform

The Arduino platform was developed with the intention of reduce costs for school projects because the prototipagens systems by this time had a high value.

Currently this technology has become quite popular and has many applications. It can be applied in simple control systems, such as opening and closing a gate, or even be implemented in an industry.

The Arduino has a microcontroller of ATMEL family, this is responsible for managing the data as a previously defined and determined programming. To insert a program in the controller chip, a compatible programming software is required, and this can be purchased on their official website (AVR 2012, Arduino 2016)

2.6.1. Uno Arduino Specifications

In this prototype, the Arduino Uno was used in the chair because this meets the requirements for the prototype. The following Figure 6 representing the Arduino board and a table of specifications.

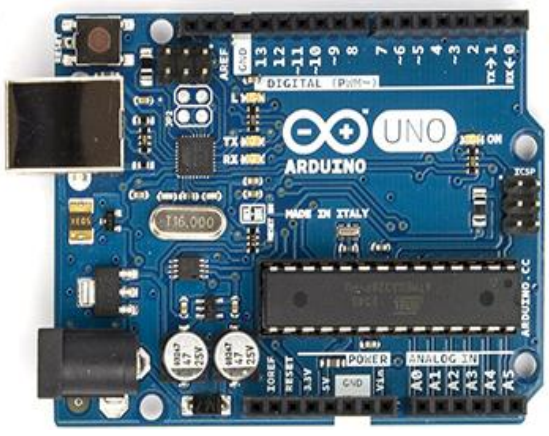

Figure 6: Uno Arduino

Table 1: Uno Arduino Specifications

Specifications	Uno Arduino
Microcontroller	ATmega328
Voltage Operation	5V
Input Voltage	7-12V
Input Voltage Limit	6-20V
Inputs / Outputs Digital	14 (6 PWM)
Analog Inputs	6
DC For I / O	40 mA
Flash Memory	32 KB
Sram	2 KB
Eeprom	1KB
Clock Speed	16 MHz

2.6.2. Nano Arduino Specifications

To construct the keychain was necessary to save the maximum space possible, for this reason that was used in this prototype Arduino Nano. In figure and the following table is observed settings.

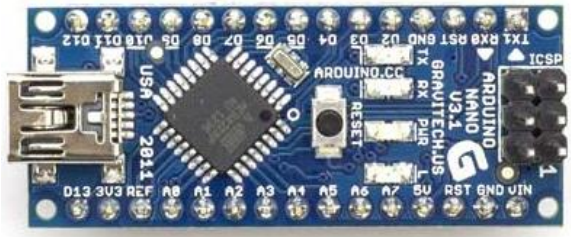

Figure 6: Nano Arduino

Table 2: Nano Arduino Specifications

Specifications	Nano Arduino
Microcontroller	ATmega328
Voltage Operation	5V
Input Voltage	7-12V
Input Voltage Limit	6-20V
Inputs / Outputs Digital	14 (6 PWM)
Analog inputs	8
DC for I / O	40 mA
Flash memory	32 KB
SRAM	2 KB
EEPROM	1KB
Clock Speed	16 MHz

2.6.3. Arduino IDE

The code needs to be entered in the Arduino memory, so it was necessary to use an IDE (Integrated Development Environment). The IDE provides the necessary tools known as toolboxes for the development of the code in WIRE programming language also able to compile and submit the code in hexadecimal to the microcontroller (Banzi 2011).

Its basic structure is composed of a function known as voidsetup () and the other as voidloop ().

The first is characterized by the initialization of variables or functions that will be used in the system.

The second function represents a loop where all the code that is inside the loop will be repeated constantly.

The IDE seen in the figure below shows a simple and friendly interface functionality. Some code examples are supplied to further facilitate the user's life and programmer, this way they will assist in the development of the prototype (McRobert, 2011).

2.7. Sensors and Actuators

To identify the presence of a child in the car, it is necessary to monitor the physical variables, in this case two components were considered: the locking of the seat belt and the pressure on the baby seat. This monitoring is done via pressure sensors, which are represented by buttons. By finding an abnormal situation the microcontroller sends a signal to the actuators in order to alert the responsible of possible forgetfulness of child or baby. There are three types of actuators used in the prototype: the sound (buzzer), light (LEDs) and mechanical (vibration motor).

