الجمهورية الجزائرية الديمقراطية الشعبية
République Algérienne Démocratique et Populaire
وزارة التعليم العالي والبحث العلمي
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique
جامعة غرداية
Université de Ghardaïa
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قسم آلية وكهروميكانيك
Département de électromécanique

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Mémoire de fin d'étude, en vue de l'obtention du diplôme

Master

Domaine : *Sciences et Technologies*

Filière : *Automatique*

Spécialité : *Automatique et systèmes*

Thème :

Modeling and realization of automatic surveillance system

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Soutenue publiquement le : 11/06/2022

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Année universitaire 2021/ 2022

Acknowledgment

All praises and thanks to Almighty ALLAH, the most beneficent and the most merciful, who gave us all abilities and helps us in our life.

We are grateful to our parents and family that supports us every time we are in need, always standing with us, guiding us through life. We would like to thank them for their unconditional love that motivates us to aim higher.

We would like to address our sincere gratitude to our supervisor Abdelouahab KHATTARAH for his support and guidance during this work. His encouragement and guidance have always been a source of motivation. It was an honor to work under his supervision.

Special thanks to our professors, academic staff and personnel at the University of Ghardaia.

Aissa and Salman El Farissi.

Wisdom

Theory is when you know everything but nothing
does not work, practice is when everything
works and no one knows why
Let's try to combine the two

Albert Einstein

Abstract

The main concentration of this project was to modulating and realizing the automatic surveillance system. The sensor-based system is composed by different elements, such us: LDRs, Lasers, MW sensor, PIR sensor, which are fixed in the entrance. Hence the Arduino receives the signal from the sensors and do the calculation, then executes the decision in form of printing the total of students and number of who go into and who go out, even shows the case of if someone stayed inside the building. Moreover, the vision-based system is applied the image processing to do counting the students from video surveillance by camera which is fixed in the entrance.

Keyword: sensor-based system, vision-based system, people counting, control the entrance, image processing, object detection.

Résumé

La concentration principale de ce projet était de moduler et de réaliser le système de surveillance automatique. Le système à base de capteurs est composé de différents éléments, tels que : LDR, lasers, capteur MW, capteur PIR, qui sont fixés dans l'entrée. Par conséquent, l'Arduino reçoit le signal des capteurs et effectue le calcul, puis exécute la décision sous forme d'impression du nombre total d'étudiants et du nombre de ceux qui entrent et sortent, montre même le cas si quelqu'un est resté à l'intérieur du bâtiment. De plus, le système basé sur la vision est appliqué au traitement d'image pour faire le comptage des étudiants à partir de la vidéosurveillance par caméra qui est fixée à l'entrée.

Mot-clé : système basé sur des capteurs, système basé sur la vision, comptage de personnes, contrôle de l'entrée, traitement d'image, détection d'objets.

ملخص

كان التركيز الرئيسي لهذا المشروع على هيكلة وانشاء نظام مراقبة أوتوماتيكي. يتكون النظام القائم على االستشعار من عناصر مختلفة ، مثل: مقاومة الضوئية والليزر ومستشعر الموجات الصغرى ومستشعر ألشعة تحت الحمراء السلبية، والذي يتم تثبيته في المدخل. ومن ثم فإن اللوحة االلكترونية Arduino تستقبل اإلشارة من المستشعرات وتقوم بالحسابات ، ثم تنفذ القرار على شكل عرض إلجمالي الطالب وعدد الطالب الذين يدخلون ويخرجون ، عالوة على ذلك، فإنه يتضح في حالة ما إذا بقي شخص ما داخل المبنى .أبعد من ذلك، يتم تطبيق معالجة الصور في النظام القائم على الرؤية لعد الطالب من المراقبة الفيديو بواسطة الكاميرا المثبتة في المدخل.

الكلمات المفتاحية: نظام قائم على المستشعرات ، نظام يعتمد على الرؤية ، عد الأشخاص ، التحكم في الممر الدخول ، معالجة الصور ، التعرف على الأشياء.

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List of abbreviations

AI: Artificial Intelligence.

LCD: Liquid Crystal Display.

LDR: Light Dependent Resistor.

MW: Microwave.

RFID: Radio Frequency Identification.

PIR: Passive Infrared.

ML: Machine learning.

DL: Deep learning.

SC: Science Computing.

API: Application Programming Interface.

USB: Universal Serial Bus.

AC: Alternating Current.

DC: Direct Current.

IDE: Integrated Development Environment.

PCB: printed circuit board.

SDA: Serial Data.

SCL: Serial Clock.

GPIO: General Purpose Input/Output.

IoT: Internet of Thing.

Introduction

Introduction

Today, technology is developing in the same direction in line with rapidly increasing human needs. The aim is making life easier every day.

Technological evolution, as well as the search for increasing efficiency and occupancy comfort, have pushed for the introduction of building automation and control systems. [1]

The AI revolution has a profound impact on the security system, almost unlimited possibilities to facilitate the monitoring process and to reduce the rate of distractions that continue to grow cause innocent victims. [2]

Installing an automatic surveillance system in the building library of Science and Technology Faculty has many options, to choose the perfect solution, it has to develop step by step.

- ✓ **Project objectives**

The objective of this project is the entrance of the building library to be automatically monitored.

- ✓ **Organization of the thesis**

The thesis is organized as follows:

- Chapter 1 introduces the people counting and different method of counting, also a brief history and it ended with a simple conclusion.
- Chapter 2 shows and arranges the different types of counting, also shows the characteristics and disadvantages of each one of them.
- Chapter 3 presents the hardware and software system design, and shows the flowchart of the algorithm used in the Arduino program. Besides, it presents and discusses the implementation of the hole project

The conclusion summarizes the work presented in this thesis and perspectives for future improvements of the project, followed by a list of references provided for further information concerning the subject.

Chapter I

Chapter I

I.1 Introduction

People counting is a way in which capacity numbers can be monitored, controlled and optimize your building.

Intelligent system design was suggested to apply in the entrance of building library of Science and Technology Faculty, according to our vision.

I.2 People Counting

People counting is mainly for counting a number of people in such us an area of interest using various technologies. People counting can be classified into two categories:

- Vision-based systems using cameras.

