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RFID and Vision Based Human Tracking System for Mobility

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Abstract
The population of many developing countries is on the rise and is mostly concentrated in urban and industrial regions. Residing in or near these areas is preferred by people as it drastically reduces their commute times even though it is costlier. Many daily commuters use public transport systems – buses being a major choice. These can cover short to long distances and also cover larger cross section of area as compared to metro, local trains. However, buses tend to get overcrowded during rush hours and can be completely empty rest of the times. This causes passenger discomfort and wastage of resources when the bus is running without passengers. In this paper, we proffer a model for monitoring and counting people in various scenarios at bus stops and buses based on RFID technology and Vision-based techniques.

Keywords: *RFID, camera, Raspberry Pi, Public Transport*

I. INTRODUCTION

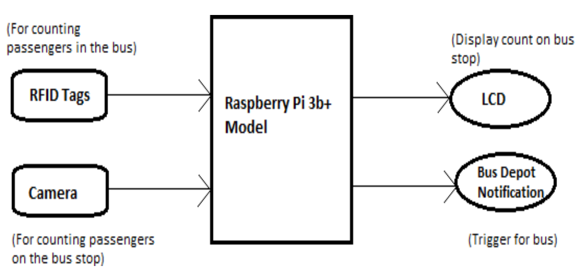
Nowadays, people all over the world prefer public transport over private vehicles for commutes due to causes like traffic congestion, high transit times, rising fuel prices, environmental awareness and so on. Governments from both developing and developed nations are striving to promote public transport over private among people as a measure for combating traffic congestion and associated problems like pollution. Several measures have been attempted all over the world, to make public transport bus services more attractive to the community. One such measure is to monitor and estimate the count of passengers at bus stops as well as in buses and supply additional buses at required crowded spots. Radio frequency identification (RFID) is a modernized automated identification and data capturing technology that is slowly earning more acceptances in the transportation system because of its ability to identify objects without a line of vision, greater reading distance, also affordable costing. Computer vision technology is an alternative for people counting systems. Computer vision technology is preferable for wider outdoor spaces and estimating dense crowd because of its non-intrusiveness, higher accuracy and non – obstructive people counting.

In this paper, we employ RFID and Vision-based technology for monitoring moreover counting passengers in buses and at bus stops respectively along with raspberry pi for internal communication of the system.

II. PROPOSED SYSTEM

RFID provides non-cash, contactless object identification and data transmission by the synergies of electromagnetic alternating fields acting between the tag and the reader. Every passenger will be provided a passive RFID tag that contains unique tag identification (TID). RFID readers will be mounted on the bus to scan the tags carried by the passengers. On detecting the tag, the RFID reader will store the count of the passengers onboard. The count of the passengers will be broadcasted on the LCDs set up at all the bus stops covering the bus route. The process of transmitting the count of people in the bus to the LCDs setup on bus stops is implemented by interfacing RFID reader and LCDs with raspberry pi 3 board. In this way, passengers are informed about the vacancies in the arriving bus. Computer vision technologies provide non-obstructive, non- intrusive, inexpensive people counting systems with higher accuracy. Computer vision technologies are used in wide-ranging regions with a crowd of varying density for people counting systems. The proposed system uses a surveillance camera mounted at bus stops to record the scene. Raspberry pi 3 processes the video frame by frame using a quad-core ARMv8 central processing unit to detect the presence of humans and supply a count of individuals in the precinct using OpenCV-Python. For human detection, a Haar cascade classifier is trained through OpenCV. This method gives the number of people at the bus stops. To control the crowd, the count of the individuals at the bus stop is overseen and if the count exceeds a threshold value, an automatic message will be triggered to bus depot requesting a supplementary bus to the required bus stop.

Raspberry Pi is a reasonably priced, credit-card sized computer with ARMv8 CPU, wireless LAN, Bluetooth, USB and HDMI (High-Definition Multimedia Interface) and Ethernet port along with camera and display interface. OpenCV-Python is accordant with raspberry pi 3. In the aimed model of the system, the intact interaction between the modules of the system is put through using the raspberry pi 3 board being the core component of the system. Fig.1 is the proposed model of our system. Fig. 2 represents the flow of the system.



