Proposal of Social Inclusion for Visually Impaired Pedestrians: Prototyping of an Intelligent Traffic Light using Arduino

Willian da Silva Ladeira[1] , Paulo Henrique Silva Lopes [2]
[1]*Student of Industrial Engineering, Faculdades Integradas de Cataguases-FIC*
[2]*Specialist in Engineering and Maintenance Management, Universidade CândidoMendes-UCAM*
Cataguases/MG, Brazil

Abstract

This article aims to present the development of a prototype using a micro controller, as a possible alternative to inclusion and traffic safety for pedestrian's bearers of visual impairment, aiding in its pedestrian crossing in bjj. We adopted the use of the Arduino UNO board to control, and its interface to program in C/C++ language, the entire operation of the elements that compose the prototype. For the representation of the functioning of a real traffic, we used PVC tubing, being made holes for the leds and snap the modules, Button and sensor. The prototype has met the expectations, the button, the sensor and the modules (ISD1820), responding to the command of the micro controller, in which the message emitted from the speakers are able to instruct the visually impaired to a crossing with security.

Keywords - *traffic lights. Visually impaired. Assistive technology. The Arduino.*

I. INTRODUCTION

Social inclusion is a theme that is increasingly being discussed and gaining prominence in discussions of society as a whole. People who have some degree of disability physical or visual, have greater difficulty of integration into common activities performed on a daily basis, thus making the intelligent cities would be a step forward for the security of the same.

It is common for people with visual disabilities need the help of third parties to perform some activities of daily life, how to locate objects and read instructions. However, autonomy and independence of locomotion of the visually impaired are perceived as of extreme importance for both the physical, as well as to the psychological and social development, bearing in mind that these people have the right to come and go freely.

The data of the last demographic census of the Brazilian Institute of Geographicalraffia and Statistics [1], show that Brazil has 35.7 million people with visual disabilities, among people who claim to have visual impairment, more than 6.6 million said they had difficulty in severe form and 6 million said they have difficulty seeing, more than 506 thousand reported being blind. Fig. 1 brings these data more clearly.

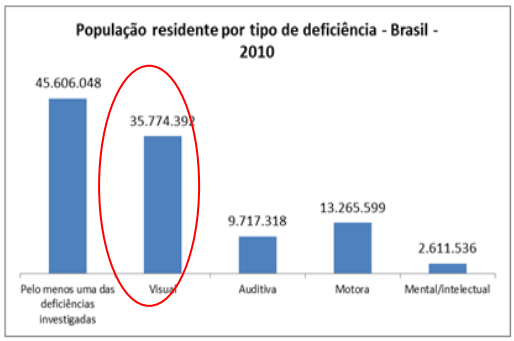

Fig. 1 - People with disabilities in Brazil

It is therefore easy to understand a little more about the aspects of visual impairment and its need in relation to the recognition that the independent locomotion enables and contributes to the improvement of the self esteem of the person with visual impairment, and consequently, associated to other factors, leads to improvement in the quality of life of these individuals.

For the Brazilian Association of pedestrians [2], the society is composed of groups of pedestrians with different needs to be met in order to ensure them disabled walk with safety and comfort; a person during his life, due to the time and the adverse events, may have special needs similar to those of other citizens born with reduced mobility, whose difficulties, too, can be overcome or softened with scientific progress.

Analyzing the current Brazilian scenario, you can see the little or almost nothing is trying to help tone the pedestrians at traffic lights in cities. The National Traffic Council [3], given these facts, adopted Resolution No. 704, which requires the installation, throughout the Brazilian territory, sound lights on public roads of wide circulation. For the implementation of this system has been set a deadline until 31 December 2019. "This resolution establishes standards and criteria for signaling semafórica, standardizing the audible, visual, compactors and modes of use of the equipment and is in accordance with the Law 10,098, of 19 December 2000".

The present work is justified on the basis of surveys, data collected, observing all the need of improvement that can be attributed to pedestrians with visual disabilities.

