ISSN (online): 2349-784X

People Counting System for Smart Energy Consumption and Mob Management

Pratiksha Sunil Paluskar
UG Student
Department of Information Technology
KKWIEER, Nashik

Roshni Anil Kasliwal
UG Student
Department of Information Technology
KKWIEER, Nashik

Shweta Vilas Mate
UG Student
Department of Information Technology
KKWIEER, Nashik

Prof. S. P. Mene
Guide & Assistant Professor
Department of Information Technology
KKWIEER, Nashik

Mr. Akash Talole
Guide, Research and Development Engineer
ESDS Software Solution Pvt. Ltd. Nashik

Abstract

The new rule for the future is going to be, "Anything that can be connected, will be connected". The system in this paper is proposed in order to take a step towards a connected and smarter future, and also to foster an efficient way for management of crowd and energy consumption. This system is built using various trends driving the future of information technology such as Raspberry pi, Image processing, MQTT publish-subscribe protocol, ESP8266 NodeMCU, and Node-RED. Raspberry pi camera module is used for capturing images at regular intervals of time; the captured image is processed by Raspberry pi using OpenCV and Haar cascade classifier which detects human heads to generate a count of the detected people. This count is published to Node-RED by Raspberry Pi which is subscribed by the ESP8266 NodeMCU to control the electronic devices according to the subscribed count, rather according to the presence or absence of people. MongoDB database connectivity is given to Node-RED wherein statistics about crowd density and distribution at a particular time and area are obtained.

Keywords: ESP8266 NodeMCU, Haar cascade, MQTT protocol, Node-RED, OpenCV, Raspberry pi

I. INTRODUCTION

In today's era of technical revolution, people are on the move, technology is advancing, and smarter resources have become a need of the hour. Many organizations and managers evaluate their work by making comparisons and statistics on the number of people visiting their centres or interested in their products. Even today, a primary method for counting traffic involves hiring human auditors to stand and manually tally the number of visitors who pass by a certain location. But human based data collection comes at great expense. Consequently, ongoing traffic measurement has been cost-prohibitive for most retailers. Thus, People Counting Systems have come into picture. People Counters enable the managers to understand and to anticipate the patterns of their passengers; whether it is a matter of assigning additional staff to accommodate the rush hour traffic or if they have to change the services they provide to the customer, with minimum manual effort.

Crowds occur in a variety of situations, for instance, concerts, political speeches, rallies, as well as at places like shopping malls, stadiums, stations, theatres etc. People counting helps in management of crowds for safety and unusual behaviour detection. It also helps in finding the volume of commuters which is important for development and management of a smart infrastructure, and taking better business decisions. In many cases counting through doorways or counting by humans is not possible or is too inconvenient. Thus, we need to switch to computer based approaches to obtain the counting estimates, when the crowd is dense.

II. RELATED WORK

A. Counting passer-by using Space-Time Images

The system proposed by A. Elmarhomy, S. Karungaru and K. Terada uses an automated method for counting passer-by using virtual-vertical measurement lines. The process of recognizing a passer-by is carried out using an image sequence obtained from the USB camera. Space-time images [(1)] represent the human regions which are treated using the segmentation process. To handle the problem of mismatching, different colour space are used to perform the template matching which automatically chooses the best matching to determine passer-by direction and speed. A relation between passer-by speed and the human-pixel area is used to distinguish one or two passers-by. In this system, the camera is fixed at the entrance door of the hall in a side viewing position.

All rights reserved by *www.ijste.org*

The experimental results verify the effectiveness of the system by correctly detecting and successfully counting people with high accuracy.

B. Human Tracking in Visual Surveillance System

The system proposed by Ashish Kumar Sahoo, et al. [2] counts the number of people moving in or out of an area supervised by a single fixed overhead camera. The algorithms used have the capability of determining people count for a single person as well as for multiple people crossing the range of camera. Single as well as multiple persons are tracked in the scene using the centre of gravity approach. Counting is basically done by tracking the person/people in the range of camera. The complete system is divided into five modules. The first module is related to acquiring image frames. An overhead camera model has been used to obtain the images. The next module is used to determine the motion of object. Unless a motion is detected in the background, the images are not processed. This increases the efficiency of the system. Then from the acquired image, background information is estimated.

C. People Counting System using Infrared Sensors

In people counters that use infrared sensors, two adjacent infrared beams are emitted by the Infrared transmitter. The beams are detected by the Infrared receiver. The counter in the receiver increments the count by one when the beams get cut as a person passes by. When multiple people simultaneously cross the count line side-by-side, the beam may only be broken the one time, and therefore only count a single entry or exit.

