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AUTOMATIC COUNTING PEOPLE SYSTEM AS A STRATEGY TO CONTROL COVID-19 SPREAD

Julián R. Camargo L., César A. Perdomo Ch. and Oscar D. Flórez-Cediel
Faculty of Engineering, Universidad Distrital Francisco José de Caldas, Bogotá D. C., Colombia
E-Mail: jcamargo@udistrital.edu.co

ABSTRACT

This paper proposes an Automatic counting people system as a strategy to control COVID-19 spread. The system proposed allows counting in real-time the number of people in a specific space, that information can contribute to the decision of the number of people that can enter a space. The automatic counting people system contributes to keeping the minimum distance between each person, a measure that many governments have implemented as a tool to prevent COVID-19 spread. The counter was implemented using an ESP8266 module, which is a low-cost device with a great capacity for information.

Keywords: blynk, ESP8266, IoT, presence sensor, total capacity.

1. INTRODUCTION

The COVID-19 pandemic has changed the consumption habits of people. According to recent investigations [1], these changes could be permanent. For this reason, the commercial sector has been working on strategies to keep their businesses open and avoid future affectations in a possible COVID-19 resurgence.

The businesses' owners principal concern is to ensure the health of their clients and employees. Controlling the total capacity of space is key in those establishments where a significant group of people can be gathered. According to the actual regulation, all businesses must reduce the total capacity between 20 % and 40 % [1].

The automatic counting people system presented in this paper suggests a strategy to mitigate and help with the prevention of COVID-19 spread. This strategy focuses on spaces with high customer traffic.

This system allows an automatic, real-time counting of people who enter and go out of a particular space, using a predefined number of people that can remain in that area.

2. TOTAL CAPACITY: DEFINITION AND CHARACTERISTICS

2.1 Definition

In this article, the total capacity refers to the number of people in a public or private space, like a theater or a restaurant [2]. Seating and capacity are some synonyms used.

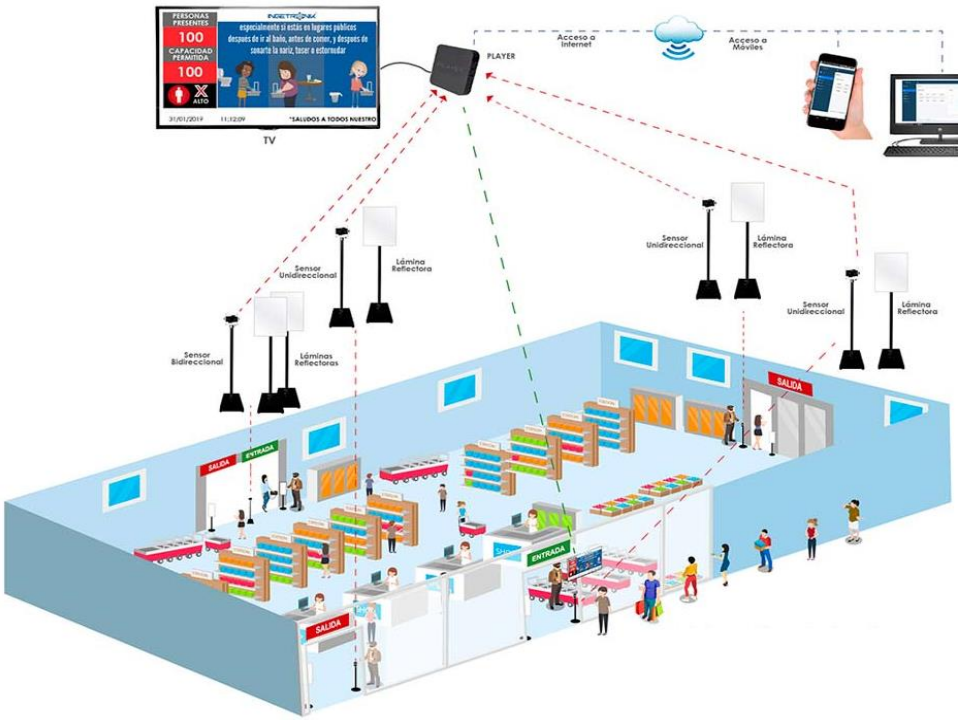

Figure-1. Typical total capacity control [5].

The total capacity describes the relationship between the area of a place and the recommended distance between each person. This relation allows determining the maximum number of people that can stay in a place for a specific amount of time [3].

Limiting the number of people in a place allows keeping the distance between them. This method has shown to be helpful advice to prevent COVID-19 spread [4].