The objective of this work is to develop a prototype for the environment of transit, which facilitates the mobility and accessibility for pedestrians with visual disabilities, through messages issued in self-speakers, which respond to the sign of a presence sensor controlled by a micro-controller. Taking as a second alternative, a button *push button* will perform, if pressed, the same function as the PIR presence sensor, reinforcing the attention of other pedestrians.

The present work has as specific objectives:

- Search the types of difficulties encountered by visually impaired from day to day,
- Search on similar works already proposed,
- Present the benefits imposed by assistive technology,
- Analyze all the conditions necessary for the operation of the traffic light,
- Search components that meet the functioning of the project,
- Develop a schedule on the Arduino IDE,
- Perform tests with the prototype developed.

II. LITERATURE REVIEW

This item has as proposal describe the key theorists who shall base this article, being explored the themes, assistive technology; classification or types of assistive technology, social inclusion of the visually impaired.

A. Orientation and Mobility of Visually Impaired

Some of the priorities of people with disabilities are accessibility and urban mobility, which characterize the movement of disabled people by cities. "The exercise of the right to "come and go" is more significant for the self respect and personal dignity, that employment or social position of prominence"[4].

Second Baggio *et al* [5], the visual impairment, in any degree, undermines the ability of locomotion of the person with security and independence. Some authors consider the limitation in orientation and mobility the most serious effect of blindness.

Still according to Baggio *et al* [5], the visually impaired, they argue that the greatest difficulty found to integrate socially and live with dignity is the conquest of autonomous locomotion, i.e., without the aid of another person.

In the World Health Organization conference [6], as *World Report on Disability* (World Report on Disability), the disability results from the interaction of people with environment in which they live, having difficulty to overcome the obstacles or situations, and cannot be considered as an attribute of the person.

B. Assistive Technology

Assistive Technology is a term that was implemented in Brazil in 1988, had its origin in the word in English *assistive technology* being its function to differentiate some equipment from other doctor and hospital area and padronizá them [7].

Assistive Technology is an area of knowledge, of the interdisciplinary characteristic, which encompasses products, resources, methods, strategies, practices and services that aim to promote the functionality related to activity and participation of persons with disabilities, disability or reduced mobility, aiming their autonomy, through the expansion of their functional skills to promote independence, quality of life, accessibility and social inclusion [8].

Second Kleina [9] this technology can contribute with people who have disabilities, and in this case, will be treated specifically with visual impairment.

Kleina also says that, when it is used some type of tool or device, it is possible to provide new possibilities for visually impaired, as for example, greater freedom, quality of life and social inclusion, thanks to increased communication, mobility, environment control, learning, work, family and friends [9].

C. Legislation

In Brazil the assistive technology has assumed other names: as adaptation, technical aids; subsistence support among others. With the aim of standardization, laws were created.

Decree no. 5,296, 2 Dec 2004, in its Art. 5, Para. 1 , SECTION I defines:

(c) visual impairment - blindness, in which the visual acuity is equal to or less than 0.05º in the better eye, with the best optical correction; low vision, which means visual acuity between 0,3º and 0.05º in the better eye, with the best optical correction; the cases in which the sum of the measure of the visual field in both eyes is equal to or less than 60°; or the simultaneous occurrence of any of the above conditions [10].

In relation to Assistive Technology, Brazilian law of inclusion of people with disabilities (status of the person with disabilities) Lei nº 13.146, de 6 de julho de 2015, says in his article 74 "is guaranteed to the person with a disability access to products, resources, strategies, practices, processes, methods and services of assistive technology to maximize their autonomy, personal mobility and quality of life."[11]

III. MATERIALS AND METHODS

At this stage of the work shall be presented concepts, definitions, techniques and tools that served as the basis of the development of the prototype. All

sources of figures and tables mentioned in this study are those of the authors of this study, with the exception of figure 2.

A. Structure of the Prototype

As shown in Table 1 are described the components used for the construction of part of the circuit and the proposed prototype. Were described the quantity of items to compose the prototype according to Q*= quantity in the table below.