- Systems using sensors. [3]

I.3 Brief history

I.3.1 Manual counter

Manually tallying the occupants of a room is a relatively effective way of gaining insights into footfall and how people utilize the space. Yet manual tally counters are prone to human error and, as a result, are inherently inaccurate. Areas such as stores and offices often have high levels of footfall in and out at multiple entrances. This means that it is very difficult for a manual people counting device to maintain accuracy and further difficulties. [4]

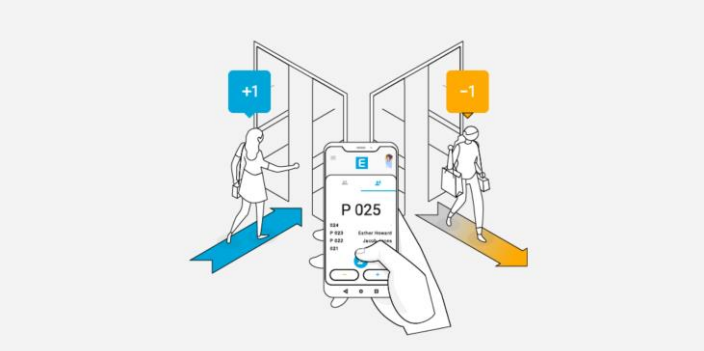

FIg 1: manual counting

I.3.2 Infrared beam counters

The simplest form of counter is a single, horizontal infrared beam across an entrance which is typically linked to a small LCD display unit at the side of the doorway. When the beam is broken a tick is 'recorded'. Since a person normally enters and leaves by the same door, dividing the 'ticks' by two gives a measure of visitor numbers. Beam counters usually require a receiver or a reflector mounted opposite the unit with a typical range from 2.5 meters (8 ft 2 in) to 6 meters (20 ft). Despite the limitations, infrared counters are still widely used due to their low cost and simplicity of installation. The first generation of people counter had an expected accuracy level of 60% to 80%. [5]

FIg 2: infrared counter

I.3.3 Ultrasonic sensor

There should be cluster of tree-node sensors; each node mounts an ultrasonic area. Wide area needs multiple clusters, coordinating node of cluster reads form nodes by RF link. Distributed algorithm of nodes decides counting process for detected people. Such system needs clock synchronization at millisecond level to exchange data simultaneously. Protocol of clock synchronization is imposing a disadvantage of this technology. [5]

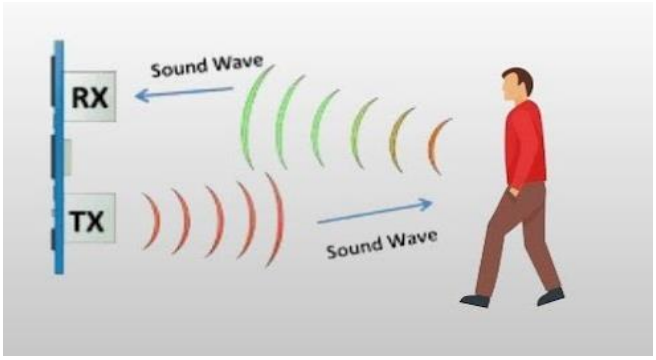

FIg 3: ultrasonic Sensor

I.3.4 Thermal counters

Thermal imaging systems use array sensors that detect heat sources. These systems are typically implemented using embedded technology and are mounted overhead. It is difficult to verify the accuracy of thermal counters as the image feed relay on the devices are heat sources. They can be inaccurate as thermal counters have difficulty measuring the dwell time of targets beyond a few seconds. Due to this, the second generation of people counter have an average accuracy of 80% to 85%.[5]

FIg 4: thermal counter

I.3.5 Infrared motion sensors

Three PIR sensors are required for each passage monitored. A coordinator connects to the sensors by a wireless RF link. The coordinator receives the events of detected motion from the sender. The coordinator concludes people count from correlating phase, number and time difference of signal peaks. PIR sensors are alternative to previous technology, however the effort and cost of installing multiple nodes of sensor for each Surveillance area is a cost-side disadvantage.[5]

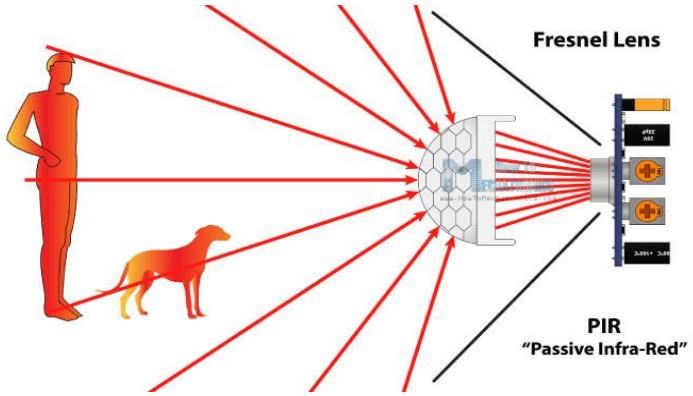

FIg 5: infrared motion sensor

I.3.6 Video counting

It based on ceiling mounted camera; people are identified by background subtraction of image. The objects (blobs) are identified and their size estimated and compared to pixels dimension of people which established previously. This analysis leads to people count

FIg 6: video counting

This technology is better than previous ones because:

1. Count is bidirectional.
2. The counting algorithm is flexible for unexpected situations.
3. Surveillance of large area.
4. Surveillance area of high traffic.
5. It is integrated with online systems or database easily.
6. Installation process is done easily.[2]

I.4 Conclusion

Automated people counting devices do not require employee supervision, meaning that they are a one-off cost and a wage does not need to be paid any more. Automated people counting sensors can also offer a cost-effective means of collecting data regarding the users of a building. At the end the entrances are supervised.

Chapter II

modelization

Chapter II: Modelization

I.5 Introduction

The control of the entrance of any constructions is really important nowadays, and the technology enhances it, especially in security side and watching who get in and who go out. because it helps to minimize the risks, monitoring the crowd and the traffic.

The main idea of setting a surveillance system in the entrance of the building library is to help the security agents in their jobs, so it is very difficult to scan the whole building in the end of the day, or anything suddenly happen.

To control the access system, we have also set some physical obstacles like a door with tight weight which is approximately 70cm, to make sure that the pedestrians go into or go out one-by-one.

There are many solutions to control the traffic in the entrance such us:

I.6 LDR and Laser diode

A photoresistor is a device whose resistivity is a function of the incident electromagnetic radiation, and A laser diode is a semiconductor device similar to a light-emitting diode in which a diode pumped directly with electrical current can create lasing. [6]

A laser diode is an optoelectronic device, which converts electrical energy into light energy to produce high-intensity coherent light. In a laser diode, the p-n junction of the semiconductor diode acts as the laser medium or active medium. [7]

In this system, we have two lasers and LDR A and B settled parallel one by one with a specified distance between them installed at the entrance to the library building. When the beam is broken A then beam B the student is registered in the case of entering and vice versa the student is registered in the case of exit. But if an animal or any equipment goes into or exits, the system will count it.

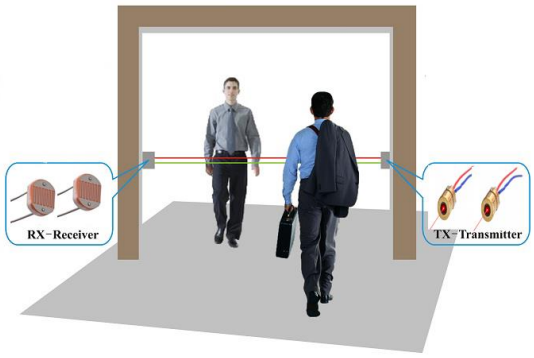

FIg 7: LDR and Laser diode solution

I.7 Thermal sensor (Microwave)

Microwave is a form of electromagnetic radiation with wavelengths ranging from about one meter to one millimeter corresponding to frequencies between 300 MHz and 300 GHz respectively. Different sources define different frequency ranges as microwaves. [8]

Adding a thermal sensor in the middle of the system to make a difference between a human and animal or anything else. However, the role of the employees in the library building is essential and important, and they cannot be counted with students.

