Post COVID-19 implementation of a bidirectional counter with reduced complexity for people counting application

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Abstract. This paper presents a system for counting people through infrared detection. The system tallies the count and update based on people moving in/out through the supervised area/premise. The counter requires two steps: detection coming in and leaving the area. Obstacle detection from infrared sensor updates the counters and the current value will be displayed in a thin-film-transistor module. With minimal hardware configuration, the developed system is robust and easier to install.

1. Introduction
Non-compliance handling of premises admission post COVID-19 are vulnerable to the possibility of Coronavirus repopagation through public gathering. Engaging restriction via strategies imposed by authorities lessen the disruptions and losses. However, challenges while ensuring compliance can be a daunting task, especially when dealing with large crowd.

Initiative by local establishment in managing compliance obligations are mostly reflected by appointing human/staff or issuing queue card to limit potential customers/visitors into premises. Despite produced effective action, proper utilization is required in keeping resources balanced in workload.

A proper automation of crowd limiting system can be develop by targeting cost and reliability. A contactless bi-directional visitor counting system has been developed and assembled in local government infrastructure. The system is equipped with a 2.8 inch thin-film-transistor (TFT) display and two adjustable infrared (IR) sensor modules. Development of real time interface via touchscreen appertained to the TFT display was also realized with minimal complexity.

The process presented is organized as follows. Research works of related work is given in section 2, in section 3, the description of the system architecture and the overall model. Section 4 describes the system Implementation results. Finally, section 5 concludes the paper.

2. Research works
Conventional practice of implementing a microcontroller unit to realize the system are noticeable throughout ref [1]. Common sensors ranging from an ordinary IR sensor to sophisticated vision-based counter system is widely explored in [2-4].

Initial beginning has revolutionized from manual counting into complex counting algorithm throughout the years. Classification of these counters which includes contact counters, passive infrared (PIR), microwave, etc are presented in [5]. Its basic feature to detect presence hence able to activate
counting sequence. Superior systems such as a high-level system might be a surveillance system such as a laser scanner capable of counting people at higher degree of efficiency [6].

Evaluation of counting software and image processing algorithms for camera sensors has been conducted among [7-11].

Various vision-based people counters have been developed. Vision Detection with tracking-based methods and segmentation with regression-based methods detect people’s locations and track them to extract the people count [12-15]. Deep learning-based people counters had recently been proposed to take advantage of the outstanding feature extraction capability of deep learning [16-18]. Most deep learning-based people counters aim to estimate the number of people in a large crowd of a given image. Complex methods are advantageous in term of accuracy, however higher cost on the market, complex setup/installation affected its practicality. Simpler solution in setup and proper message delivery are the main attribution in achieving the proposed system realization.

3. System hardware
Minimal configurations are executed through system implementation; which consists from an Arduino Uno board, a TFT module and two infrared sensor modules. The Arduino Uno board facilitate programming and incorporation into other circuits, i.e. sensor modules. Two infrared sensor modules with sensing range up to 30cm are connected to the system. Detection from entering or exiting will enable counting process. The TFT modules are the preferred display element to provide sizable customized characters (including numbers), with configurable colour coding and it is equipped with a touchscreen feature.

4. Methodology
The proposed system architecture is shown in figure 1. Blocked transmitted IR (Infrared) signal will enable obstacle detection. Detection from either Ultrasonic module sensor 1 or Ultrasonic module sensor 2 will activate counter. Detection sequence coming from Ultrasonic module sensor 1 to Ultrasonic module sensor 2 will cause counter counting up and vice versa for opposite direction. Arranging the sensors (i.e. Ultrasonic module sensor 1) at the front of entrance and followed by Ultrasonic module sensor 2 at the back in such a way that movement of incoming/outgoing in a single line is possible.

![Ultrasonic module sensor 1](image1)

![Ultrasonic module sensor 2](image2)

![Arduino Uno](image3)

**Figure 1.** Overall system block diagram

The proposed system flowchart is shown in figure 2. When start, the program begins with system initialization. Counter reset and sensors scanning are conducted not more than 1.3kHz (1.298kHz). Upon IR detection, counter subroutines will be selected according to flow direction. Counter status is updated subsequent to counter execution. The counter is set to count up to 99 persons maximum, while a limiting value is set at 4 persons. These amounts can be adjusted according to the property requirement/capacity. A TFT module will display the current counter value. During start up, delay for 10 seconds commences prior to system operation. The delay is an animated countdown from 10 to 0 second in red font colour before proceed to normal display, which is to tally count (active count). Active
count begins in green font colour to indicate allowable status until the counter reaches 5, and the font colour will change to red for entrance denial. Counter decrease will enable back active count.

Start

Initialization

Countdown 10s

Reset counter? Yes

Set counter to 0

No

Sensors scanning

Countdown 10s

In ? Yes

Count up

No

Out ? Yes

Count down

No

Update counter

Update TFT

End

Figure 2. System flowchart

5. Results and discussion
The developed system is assembled in a local government structure (secondary school toilet) as shown in figure 3. The prototype is placed on top of the door frame. IR sensors are placed horizontally in the middle of the door frame.
Figure 3. System installation

Upon activation, the countdown (10sec) begins as shown in figure 4. The text “TUNGGU” requires user to wait until countdown complete. Also included the reset counter menu and its IR sensors.

Figure 4. System prototype

Figure 5 indicates active count with green font colour. Also, the text “MASUK” appear to notify user the to enter the premise. Figure 6 indicates full count with red font colour. The text “PENUH” is to notify user the full status.
6. Conclusion

In this paper, a bidirectional counting system smoothly operates based on IR obstacle detection. Counting is accomplished and displayed by utilizing a TFT module. The system was implemented with minimal setting thus allowing for robust and easier installation. The performance of sensors is capable of updating changes in capacity regardless of flow direction.

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