D. People Counting System using Thermal Sensors

A thermal sensor used in people counters is mostly a ceiling mounted sensor designed specifically to count multiple people in both directions. This sensor senses the thermal heat generated by people passing through its field of view. It will track individuals as they walk through the field of view but only record a count when the person physically crosses the zone lines. Some of the drawbacks of people counters using thermal sensors are, if the temperature within the counting area is greater, this system cannot give an accurate count. Also, if a person just comes out of an A/C environment, the sensor cannot detect him. The system cannot differentiate between a human and a pet animal.

III. THE PROPOSED SYSTEM

A. System Overview

This system is made up of Raspberry pi camera module, Raspberry pi, ESP8266 Node MCU and is driven using technologies like Node-RED, MQTT publish-subscribe protocol, etc. Fig. 1 depicts the architectural framework of the proposed system.

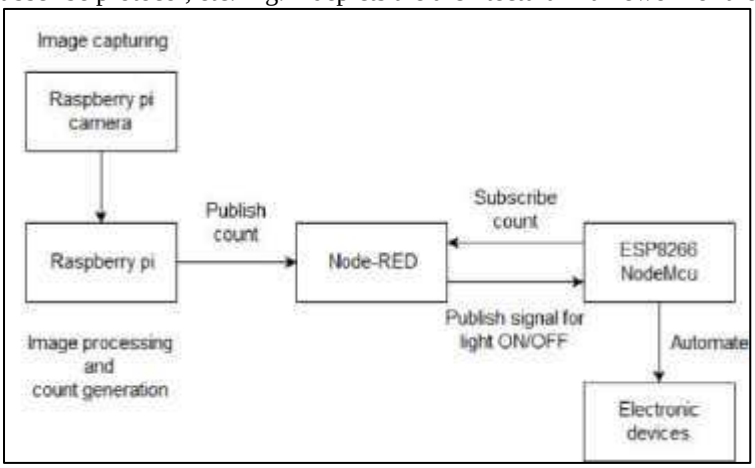

Fig. 1: System Architecture

B. Image Capturing

The proposed system makes use of a Raspberry Pi Camera module for capturing images. The module captures a five-megapixel image and then it is stored in JPG format. The camera is connected to the Raspberry Pi and Raspberry Pi is mounted on the top of a wall of the particular room similar to a CCTV camera. The images are captured after a fixed time interval. The Raspberry Pi will process each image.

C. Image Processing and Count Generation

Image processing is a crucial step in this project. In proposed system, a Haar feature-based cascade classifier is used to detect heads in the image. Cascading Classifiers are trained with several hundred "positive" sample views of a particular object and arbitrary

All rights reserved by *www.ijste.org*

"negative" images of the same size. After the classifier is trained it can be applied to a region of an image and detect the object in question. To search for the object in the entire frame, the search window can be moved across the image and check every location for the object. There are Haar Feature-based Cascade Classifiers and LBP (Local Binary Patterns) classifiers. LBP is faster than Haar cascades but less accurate. Hence Haar cascade classifier is used in this project.

The OpenCV library is used for image processing operations and detection of heads. OpenCV (Open Source Computer Vision) is an open-source real-time computer vision and machine learning library for python. OpenCV has many pre-trained classifiers to detect face, eyes etc. We have used a similar pre-trained classifier for head detection [(3)]. The cascade is applied after performing some image enhancement operations on the image for better results. Along with the total count of heads in the room, the count of people present in each section (quadrant) of the room will also be given, which can be a parameter for automation. Raspberry Pi module will publish this information to the Node-RED using MQTT publish-subscribe protocol. Fig. 2 (a) below is an image of people seating in a seminar hall, this image gets processed to produce image Fig. 2 (b) that shows the heads detected by the Haar cascade classifier.

Fig. 2: (a) Original Image

Fig. 2: (b) Image with heads detected

Fig. 2: Head Detection Using Haar Cascade Classifier

D. Automation of Devices

The system proposed in this project will automate the manually controlled devices. There are various low-cost micro-controller modules available for IoT. One such module is the ESP8266 NodeMCU Wi-Fi module which is used in this project. The ESP8266 NodeMCU module can be programmed with Arduino IDE. This module will subscribe to the topics published by Node-RED and control the devices according to it. The Wi-Fi module can be installed in the switch board and connected to a relay to control lights automatically as per the presence or absence of people. Fig. 3 shows a small demonstration of the working of ESP8266 NodeMCU where the LED lights can be replaced with original lights in the room by installing the WiFi module in the switch board. The glowing lights demonstrate the presence of people in that area.