Figure-1 shows a total capacity control taken in a shopping mall with two entrances and three exits.

2.2 Types of Total Capacity Control

There are different ways of implementing total capacity control, such as:

- A designated person can count manually the number of people
- Cameras and apps for counting people
- Occupancy sensors
- Access controls at one or different entrances and exits.

Counting manually could seem like the easiest and affordable solution to the total capacity control, but this method is not very efficient due to human error. It also needs, a human resource that can be used in other types of control [4].

2.2.1 Cameras and apps for counting people

Cameras and apps for counting people consist in video analysis.

The cameras, besides counting the people, can detect the number of people entering and going out of a place, and allows to set the limit number of people in a place. When the maximum number of people is reached inside a place an alarm is triggered, this alarm could be visual, like a traffic light, or a sonorous alarm.

Figure-2 shows a diagram of a camera and app for counting people.

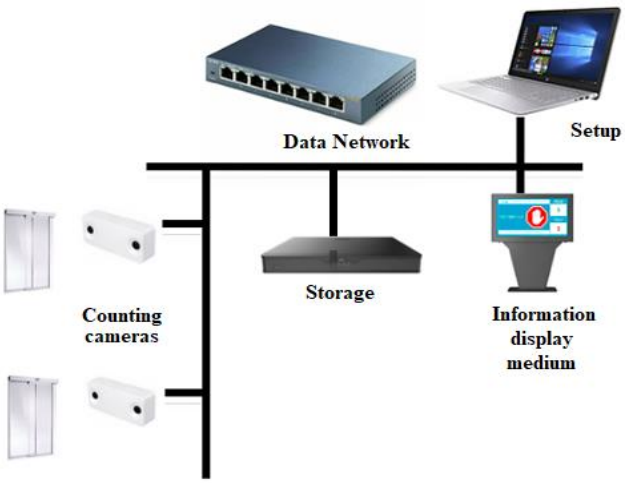

Figure-2. Total capacity control using camera [4].

The total capacity control can be integrated into the access control system. This function can send a signal that blocks the entry access to control the occupation of a place [4].

2.2.2 Sensors and apps for counting people

Sensors and apps for counting people allow automatically counting people. These methods use sensors, in most cases optical sensors, that count the number of people that get in and out of a specific space. That number is indicated using visualization devices like a tablet or a smartphone. In cases where the maximum number of people is exceeded, the device gives a visual alarm [5].

Figure-3 shows a diagram of sensors and app for counting people.

Figure-3. Diagram of sensors and app for counting people [5].

3. METHODOLOGY

3.1 Description of the System

The system is composed of n control stations. N is the number of entrances to control.

Each control station has an ESP8266 module used to control the communication via WiFi, to transfer the data generated by the occupancy sensors, and to generate alerts when the total capacity is exceeded [6 -11].

An app developed in Blynk centralizes the whole process in a smartphone. This app sends and receives the information sent by the control station.

Figure-4 shows the general diagram for a total control system using occupancy sensors.