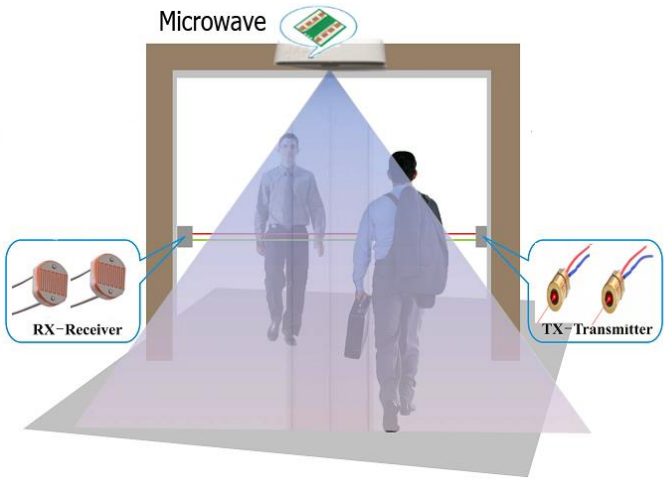

FIg 8: Microwave solution

I.8 RFID

Radio Frequency Identification is a form of wireless communication that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person. [9]

Add the RFID to the budget's employees, so the system will make them in exception case.

On the other hand, how we can give each student a RFID signal and something else which is probability of losing or forgetting it, more than that it needs fund.

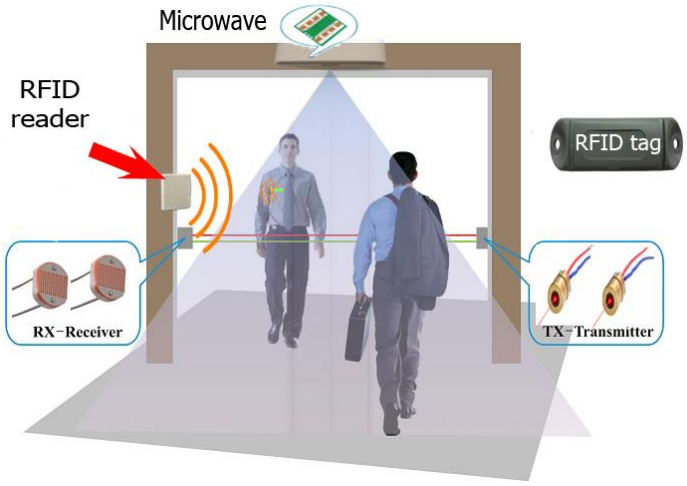

FIg 9: RFID solution

I.9 Fingerprint

An impression or mark made on a surface by a person's fingertip, able to be used for identifying individuals from the unique pattern of whorls and lines on the fingertips. [10]

It is easy to use and it facilitates the process, but it is not professional.

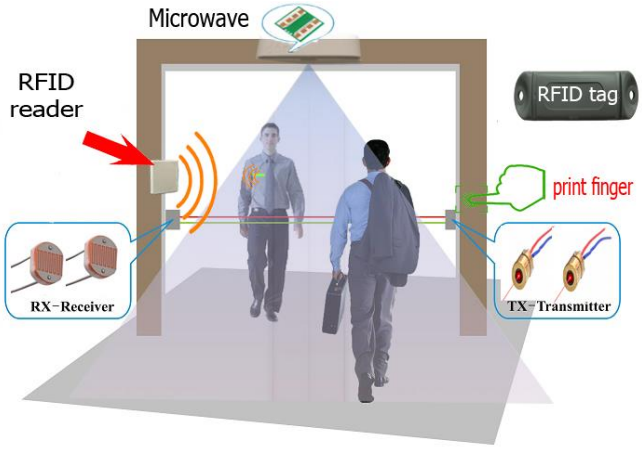

FIg 10: Fingerprint solution

I.10 Image processing

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms a core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps:

- Importing the image via image acquisition tools.
- Analyzing and manipulating the image.
- Output in which the result can be an altered image or report that is based on image analysis.

There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction. [11]

By image processing we can do several tasks like:

- Face recognition.

- Counting students.

- Exception of employees and security agents from the counting.

- Detection of suspicious case.

- Registration of behavior.

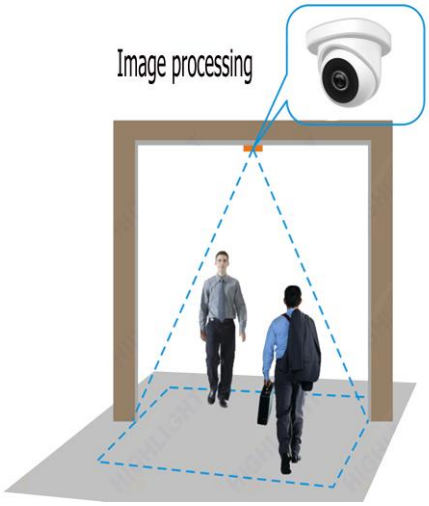

FIg 11: Image processing solution

I.10.1 What Is an Image?

An image is represented by its dimensions (height and width) based on the number of pixels. For example, if the dimensions of an image are 500 x 400 (width * height), the total number of pixels in the image is 200000.

Image processing requires fixed sequences of operations that are performed at each pixel of an image. The image processor performs the first sequence of operations on the image, pixel by pixel. Once this is fully done, it will begin to perform the second operation, and so on. The output value of these operations can be computed at any pixel of the image.

Image processing is the process of transforming an image into a digital form and performing certain operations to get some useful information from it. The image processing system usually treats all images as 2D signals when applying certain predetermined signal processing methods. [12]

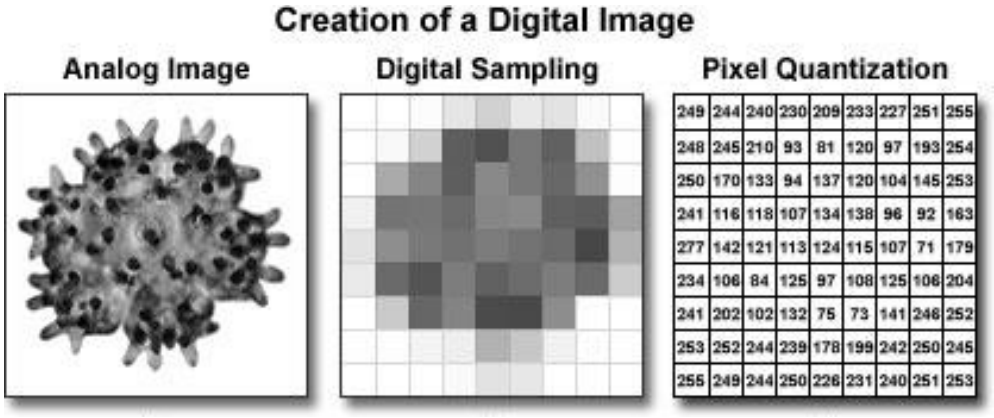

FIg 12: creation of a digital image

There are five main types of image processing:

- Visualization: Find objects that are not visible in the image.