Items	Description	Q*
The controller	The Arduino UNO R3	1
Module	Voice recorder /ISD1820	2
Module 2	Mini PIR sensor HC-SR 505	1
IR Leds	Red/Yellow/Green.	2/1/2
Speaker	8 Ω AND 0.5W	2
Jumper cables	Premium 20 cm/ male and female	20
Source	5 v/ 2ª	1
Protoboard	400 points	1
Resistors	100 Ω	6
Button	*Push Button*	1
Pipe	PVC	1m
90° Curve	1/2 PVC	1
Reducing Bush	25x20mm	5
Reducing Bush	50x25mm	1

Table I - Items Described For The Construction Of The Prototype

B. The Arduino

Figure 2 brings a model of the Arduino board, the UNO Rev3, chosen for the prototype due to its low cost and its practical form of programming.

Arduino is a physical computing platform, in which digital systems connected to the sensors and actuators are capable of measuring variables in the physical environment, perform numerical calculations, and make logical decisions in the computing environment. [12]

Fig.2 - Arduino UNO Rev3

The Arduino UNO, will be responsible for controlling the whole process. Can be programd in an environment of the platform itself, in a practical and didactic, allowing the implementation of modules and communication with other components as listed below in the following topics.

A. PIR Sensor

The mini PIR sensor HC-SR505 as Fig.3, uses infrared sensors to detect the movement of people, and thanks to its size can be embedded in a number of cases, in addition to that, for the purposes of prototyping in reduced size, is ideal. PIR sensors has as characteristic high sensitivity and reliability, being used in numerous equipment such as alarms, emergency lights, automatic illumination of lamps.

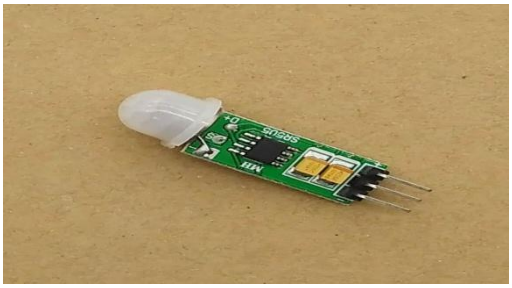

Fig. 3 PIR Sensor - HC-SR505

The Mini PIR Sensor depicted in Fig. 2, will function in the operation of the prototype, send a signal to the microcontroller communicating that there is the presence of people about to cross the crosswalk, at a specific point to where you will be directed according to its scope.

B. Push Button

The Buttons Push Button represented by Fig. 4 are electronic components that execute commands when pressed, and may close or open circuits.

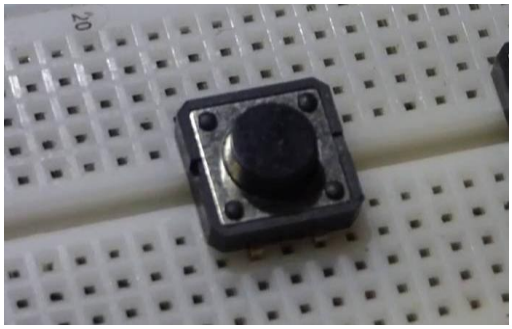

Figure 4 - Push Button

The role of the button in the prototype will provide another alternative for the visually impaired in relation to the crossing, where, to be pressed the result obtained must be the same as obtained by the operation of the Mini PIR Sensor, shown in Fig.3.

C. Audio Guidance

The Voice Recording module is based on the ISD1820 Fig.5, which is a device for recording and playing back messages. Through the existing microphone, indicated in fig. 5, it becomes possible to record messages in real time, being stored in internal EEPROM memory, which is non-volatile memory. With this type of memory you can disconnect the module without loss of audio recorded previously, the module also counts with a capacity of up to 10 seconds playback and the total of 20s for the recorder.

This module has 3 buttons to control, responsible for performing some specific functions, they are, the REC button, when pressed starts the recording of sound, the PLAYE: Plays all recordings stored in memory and the PLAYL that produces the recordings while the button is being pressed.