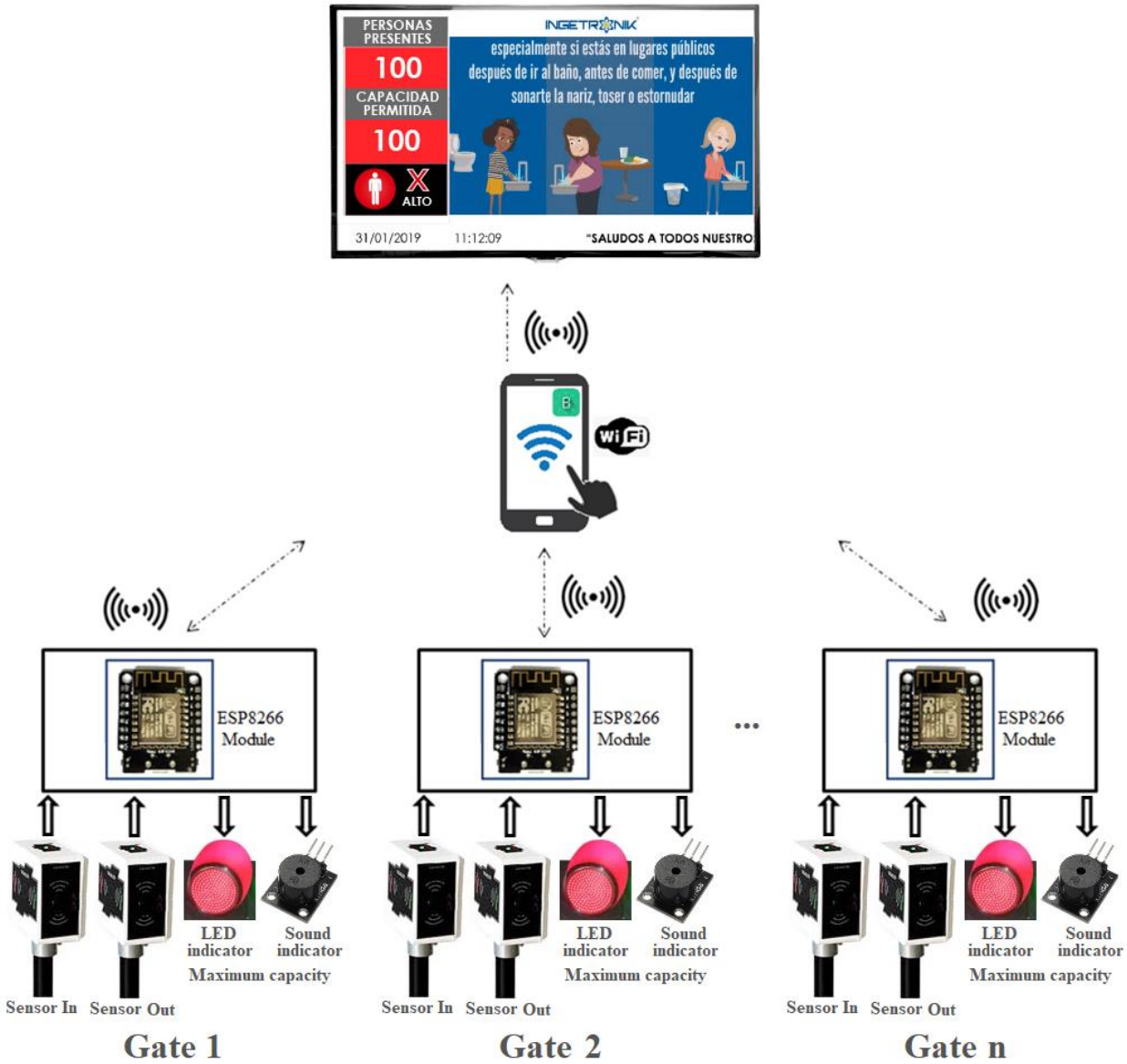

Figure-4. General diagram for a total control system using occupancy sensors.

3.2 Application of the ESP8266 Module

Each control station has the same components:

- An ESP8266
- Two optical sensors to detect the entry or exit
- A LED indicator
- An audible indicator to inform when the total capacity has been exceeded

The ESP8266 module receives information via WIFI, from the app developed in Blynk and from the optical sensors.

The ESP8266 module generates the alert when the total capacity has been exceeded, and it also sends information to the app to update the data shown on the screen.

Figure-5 shows the process of control and communication done by the ESP8266 module.

To begin, the ESP8266 module sets up peripherals and starts variables, subsequently stays in a timed standby mode to check the status of the optical sensors, firstly verifies the entrances sensor and finally the exit sensor. If one of the sensors is on, the module activates the counter to verify the value and to calculate the current capacity.

When the number calculated exceeds the total capacity number the module generates an alert; otherwise, if the number calculated is lower than the total capacity number, the module sends the information to the app.