-Recognition: Distinguish or detect objects in the image.

-Sharpening and restoration: Create an enhanced image from the original image.

-Pattern recognition: Measure the various patterns around the objects in the image.

-Retrieval: Browse and search images from a large database of digital images that are similar to the original image.

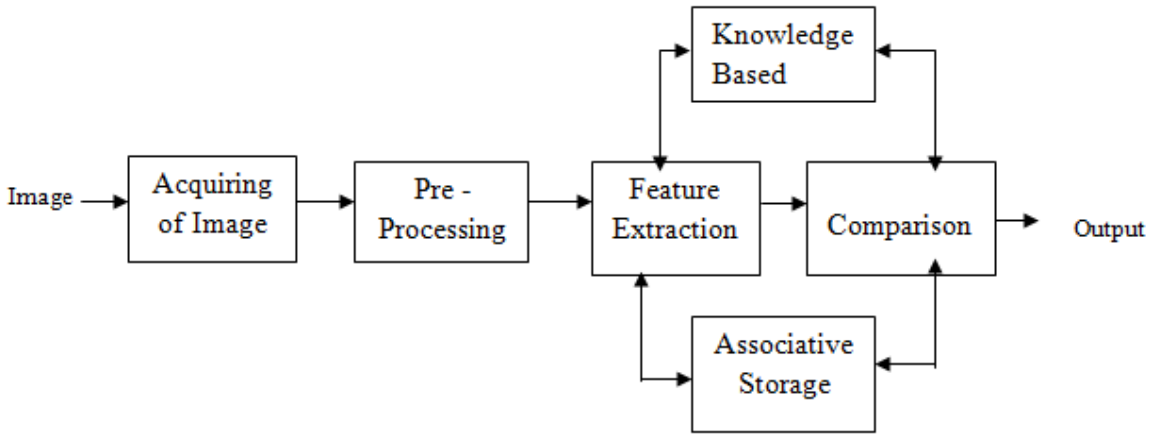

FIg 13: Digital image processing system

I.10.2 People Counting and image processing

The methodology used for people counting is based on computing vision. Different purposes to conduct people counting can differ vastly depending on the research problems being initially set. In terms of scale, the only variation is the scale of captured images or video footage being used for processing people counting algorithms, namely large-scale and small-scale people counting. Large-scale people counting serves a purpose of estimating the size of crowd and flow of people, from high density of people in an area and challenge of dynamic crowd motion and background interference.

For small-scale people counting, vision-based systems, more features can be implemented in addition to the sensor-based systems. Namely, people can be tracked down, located in first appearing, studied on direction of their moving, etc. using a variety of machine learning techniques. Camera is also possible to extend field of view. This project aims at counting students who use the library by a single camera. [3]

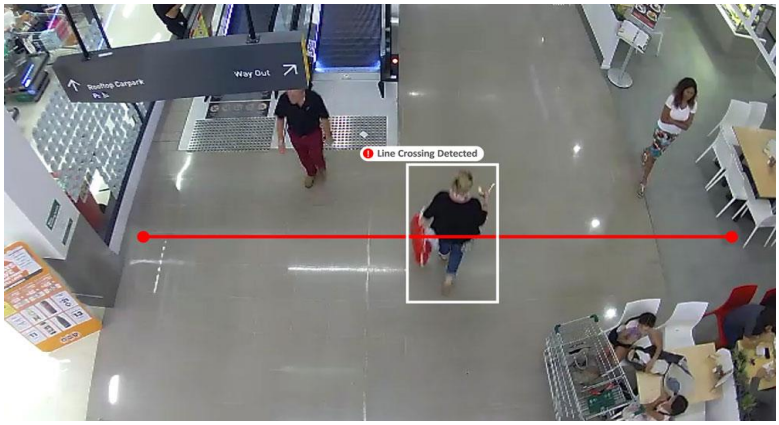

FIg 14: line crossing video analytic

I.11 OpenCV

OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. The library is written in C and C++ and runs under Linux, Windows and Mac OS X. There is active development on interfaces for Python, Ruby, Matlab, and other languages.

OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. It was designed for computational efficiency and with a strong focus on real time applications. [13]

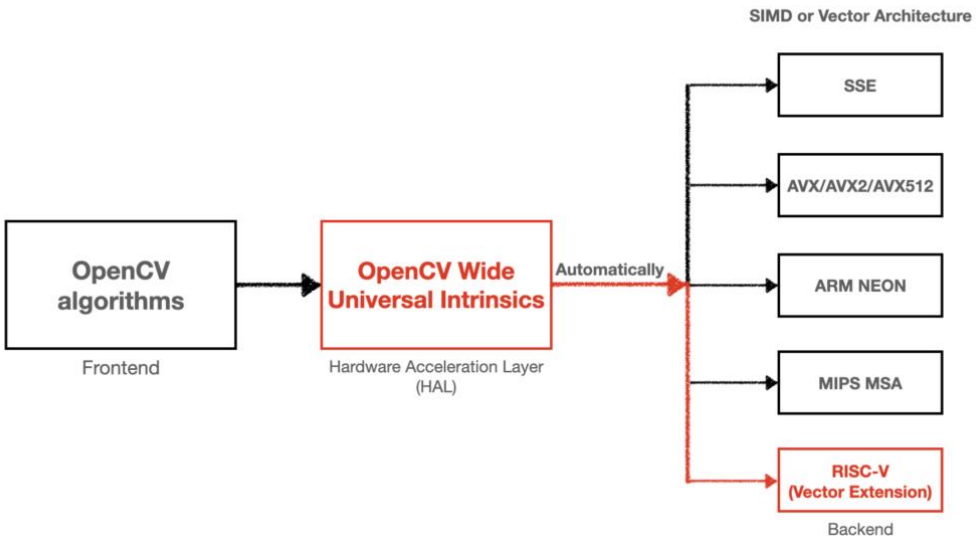

FIg 15: OpenCV architecture

I.12 TensorFlow

TensorFlow is an open source end-to-end platform for machine learning. It provides a comprehensive ecosystem of tools for developers, enterprises and researchers who want to push the state of the art of ML and build scalable machine learning powered application. TensorFlow was designed for helping people to learn, build models easily. With an intuitive easy to use set of APIs that makes it simple for you to learn and implement ML, DL and SC, it provides many rich collections of tools for building models, these include data pre-processing, data ingestion, model evaluation, visualization, and serving. But it not just for building models, any researcher or developer can easily train and deploy models anywhere with TensorFlow. It is designed to be highly portable, running on a variety of devices and platforms. [14]