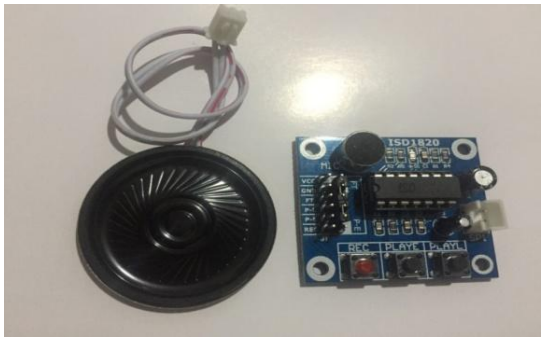

Fig. Module 5 - Voice Recorder and Player ISD1820/Speaker

The messages defined for the guidance of the visually impaired will be recorded separately, one in each Module, Figure 5, they are:

- "Attention! Wait!" - This message will be to keep the visually impaired or pedestrian alert.
- "Crossing released!" - This message will be issued immediately after the previous one when the cars are stopped.

D. Development of the Program

For Vicente [13], programs for the Arduino are known as sketches (draft or sketch).

The development environment for the Arduino is quite simple and didactic, possessing only basic functionality such as compiling, debugging, editing and uploading (loading) of the program to the memory of the Arduino.

The programming, according to Fig. 6, applying a prearranged codes, was made within the own Arduino IDE, using the language C/C++. The development of programming consists in research on work that has already been used the same codes.

PROGRAMA_FINAL

```
int ledsiga = 9;
int ledatencao = 10;
int ledpare = 11;
int ledatravessar = 8;
int lednatravessar = 7;
int sensor = 5;
int AUTOvermelho = 7;
int AUTOverde = 8;
int botao = 4;
int acionamento;

void setup() {
  pinMode(ledsiga,OUTPUT);
  pinMode(ledatencao,OUTPUT);
  pinMode(ledpare,OUTPUT);
  pinMode(ledatravessar,OUTPUT);
  pinMode(lednatravessar,OUTPUT);
  pinMode(sensor,INPUT);
  pinMode(AUTOvermelho,OUTPUT);
  pinMode(AUTOverde,OUTPUT);
  pinMode(botao,INPUT);
}
```

Fig. 6 – Declared Variables

Analyzing the Fig. 6, first integer variables were created to keep the port number in which each component is connected. Then, in the *setup method*, the doors were defined as being or *input* or *output*, in accordance with its operation. The *pinMode* command requires two parameters: the port number and the mode (INPUT OR OUTPUT).

The third step, shown in Fig.7, consists in the definition of *DigitalWrite command* to erase or ascend *Leds*. This command requires two parameters: the port number and the logic level (HIGH or LOW). Use the command *delay* to determine how long the LEDs are lit or erased. This command requires one parameter: The time in milliseconds that the program flow will be put on hold.

```
PROGRAMA_FINAL
void loop() {
digitalWrite(ledsiga, HIGH);
acionamento = digitalRead(sensor);
  if (digitalRead(ledsiga)==HIGH);
  {
       if ((acionamento==HIGH) || (botao==HIGH)){
       digitalWrite(AUTOvermelho,HIGH);
       delay (4000);
digitalWrite(ledsiga, LOW);
delay (400);
digitalWrite(ledatencao, HIGH);
delay (2000);
digitalWrite(ledatencao, LOW);
digitalWrite(ledpare, HIGH);
digitalWrite(AUTOvermelho,LOW);
delay (2000);
   if (digitalRead(ledpare)==HIGH){
       if (acionamento == HIGH){
       digitalWrite(AUTOverde,HIGH);
delay (4000);
digitalWrite(ledpare, LOW);
delay (400);
digitalWrite(AUTOverde,LOW);
delay (1000);
     }
    }
   }
  }
}
```

Fig. 7- Declared variables (Part 2)

As shown in Figure 7, has required the use of the structure *IF*, responsible for checking condition, where there is a need, for the implementation of each situation within the program prepared for the lights. After several attempts to compile the project program does not failures.