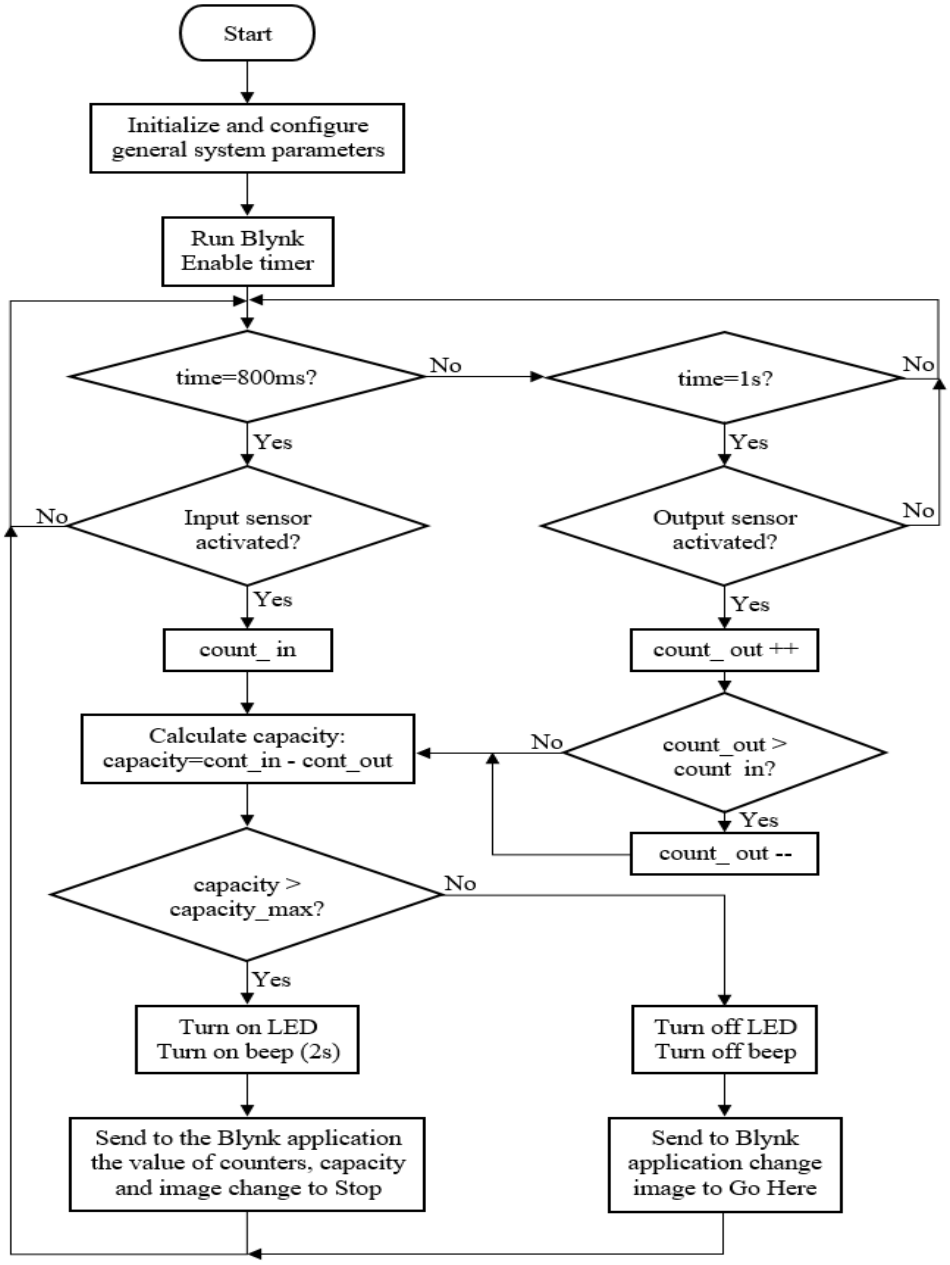

Figure-5. Process of control and communication done by the ESP8266 module.

3.3. App Developed in Blynk

Blynk is a platform for IoT. Blynk allows controlling an app using a microcontroller and an iOS or Android device.

Using Blynk the user can create a graphic interface of "drag and drop". This application is focused on platforms like Arduino, Raspberry Pi, ESP8266, Intel Galileo, serial devices, and WiFi [12-14].

Figure-6 shows the architecture of an application using Blynk.

The app described in this paper was created using Blynk.

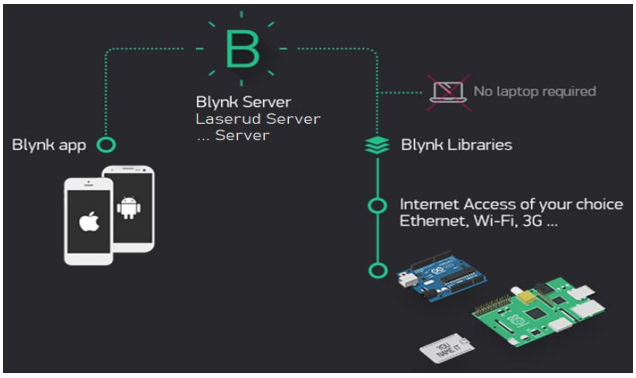

Figure-6. Architecture of an application Blynk. [12].

The app visualizes the information collected by the ESP8266 module, shows the current capacity on a

screen as an entry control; and informs the supervisor, via text message or email, when the total capacity has been completed.

When the app is running the ESP8266 module sends the actual values of the counters: entrance counter (*cont_in*) and total capacity counter (*cont_aforo*). These values are visualized on the app, and a numerical state will select which image has to be shown, it could be an enter or a stop image.

Figure-7 shows the images used to control the entry to a controlled space.

Figure-7. Images used to control the entry to a controlled space.