3. PROPOSED SYSTEM DEVELOPMENT

To develop the prototype was necessary to use some electronic components, which are easily accessible and low cost. The following issues will be demonstrated the development stages of the safety device.

3.1. Construction of the Chair and Keychain

This topic is intended to present the development of the electrical circuits through Fritzing software, sensors and actuators of the chair, as well as their descriptions.

3.1.1. Electric Buzzer System

The Buzzer is an actuator in order to warn, sonically, because there has been a possible anomaly. It has been implemented in both the keychain as the chair and your electrical circuit can be seen in the following figure.

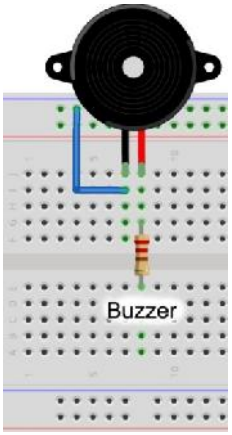

Figure 7: Electric Buzzer System

This subsystem has a track called Buzzer. It should be connected to an Arduino digital port for proper operation. moreover, it was necessary to add a resistor 220ohms to limit the system current.

3.1.2. Electrical System of Switches

The switches are touch sensitive sensors and normally open type. They were separated into two subsystems, one for the chair and the other to the keychain. In figure 8 can be seen the two pressure sensors simulating the belt sensor and the seat.

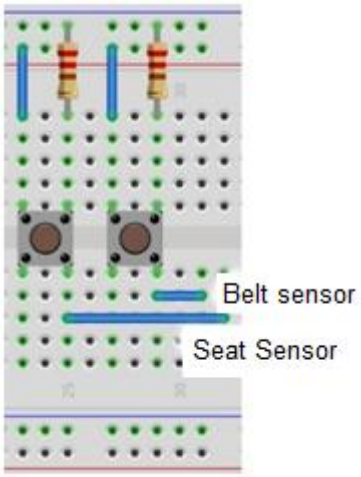

Figure 8: Belt and Seat Sensors

The second is represented by four pressure sensors. They are responsible for entering the password for the activation and deactivation of the keychain, if required. The figure below demonstrates the electric scheme.

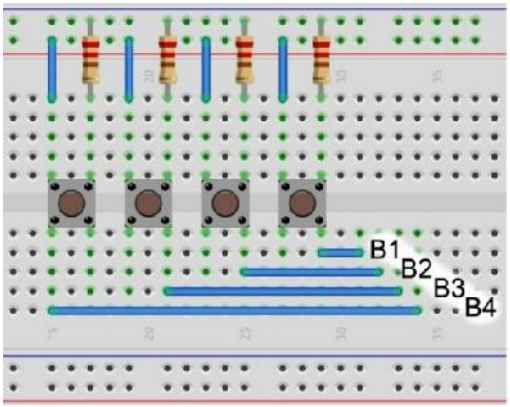

Figure 9: keychain Sensors

These systems have 10k ohm resistors that are required to limit the current Arduino and also to ensure the logic level 0 when the actuator is not actuated.

3.1.3. Electrical system of the LEDs

LEDs have intended to visually alert the current system state. It is divided into two modules, one for the seat and one for the keychain.

The first features 8 LEDs of which 6 are to draw the attention of people passing around the car and 2 to indicate the System Figure 10 connection.

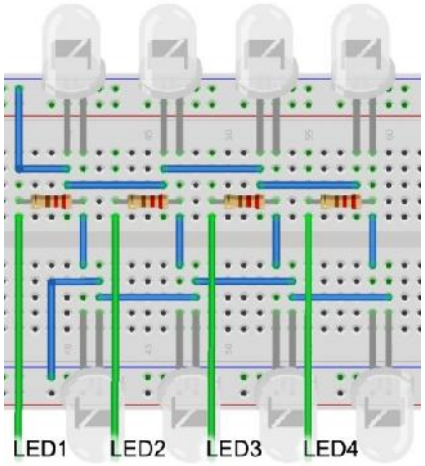

Figure 10: Set of LEDs Chair

The second contains 4 LEDs, where 2 to indicate the system connection (green LED and red LED), one for the active function on / off keychain (blue LED) and the last to indicate the alert status (Yellow LED).