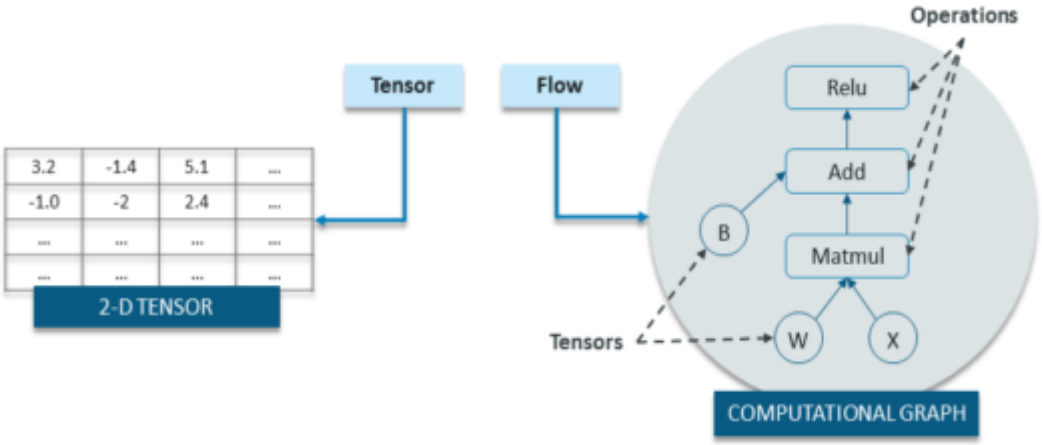

FIg 16: TensorFlow

I.12.1 Why TensorFlow

TensorFlow gives you the flexibility and control with features like the Keras Functional API and Model Sub-classing API for creation of complex typologies. For easy prototyping and fast debugging, use eager execution. TensorFlow also supports an ecosystem of powerful add-on libraries and models to experiment with, including Ragged Tensors. [14]

I.13 Conclusion

This study develops an ideal system of students counting to solve some problems, such us monitoring the entrance, counting the students, face recognition and store the data of traffic.

Chapter III

Realization

Chapter III: Realization

I.1 Introduction

There are many microcontroller boards realize a project like people counting systems, such us: Launchpad MSP430, Quark D2000, ESP8266 Microcontroller Board, BeagleBone Black, MBED LPC1768, ESP32 Microcontroller Board, Arduino Pro Mini 328, Teensy 4.0, Arduino Uno Microcontroller Board … But to choose the perfect one we set some standards, like the existence of electronic elements and pieces, robustness, prices, simplicity. [15]

I.2 LDR sensors

The working principle of an LDR is photo-conductivity, which is nothing but an optical phenomenon. When the light is absorbed by the material then the conductivity of the material enhances. When the light falls on the LDR, then the electrons in the valence band of the material are eager to the conduction band.[6]

The characteristics of using the LDR:

- It receives digital input.

- It is very common, and simple to use.

- adaptable with different electronics boards.

- Inexpensive.

- very sensitive to light. But we created a simple mechanism, which is fixing the LDR in small tube to receive just the laser diode.

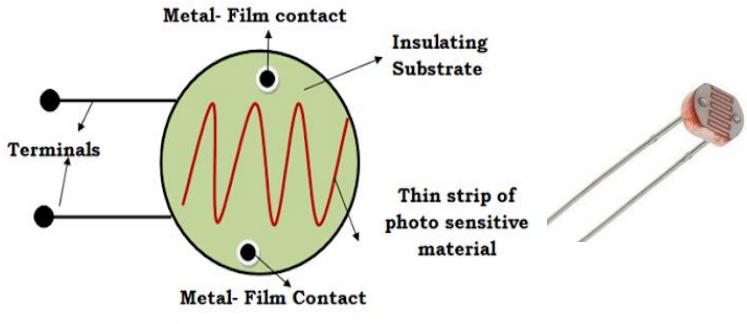

FIg 17: LDR sensors

I.3 Laser diode

Laser diode is an optoelectronics device, which converts electrical energy into light energy to produce high-intensity coherent light. In a laser diode, the p-n junction of the semiconductor diode acts as the laser medium or active medium.[7]

The characteristics of using the laser diode module:

- It receives digital input.

- It is very common, and simple to use.

- adaptable with different electronics boards.

- Inexpensive.

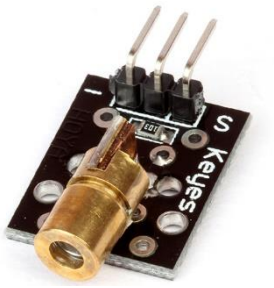

Fig: laser diode 18

I.4 MW sensor

A microwave motion sensor uses electro-magnetic radiation whose frequency ranges from 0.3 GHz to 300 GHz (wavelengths from 1 mm to 1 m). It emits waves which are then reflected back to the receiver. The receiver analyzes the waves that are bounced back. If there is an object moving in the area, these waves are going to be altered. The microwave detector is able to identify changes from moment to moment. Ideally, the receiver should be receiving the same waves back again and again.[8] It was suggested to ensure that who passes to the monitored entrance is human.

The characteristics of using the microwave module:

- It is really sensitive with human body.

- It has broad bandwidth and high data transmission rate.

- can be used in the harsh environment where the heat cycles are not regular.

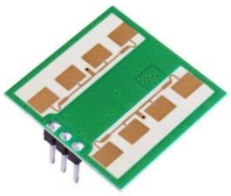

FIg 19: microwave sensor

I.5 PIR sensor

PIR sensor an electronic device used to detect motion by receiving infrared radiation. When a person walks past the sensor, it detects a rapid change of infrared energy and sends a signal.

The characteristics of using the PIR sensor:

- Passive detection system unlike the radar systems.
- Relatively low power consumption.
- Accurate detection, with precision optics.
- Improved noise and external light interference resistance for performance enhancement.
- Affordable price. [9]

FIg 20: PIR sensor

I.6 Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable and power it with an AC-to-DC adapter or battery to get started. You can tinker with your Uno without worrying too much about doing something wrong, worst-case scenario you can replace the cheap chip and start over again. [16]

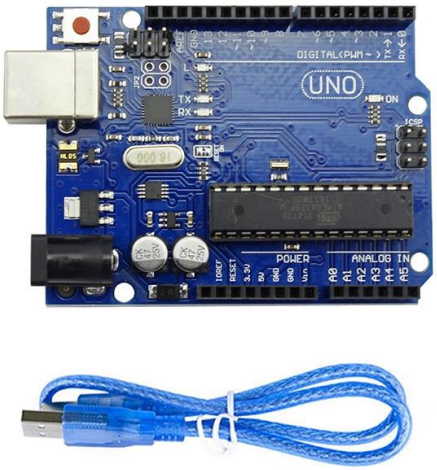

FIg 21: Arduino Uno

I.6.1 Why Arduino?