E. Electronic Diagram

For a demonstration of the prototype, depicted in Figure 8, we opted for the use of the Fritzing. The Fritzing is a Software for the creation of electronic diagrams with the Arduino and others, in order to make possible a view very close to the final result.

During the preparation of the diagram of the prototype, it was noticed that the Fritzing not possessed the ISD1820 module and the

Mini HC Sensor-SR505 in your gallery. Then became necessary to the creation of these components. Based on research to identify a software that would be able to create the components, identified the Inkscap, with capacity to meet. The Inkscape is a vector graphics editor, able to meet the goal. What differentiates the Inkscape is the use of native *Scalable Vector Graphics* (SVG),
in Portuguese Scalable Vector Graphics, an open standard based on XML of the consortium W3C.

Analyzing the graph template created and presented in Fig.8, we used a 5v power supply for the power supply of the entire circuit, also used the USB port for some tests. The VCC and GND pins of the Arduino must be connected to the *Protoboard*. The Push *Button* was connected into port 4 with *jumper* in orange color. On port 5, connected to the Mini PIR Sensor using *Jumper* in lilac. On port 7 of the Arduino, is connected to the red LED for pedestrians, in 8 the green led also to pedestrians. To represent the traffic of cars: green led on port 9, the yellow on port 10 and red on port 11. For the reproduction of audio messages in the ISD1820, which contains the message stored "Attention! Wait!", the pin PLAY-and was connected to the same line of red Led for pedestrians. In line with the green LED for pedestrians, is connected to the play-and the module that contains stored the message " Crossing released!".

Observing the model presented in Fig. 8, it is clear how the visualization of the circuit facilitates the understanding and the assembly of the components in accordance with each port or connection with the help of the *Protoboard.*

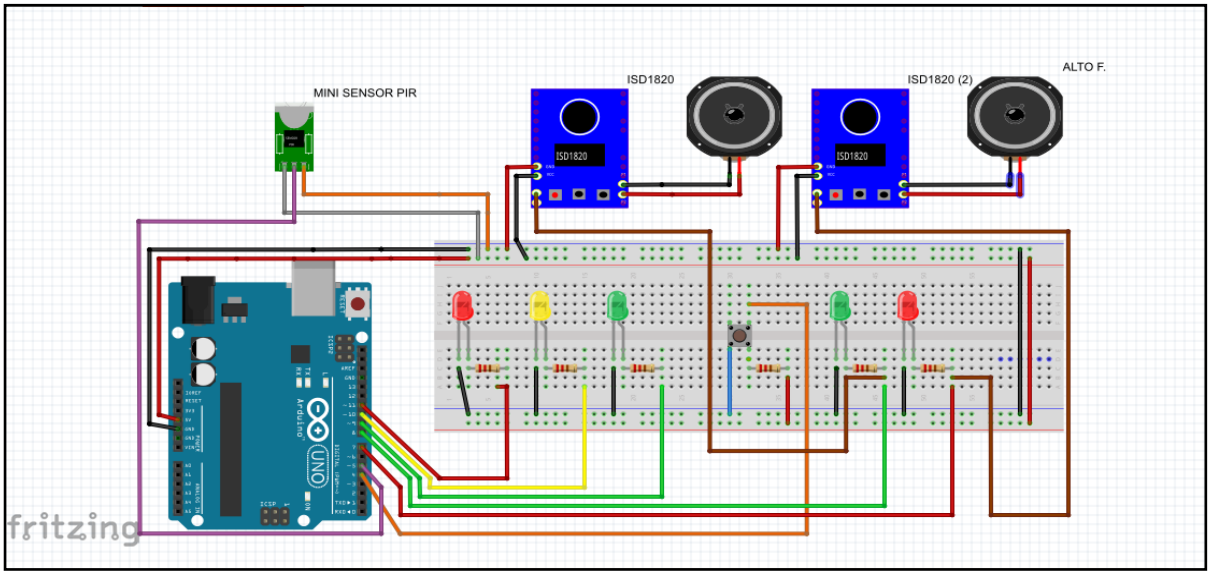

Fig.8 Modulation of the prototype developed in Softwae Fritzing

IV. RESULTS AND DISCUSSION

As all the need presented in the previous chapters and the importance of the application of technology for social inclusion, the prototype, intelligent traffic lights, showed himself as a possible alternative, in dealing with the problems which could be solved with your application.