Every time that a person goes in or goes out of a controlled place, the value is updated and sent from the ESP8266 to the app. These values can be visualized as a percentage of the occupation, each percentage is represented by a color, from green to red depending on the degree of occupation.

Figure-8 shows the visualization of the information on the app.

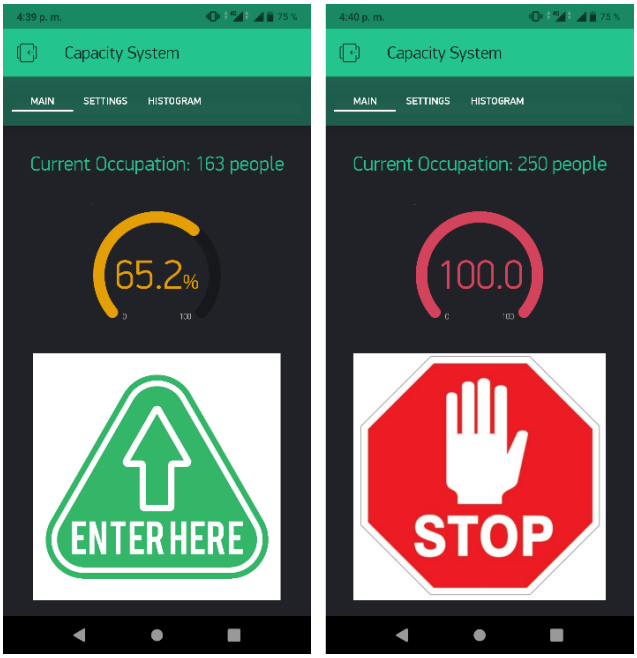

Figure-8. Visualization of the information on the app in Blynk.

The app also provides a graphic of the historical total capacity. This information will help managers to take corrective actions in the future.

The historical record can be reviewed in different periods: second by second, half-hour, one hour, one day, and one week. The app also allows checking a particular point of the record of an hour and total capacity at that moment. The complete information can be downloaded as an excel file.

Figure-9 shows the histogram generated by the app.

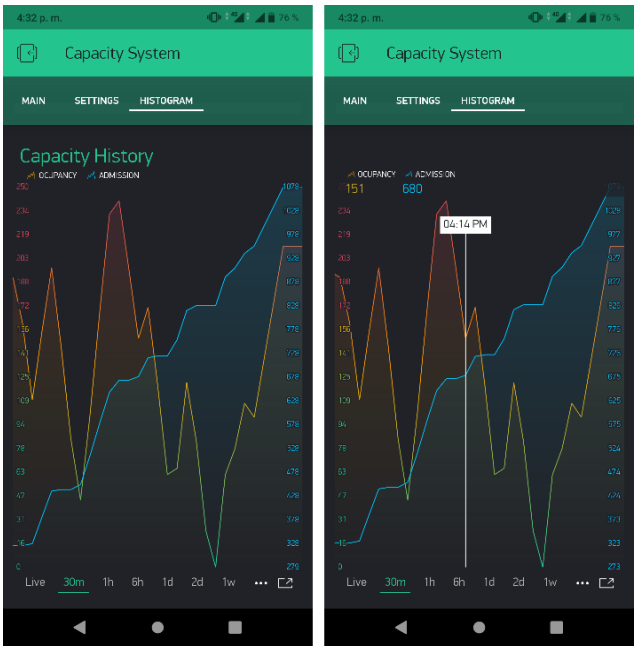

Figure-9. Histogram generated by the app.

4. TESTS AND RESULTS

The proposed system was implemented using only one entry point.

Table-1 shows the results obtained in the test with precision from 98 % to 100 %.

Table-1. Results obtained in the test using only one entry point

	Entry	Exit	Capacity
Capacity System	54	23	31
Manual Counting	55	23	32
Capacity System	93	45	48
Manual Counting	94	45	49
Capacity System	127	81	46
Manual Counting	129	82	47
Capacity System	159	138	21
Manual Counting	159	137	22

5. CONCLUSIONS

The app presents a better performance in controlling the total capacity of a place compared to the manual counting.

The app allows controlling in real-time the total capacity of a controlled place, generating a visual or sonorous alert every time that that capacity has been exceeded. These types of alerts may not be generated at the right time using the manual counting method.

The COVID-19 pandemic has changed the social dynamic in many aspects, and the total capacity control has become a very useful tool to avoid COVID-19 spread. The app developed and described in this paper can be a useful tool for this purpose.

The app described in this paper is a great example of how technology and IoT help to create practical solutions to nowadays problems.

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