There are many other microcontrollers and microcontroller platforms available for physical computing, such as Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

- Extensible software and hardware.

- It is an open source.

- It is re-programmable.

- Cross-platform, The Arduino Software (IDE) runs on all categories of operating systems.

- Simple, clear programming environment and easy to use.

- It is easy to use.

- It is a fordable and inexpensive.

- It is sufficient for our project's need. [16]

I.7 Necessary accessories

I.7.1 LCD screen

A 16x2 LCD means that the screen can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. It was added to display the result. [17]

FIg 22: 16x2 LCD screen

I.7.2 I2C_LCD link

I2C_LCD is an easy-to-use display module; it can make display easier. Using it can reduce the difficulty of make, so that makers can focus on the core of the work. We developed the Arduino library for I2C_LCD, user just need a few lines of the code can achieve complex graphics and text display features.

The I2C protocol defines the succession of logic states on SDA and SCL, and how the circuits must react in the event of a conflict. On the I2C bus, the dominant logic level is 0, the recessive level is 1. In the absence of a command, the logic level (rest) is therefore 1. [18]

FIg 23: I2C_LCD

I.7.3 Bread-board and jumpers.

For construction and connecting the devices with Arduino.

I.8 Sensor based system Design

I.8.1 Electrical Design

The microcontroller used is an Atmega 2560 which comes with a development and programming board named Arduino Uno. The programming language is Arduino C, it very similar to C ++ language, but includes several libraries that help in the control of the I/O ports, timers, and serial communication. [1]

The circuit diagram is simulated in Fritzing Program, it was designed as following:

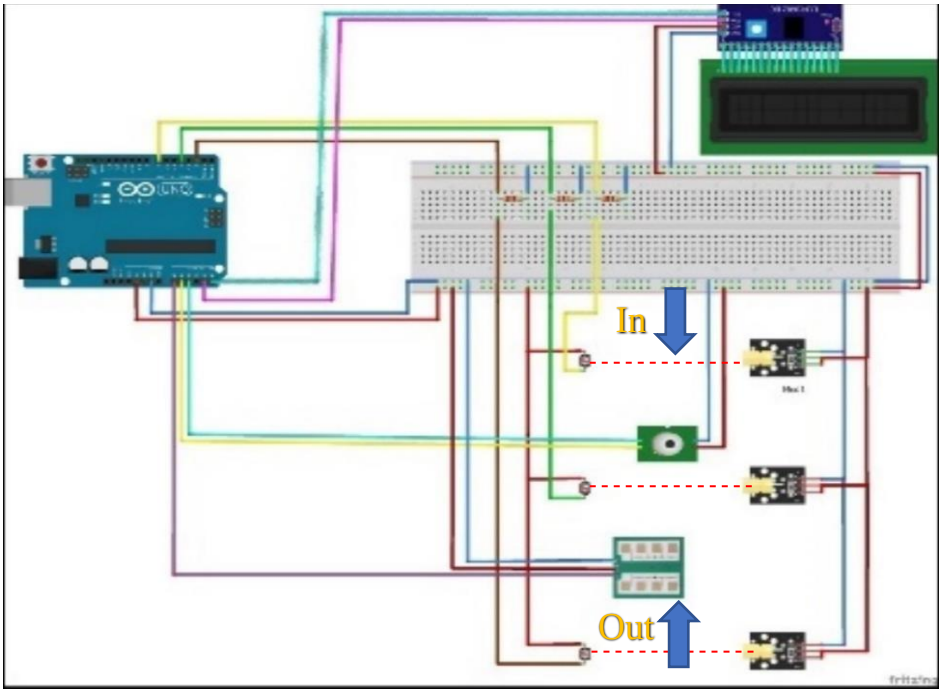

FIg 24: Circuit diagram

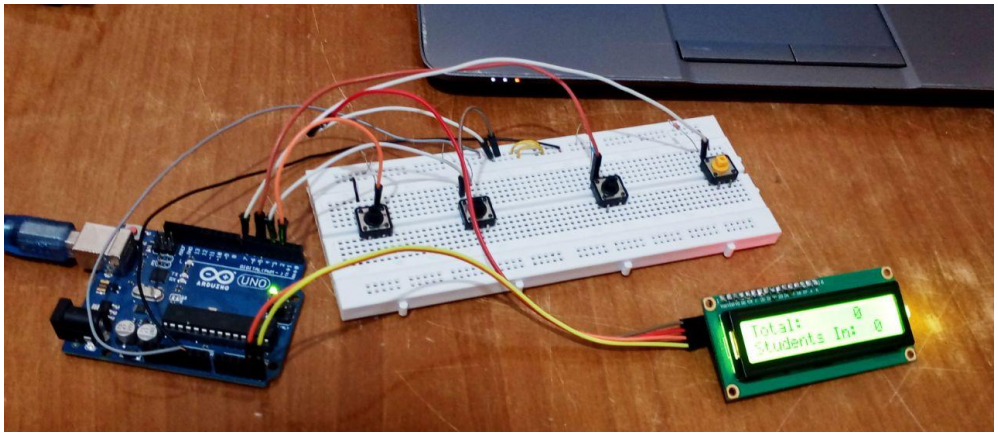

FIg 25: Realization circuit

I.8.2 Software

The setup function configures the input/output pins and adjust the serial monitor and printing setting.

The loop function which runs continuously, it reads the entire range of values that come from the analog and digital pins, which is related with: LDR sensor, PIR sensor, MW sensor. the loop function follows the instructions which is contained conditions and decisions. Substantially, if sensors conditions are existed, the decisions of counting are executed, then the results are appeared in the LCD screen.

Setting three lines of (laser diode module + LDR sensor) with same distance between them, to make sur the issues bellow do not happen:

- If two people came in same time but opposite direction.

- If a person reaches into the sensor system area, but he steps back.