A. Operation

After the preparation of the diagram, the integration of all components as expected, Fig.9.

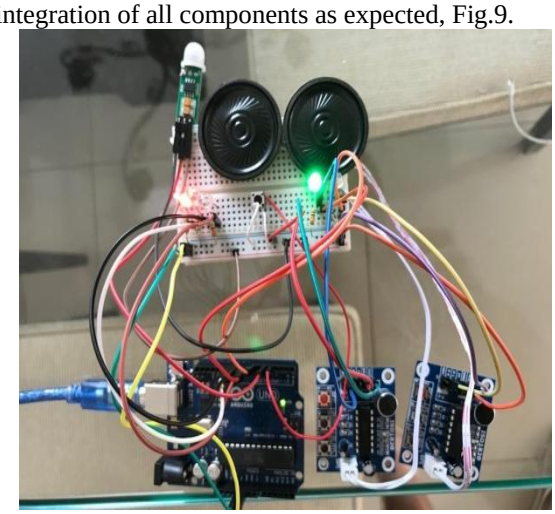

Fig. 9 - Electronic Circuit of the Prototype

The part of the implementation of the semaphore and its components, Fig.9, worked in accordance with the programming carried out and executed by the Arduino. The leds could represent so faithful an operation of a traffic light in accordance with their respective colors. The Mini PIR sensor has fulfilled its role of perceiving the approximation, showing that can be effective in the case of pedestrians with visual disabilities. The button worked as an alternative to a possible failure of the sensor or even a question optional. The messages recorded in the ISD1820 module is maintained in normal conditions during the tests. The speakers managed to perform positively in order to convey the message of the system.

B. Final Prototype

The representation of the traffic might be better represented in the form of simple model, just to make the tests and the applicability somewhat more visible, facilitating the understanding. The choice of PVC became feasible due to the ease of jumper crossing. In order to obtain a better appearance, the entire traffic light was painted in black.

Analyzing Fig. 10, the way the jumpers were taken to the base of the prototype is shown.

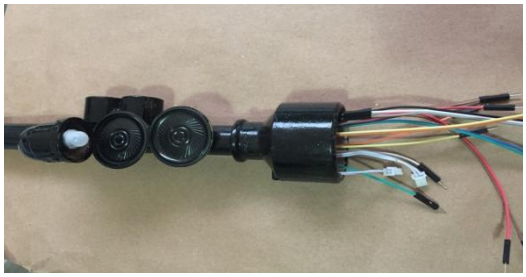

Fig.10 - Passing the jumpers

The jumpers were passed one by one and plugged into each component to be powered. The pipe supported the passage of all jumpers as shown in Fig. 10, thus making it unnecessary to pass them through the outside of the prototype, as planned.

Fig. 11 shows the push button, positioned at the rear of the traffic light pole.

Fig. 11- Push Button

The Push Button Fig. 11, when pressed, was able to change the state of the traffic light, if it shows a valid option of safety in pedestrians crossing. The push-button placed and must be at an accessible height for the pedestrian.

The finished prototype Fig.12, faithfully representing a traffic light, regarding the structure, according to the models used in our day to day.

Fig. 12- Prototype finalized

As shown in Fig. 12, the Intelligent Traffic Light is fixed in a box, designed to fit all components responsible for the Traffic Lights operation. To represent each luminaire were used

Reduction Bushings 25x20mm. The base, to be fixed, was used a Reduction Bush 50x25mm. The Sensor was positioned above a specific point limiting the pickup area, close to the speakers.

The program ran perfectly without interruptions, keeping the stable operation.