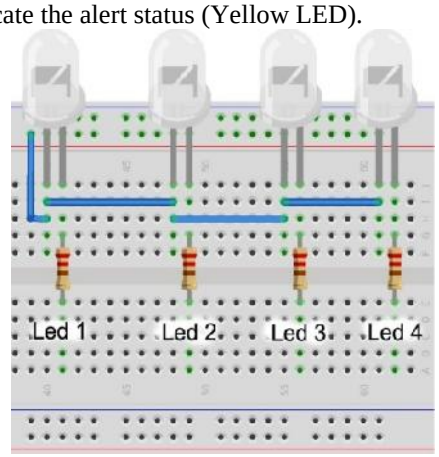

Figure 11: Set Keychain LEDs

For the system to control the current were used 220 ohm resistors in keychain LEDs and 160 ohms in LEDs chair.

3.1.4. Electrical System - Vibratory Motor

This subsystem has been implemented in keychain as mechanical warning means in case of a possible oblivion. In the following figure is shown the electrical system of the vibratory motor.

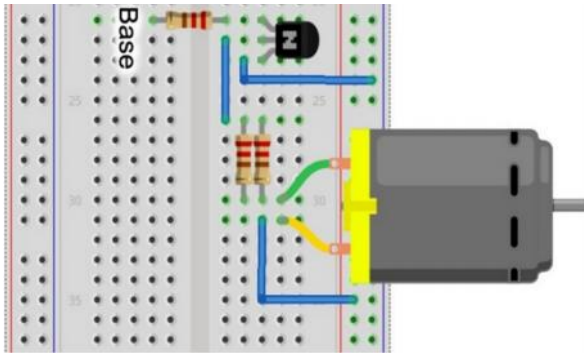

Figure 12: Set Keychain LEDs

The vibrator module requires a greater current, in this case adjusted to 60 mA, but to avoid damaging the digital output Arduino, limited to 40 mA, it was necessary to use an NPN transistor (BC-368) to perform the switching of the same.
The BC-368 transistor has three pins, which are the base, collector and emitter. The first, to be excited, is responsible for controlling the current between the collector and emitter. The second is introduced into the device to be switched with the 9V battery voltage. Finally, the third is connected to GND where the current collector and the base will be added. The resistors have base and collector, respectively, 1kohm and 220 ohms (two in parallel generating a total resistance of 110 ohms.

4. RESULTS

The tests were performed with the device inside a car simulating a baby seat in the back of it. Through physical testing were obtained some data concerning the distance in meters.

Table 3: Tests Distance in Meters

Local	Description	≈ 65dBm	≈ 10dBm	Loss of Signal
CAR (Open Place)	When the place where the car was parked, do not have significant obstacles exist for reducing the frequency between XBee modules.	24 meters	12 meters	128 meters
CAR (Closed Place)	When the distance is near a closed space, causing the keychain and the chair to communicate with interference from the walls.	16,4 meters	8,3 meters	87,6 meters

When the frequency between the XBee's arrived at approximately 65dBm, when the alarm was triggered and subsequently approximately 10 dBm, when the alarm was tripped. This occurs by the approach of key chains to the car in which the seat is installed. The table above illustrates very well the data acquired.

5. FINAL REMARKS

The proposed system has proved to be an excellent technology solution for frequent events in society. The device was built with low-cost equipment, easy purchase and installation. Initially your wireless communication module XBee showed the more complexity in the development of the project, because it requires an adapter for regular supply voltages and control, and the reason for its configuration parameters require more compared to previous models.
Due to the utilization of signal power to estimate the distance, the system did not show a good precision, but is sufficient to develop the prototype. This read signal varies with the distance and the amount of obstacles between the transmitter and the receiver.
The keychain interface is only representative because it contains components that can be used in a more sophisticated and smaller model. Regarding the use of the seat, installed sensors served to simulate the resistive sensor and the seat belt in it, because the application in a real car seat would take much time and equipment purchase and provision would be necessary. After some contacts with companies supplying of the device, they have not demonstrated interest in developing the product. However, the result of this project was satisfactory and proved to be very promising for the development of vehicle safety in the industry, despite not having any support from manufacturers.
As a proposal for future work recommended further study of signal in dBm over the distance in meters, taking into account the influences that the physical environment has on the system making it thus more accurate.

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