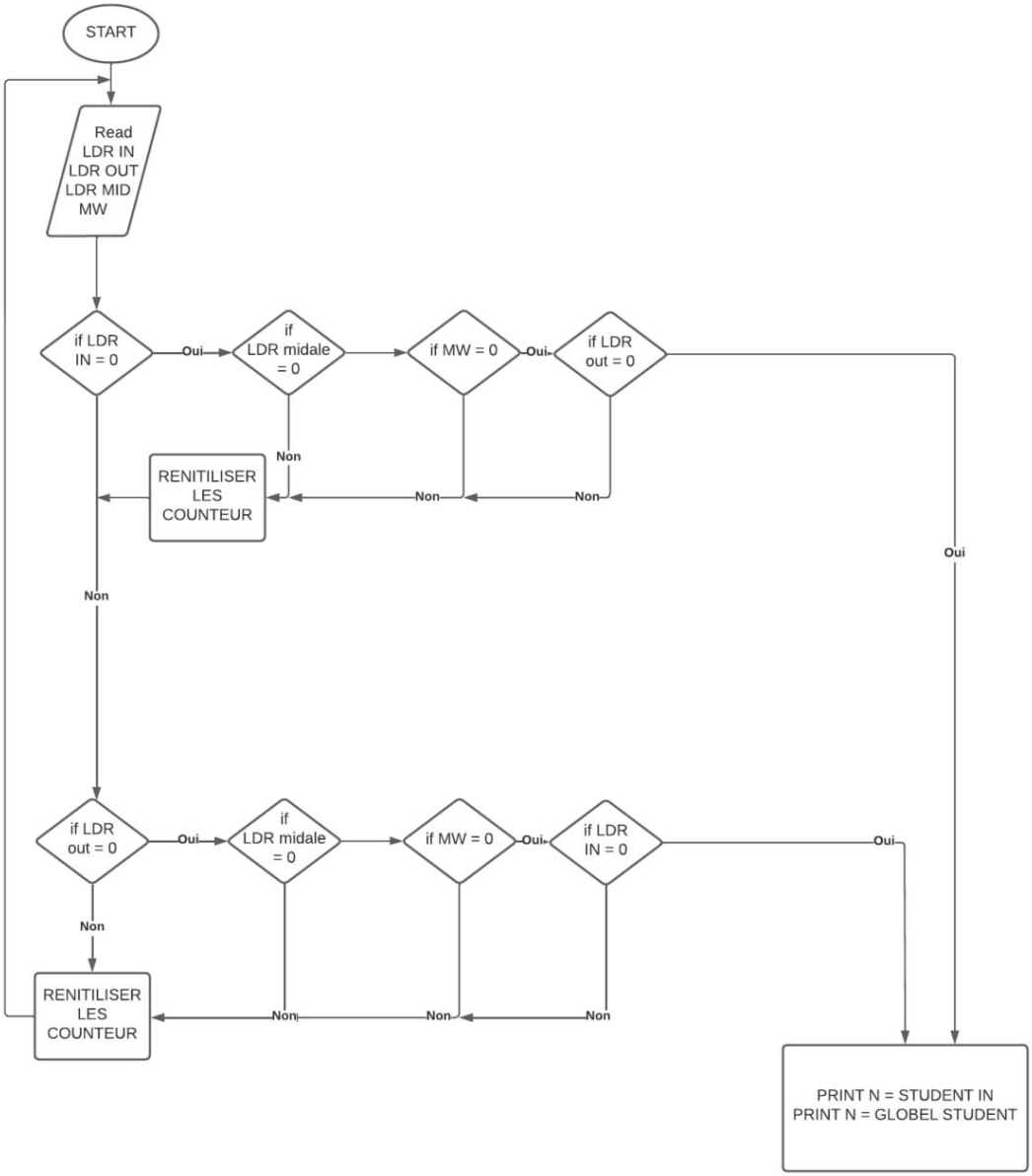

FIg 26: Flow chart

I.8.3 Some trouble

- It cannot count more than one person in same time.

- It cannot be bi-directional.

- The wires are very sensitive, and make trouble to process.

- An inability to differentiate between student and employees.

I.9 Vision based system Design

I.9.1 Hardware

I.9.1.1 Raspberry pi

The Raspberry Pi launched in 2012, and there have been several iterations and variations released since then. The Raspberry Pi is a very cheap computer that runs Linux, but it also provides a set of GPIO pins, allowing you to control electronic components for physical computing and explore the IoT. [19]

I.9.1.1.1 Performances:

- 1.4GHz 64-bit quad-core processor.

- dual-band: 2.4GHz 5GHz wireless LAN.

- Bluetooth 4.2/BLE, faster Ethernet.

- PoE support (with separate PoE HAT).

- Gigabit Ethernet over USB 2.0 (maximum throughput 300 Mbps).

- 4 × USB 2.0 ports.

- Extended 40-pin GPIO header.

- HDMI, MIPI DSI display port.

- MIPI CSI camera por.

- 4 pole stereo output and composite video port.

- 1GB LPDDR2 SDRAM.

- Micro SD format for loading operating system and data storage.

- Micro SD is Not included. [19]

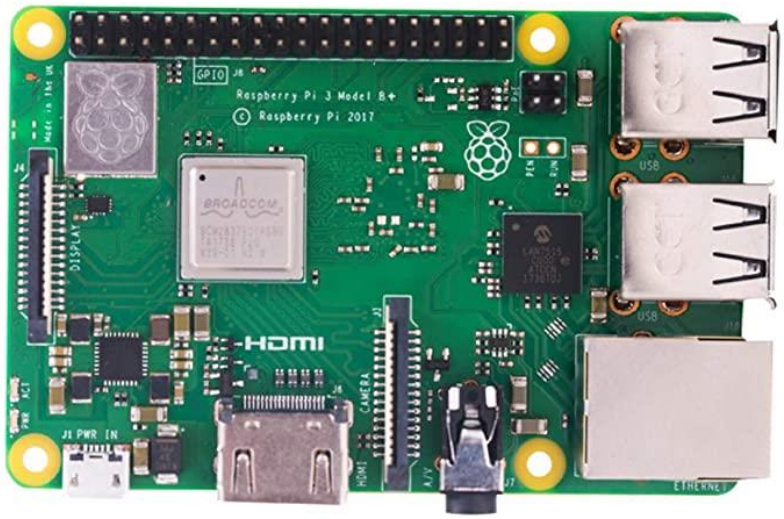

FIg 27: Raspberry pi (3B+) 1

I.9.1.2 Camera Pi

A camera pi is a piece of electronic equipment that is used for taking photographs and recording videos. It connected with Raspberry pi by IDE cable was mandatory added for immediate capturing**.**

One of the advantages of using camera pi is the ability of do some modification in its library.

FIg 28: Camera Pi accessory

I.9.2 Image processing

Object detection using cascading classifiers is an efficient method of object detection proposed by Paul Viola and Michael. It is an approach based on machine learning. The Cascade function is formed from many positive and negative images. It is then used to detect objects in other images.

First, a classifier is trained using a few hundred views of a particular object (a face or a human body), called positive examples, which are scaled in the same way. Size (for example, 20x20), and negative examples - arbitrary images of the same size.

Once a classifier is trained, it can be applied to a region of interest (of the same size as used during training) in an input image. The classifier outputs a “1” if the region is likely to indicate the object (a face or a human body) and “0” otherwise. To search the object in the entire image, you can move the search window over the image and check each location using the classifier. The classifier is designed to be easily "resizable" so that it can find the objects of interest of different sizes, which is more efficient than resizing the image itself. Thus, to find an object of unknown size in the image, the scanning procedure must be performed several times at different scales.

The word "cascade" in the classifier name means that the resulting classifier is composed of several simpler classifiers (steps) which are applied later to a region of interest until the candidate is rejected at some step or all steps are completed. [20]

In this procedure, we rely on files that are created and made available to developers for use in their applications. These files are available on the GitHub forum.

By image processing, the system can solve the previous issues in one little bit complicated program.