V. CONCLUSIONS

According to the IBGE data, it is possible to observe how great is the number of people who have some kind of deficiência, and how it is necessary to emphasize the importance of social inclusion in the life of these individuals. For a better go and come, equipment and components see being developed to improve the security of the same.

In some respects, there was a certain need for safety in traffic in the case of the visually impaired. Assuming this scenario came up with the idea of developing a system that facilitates the identification and the crossing of the visually impaired, is so severe or not, according to the status of the lights.

The Prototype worked as expected, the sensor has responded to what has been proposed, as well as the drive by button. The Recorder Module is capable of providing an audio communication through which it is recorded, providing security for the visually impaired. In addition to the security offered to the visually impaired, it is worth mentioning the issue of safety to drivers in certain zones, where they are vulnerable, not having the obligatory stop if there is no presence of pedestrian.

Not yet been performed tests in real environment. Testing the prototype with the visually impaired will be indispensable to collect the accuracy of what it intends to accomplish.

REFERENCES

[1] Instituto Brasileiro de Geografia e Estatística – IBGE. Censo Demográfico 2010 - População Residente com Deficiência Visual. Available at: <https://agenciadenoticias.ibge.gov.br/>. Acessed: October 16, 2018.

[2] Associação Brasileira de Pedestres – ABRASPE. Medidas Prioritárias Para Proteção do Pedestre. Available: <http://www.pedestre.org.br>. Acessed: October 20, 2018.

[3] Conselho Nacional de Trânsito - CONTRAN. Resolução n*704, 10 de Outubro de 2017. Available: <http://www.denatran.gov.br/images/Resolucoes/Resolucao7042017.pdf>. Acessed: April 18, 2018.

[4] Maciel, S. F.. O “ir e vir” do Deficiente Visual (princípios, técnicas e procedimentos). São Paulo, 2003.

[5] Baggio, Miguel Angelo et Al. Padevi-Protótipo de Auxílio a Deficientes Visuais. Revsita de Empreendedorismo, Inovação e Tecnologia, v. 1, No. 1, p. 45-57, 2015.

[6] Organização Mundial da Saúde- OMS, 2011. Relatório Mundial Sobre Deficiência - São Paulo. Available: <http://www.pessoacomdeficiencia.sp.gov.br/usr/share/documents/RELATORIO_MUNDIAL_COMPLETO.pdf> Acessed: April 10, 2018.

[7] Santos, P., & Oliveira, L. C. Tecnologia Assistiva: um estudo sobre o uso de aplicativos para deficientes visuais, 2017, p. 3.

[8] Gomes, A. G. S; Da silva, R. N.; Dos santos, R. F. Desenvolvimento de Tecnologia Assistiva de Baixo Custo Utilizando a Plataforma Arduino, 2017.

[9] Kleina, C. Assistive Technology in special education and inclusive education 1. ed. Curitiba. Paraná. 2012. Intersaberes Publisher. Available in: <http://eniac.bv3.digitalpages.com.br/users/publications/9788582120354/pages/5>.

[10] Brazil. Decreto nº 5.296 of 2 December, 2004. Regulamenta as Leis nº 10.048, de 8 de novembro de 2000, que dá prioridade de atendimento às pessoas que especifica, e 10.098, de 19 de dezembro de 2000, que estabelece normas gerais e critérios básicos para a promoção da acessibilidade das pessoas portadoras de deficiência ou com mobilidade reduzida, e dá outras providências. Available at: <http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/decreto/d5296.htm>. Acessed: April 18, 2018.

[11] Brazil. Lei no. 13.146, of 6 July 2015. Institui a Lei Brasileira de Inclusão da Pessoa com Deficiência (Estatuto da Pessoa com Deficiência). Available at: <.http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13146.htm>. Acessed: April 18, 2018.

[12] (2018) The Arduino. Available at: < https://www.arduino.cc>

[13] San Vicente, M. Arduino Básico. São Paulo: novatec, 2011. Single Volume, pp. 18-31.