All rights reserved by *www.ijste.org*

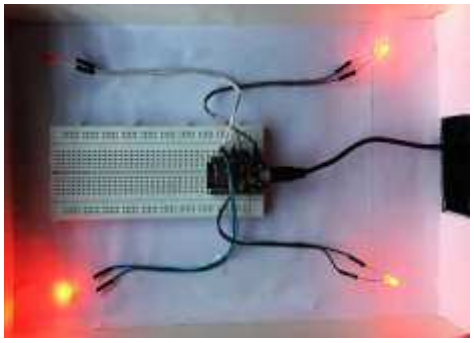

Fig. 3: Automation using ESP8266 NodeMCU

E. Data Analytics

After getting the count, the system will give statistics, thereby enabling the organization to take evacuation measures, to check marketing effectiveness, etc. It will be beneficial from business perspective. Node-RED provides a wide range of UI nodes using which a user-friendly GUI can be built. The UI nodes include charts, gauge etc. By using these you can get the information in a graphical format. It also includes a template node; using which custom UI widgets can be developed. In this project, chart of recent count can be viewed. Also, the count in each section can also be viewed in a count vs. time stamp graph. Average count of specific date and its distribution can be viewed. Table for date-wise average count and its distribution is also given. Knowing which section of a room is more crowded on which day and at what time can be useful for better understanding of customers' buying behaviour and also for providing better services to the customers. Fig. 4 and Fig. 5 shows the various statistics generated by Node-RED. These results can be viewed on the Node-RED dashboard.

Fig. 4: Timestamp Vs. Count chart and Current Count

All rights reserved by *www.ijste.org*

Fig. 5: Crowd Distribution

IV. ALGORITHM

1) FRAMES ← 100, TIMEINBETWEEN ← 300, frameCount ← 0
2) while (frameCount < FRAMES)
    a) Capture image from Pi-camera and store it.
    b) Read stored .jpg file.
    c) Increase contrast of image.
    d) Load haar cascade classifier file.
    e) count ← 0, quad1 ← 0, quad2 ← 0, quad3 ← 0, quad4 ← 0
    f) Detect heads using detect MultiScale() function.
    g) for (every person detected)

if (person detected in quadrant 1), then
quad1 = quad1 + 1
else if (person detected in quadrant 2), then
quad2 = quad2 + 1
else if (person detected in quadrant 3), then
quad3 = quad3 + 1
    else
quad4 = quad4 + 1

    h) count = count + 1, frameCount = frameCount + 1
    i) Write an image with detected people
    j) Sleep for time TIMEINBETWEEN
3) Connect client to Broker
4) Publish a json string containing count, quad1, quad2, quad3, quad4
5) Disconnect client

V. CONCLUSION AND FUTURE WORK

In this system, an approach for people counting using computer vision library OpenCV and automation of electronic devices using ESP8266 WIFI module is presented. Using a camera for people counting is a good alternative to other sensors as it gives more accurate results. The obtained count of people can be stored in MongoDB database to generate statistics which can be analysed to take smarter business decisions and manage crowd. MQTT publish-subscribe protocol is used for communication between Raspberry-pi and ESP8266 NodeMCU WIFI module. The WIFI module can subscribe to the count from Node-RED to automate devices for smarter energy consumption. The future scope of this system is to fetch real time images from CCTV camera and to integrate results from multiple images to process them on Raspberry pi so that a larger area can be covered and the scope of automation can be enhanced.

REFERENCES

[1] A. Elmarhomy, S. Karungaru and K. Terada, "A New Approach for Counting Passers-by Utilizing Space-Time Images", International Journal of Computer, Electrical, Automation, Control and Information Engineering
[2] Ashish Kumar Sahoo, Sandeep Patnaik, Pradyut Kumar Biswal, "An Efficient Algorithm for Human Tracking in Visual Surveillance System", IEEE Second International Conference on Image Information Processing
[3] Irshad Ali, Matthew N. Dailey, "Multiple Human Tracking in High-Density Crowds", Computer Science and Information Management Program, Asian Institute of Technology (AIT), Pathumthani, Thailand

All rights reserved by *www.ijste.org*