I.10 Conclusion

In this chapter, the different used components and equipment are defined even its their characteristics and its advantages. Ditto, the implementation of both of sensor based system and vision based system.

Conclusion

Conclusion

In this thesis, the automatic surveillance system was presented. Starting with a definition of people counting and brief history.

In chapter II, the modulization of the optimal of our system was showed, which we shall appley it. Each element of both of the two system were discussed from different sides, such us advantages, weaknesses and characteristics.

Chapter III was appearing the implementation of what had been modelized in the second chapter. So that it was showing the reason of selecting each component. Even the realization the both of systems.

The last stage of the realization of sensor based system was arrived in prototype of automatic counting the students who go into the library and discounting them from the counter, if they go out. Even presents the whole total of students and appears the case of if someone stayed inside of the building at the end of the day.

In another hand, the realization of vision based system was arrived in preparation of program and right libraries for Raspberry Pi, then start teaching the system for doing the counting from video surveillance. We arrived till this point because of the limit time and the wide project in both of side sensor based system and vision based system.

As perspectives, going forward with machine learning to add some features to the system such us: face recognition, student behavior, applying the student data to the system, adding warning system if something happens suspicious.

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Appendix

Arduino code source

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd (0x27, 20, 4);

const int LAZER_INPin1 = 2;

const int LAZER_MIDDLEPin1 = 3;

const int MW_PIRPin1 = 5;

const int LAZER_OUTPin1 = 7;

const int ledPin = 13;

int button1_IN = 0;

int button2_MIDDLE = 0;

int button3_MW_PIR = 0;

int button4_OUT = 0;

int total=0;

int TOTAL = 0;

int STUDENTS_IN=0;

int prestate_IN= 0;

int prestate_MIDDLE = 0;

int prestate_MW_PIR = 0;

int prestate_OUT = 0;

int LAZER_int = 0;
```

```
int LAZER_MIDDLE = 0;

int MW_PIR = 0;

int LAZER_OUT = 0;

void setup() {

  pinMode(ledPin, OUTPUT); pinMode(LAZER_INPin1, INPUT);
pinMode(LAZER_MIDDLEPin1, INPUT);

  pinMode(MW_PIRPin1, INPUT); pinMode(LAZER_OUTPin1, INPUT);

  Serial.begin(9600);

  lcd.backlight ();

  lcd.setBacklight(HIGH);

  lcd.clear();

  lcd.init();

  lcd.begin (16,2);

  lcd.setCursor(0, 0);

  lcd.print("Students In:");

  lcd.setCursor(0,1);

  lcd.print("Total:");

}

void loo() {

  button1_IN = digitalRead(LAZER_INPin1); button4_OUT =
digitalRead(LAZER_OUTPin1);

  button2_MIDDLE = digitalRead(LAZER_MIDDLEPin1); button3_MW_PIR =
digitalRead(MW_PIRPin1);
```

```
  if (button1_IN == HIGH && prestate_IN== 0) {
    LAZER_int += 1;
    Serial.print("LAZER_int IN: ");
    Serial.println(LAZER_int);
    prestate_IN= 1;
  }
  else if (button2_MIDDLE == HIGH && prestate_IN== 0 && prestate_MIDDLE == 0 &&
LAZER_int > 0) {
    LAZER_MIDDLE += 1;
    Serial.print("LAZER_MIDDLE IN: ");
    Serial.println(LAZER_MIDDLE);
    prestate_IN= 1;
    prestate_MIDDLE = 1;
  }
  else if (button3_MW_PIR == HIGH && prestate_IN== 0 && prestate_MIDDLE == 0 &&
prestate_MW_PIR == 0 && LAZER_int > 0 && LAZER_MIDDLE > 0) {
    MW_PIR += 1;
    Serial.print("MW_PIR IN: ");
    Serial.println(MW_PIR);
    prestate_IN= 1;
    prestate_MIDDLE = 1;
    prestate_MW_PIR = 1;
  }
```

```
  else if (button4_OUT == HIGH && prestate_IN== 0 &&prestate_OUT == 0 &&
prestate_MIDDLE == 0 && prestate_MW_PIR == 0 && prestate_OUT == 0 &&
LAZER_int > 0 && LAZER_MIDDLE > 0 && MW_PIR > 0) {

    STUDENTS_IN++;

    TOTAL++;

    Serial.print("STUDENTS IN: ");

    Serial.println(STUDENTS_IN);

    prestate_OUT = 1;

    prestate_IN= 1;

    prestate_MIDDLE = 1;

    prestate_MW_PIR = 1;

    prestate_OUT = 1;

    LAZER_int = 0;

    LAZER_MIDDLE = 0;

    MW_PIR = 0;

  }

  else if (button1_IN == LOW && button2_MIDDLE == LOW && button3_MW_PIR ==
LOW && button4_OUT == LOW) {

    prestate_IN= 0;

    prestate_MIDDLE = 0;

    prestate_MW_PIR = 0;

  }

  if (button4_OUT == HIGH && prestate_OUT== 0) {
```

```
    LAZER_OUT += 1;
    Serial.print("LAZER_OUT OUT: ");
    Serial.println(LAZER_OUT);
    prestate_OUT = 1;
  }
  else if (button2_MIDDLE == HIGH && prestate_MIDDLE == 0 && prestate_OUT == 0
&& LAZER_OUT>0) {
    LAZER_MIDDLE += 1;
    Serial.print("LAZER_MIDDLE OUT: ");
    Serial.println(LAZER_MIDDLE);
    prestate_OUT = 1;
    prestate_MIDDLE = 1;
  }
   else if (button3_MW_PIR == HIGH && prestate_MW_PIR == 0 && prestate_OUT == 0
&& prestate_MIDDLE == 0 && LAZER_OUT>0 && LAZER_MIDDLE > 0) {
    MW_PIR += 1;
    Serial.print("MW_PIR OUT: ");
    Serial.println(MW_PIR);
    prestate_OUT = 1;
    prestate_MIDDLE = 1;
    prestate_MW_PIR = 1;
  }
```

```
  else if (button1_IN == HIGH && prestate_OUT == 0 && prestate_MIDDLE == 0 &&
prestate_MW_PIR == 0 && LAZER_OUT > 0 && LAZER_MIDDLE > 0 && MW_PIR > 0
) {
    STUDENTS_IN--;
    Serial.print("STUDENTS IN: ");
    Serial.println(STUDENTS_IN);
    prestate_OUT = 1;
    prestate_MIDDLE = 1;
    prestate_MW_PIR = 1;
    LAZER_int = 0;
    LAZER_MIDDLE = 0;
    prestate_MW_PIR = 0;
  }
  else if (button1_IN == LOW && button2_MIDDLE == LOW) {
    prestate_OUT = 0;
    prestate_MIDDLE = 0;
    prestate_MW_PIR = 0;
  }
  lcd.setCursor(16, 0);
  lcd.print(total);
  lcd.setCursor(16, 1);
  lcd.print(STUDENTS_IN);
}
```