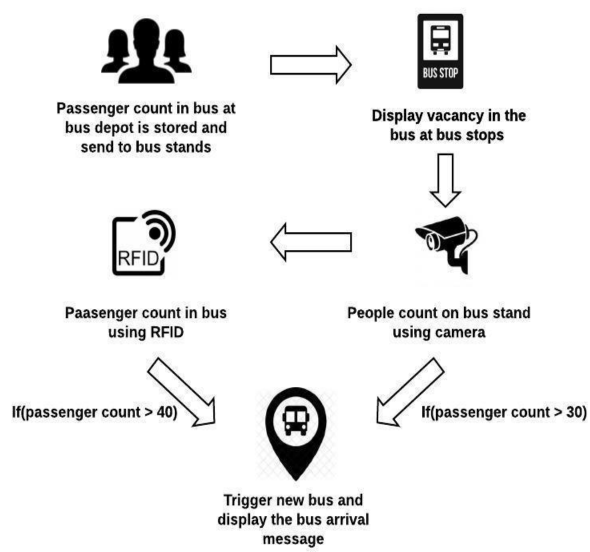


Fig.1 Proposed model of the system

Fig.2 Flow chart of proposed system

III. SOFTWARE AND HARDWARE TOOLS

In our study, for hardware setup, we use Raspberry Pi 3. It consists of 802.11n Wireless Local Area Network with 1.2GHz 64 -bit quad-core ARMv8 CPU along with Bluetooth 4.1 and BLE i.e. Bluetooth Low Energy. Additionally, Raspberry Pi 3 also consists 1GB RAM, 40 GPIO pins, 4 USB ports, Ethernet port, Camera interface, Full HDMI port, a Micro SD card slot and Display interface. The software used here is OpenCV-Python. It is a library which is aimed to resolve computer vision issues regarding of Python bindings. A very wide variety of programming languages like C++, Python, Java, etc are supported by OpenCV library. By joining the best features of the OpenCV-C++ API and the Python programming language, it is the Python API for OpenCV. Haar cascade classifier is used for detecting head with the help of samples that are collected on the site. Haar cascade classifier is trained using Haar features through OpenCV. The camera used is Quantum QHM495LM webcam with 6 light sensors, still image resolution of 25 megapixels, maximum frame rate of 30fps and Image quality of RGB24 or I420. RFID used is 18EM RFID reader module with operating voltage of +4.5V to +5.5V, operating frequency of 125 KHz, reading range of 10cm and communication parameter of 9600bps, depending on TAG Integrated Antenna. Fig.3 shows the interfacing of RFID reader module and LCD display along with raspberry pi 3. Fig.4 shows the LCD display interfaced to raspberry pi 3.

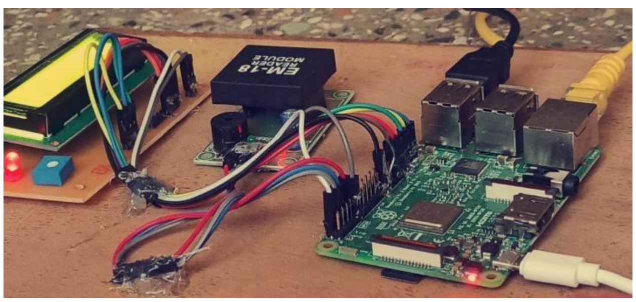


Fig.3 Interfacing of RFID and Raspberry Pi

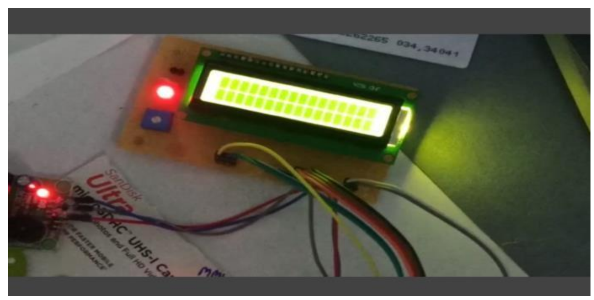


Fig.4 LCD display interfaced to Raspberry Pi.

IV. RESULT ANALYSIS AND DISCUSSION

The information from the hardware setup is collected by using Raspberry Pi 3 and then it is arranged in the tabular form to visualize the tag number, tag read status, people count, and bus status. As the passenger will scan that particular tag, then the information on the tag is collected and the passenger count is then displayed on the LCD. Fig.5 represents the tag is being read by the RFID reader. Total tags – 3.

Tag Number –

1) 270022831492
2) 27002284F978
3) 27002284C948

Fig.5 RFID reader reading the RFID tag

Table I displays the consolidated data or information from RFID tags and it also provides the bus status with passenger count. The information illustrates that the tags numbered 270022831492, 27002284F978, 27002284C948 shows the people count on the bus which is then displayed on LCD on the bus stop.

TABLE I
EXPERIMENTAL RESULT OF RFID TAGS READING

Sr .No.	**Tag count**	**Tag Number**	**Tag Read Status**	**Passenger Count**	**Bus Status**
1	1	270022831492	Increment	1	Not full
2	1	270022831492	Decrement	0	Not full
3	2	27002284F978	Increment	1	Not full
4	2	27002284F978	Decrement	0	Not full
5	3	27002284C948	Increment	1	Not full
6	3	27002284C948	Decrement	0	Not Full
7	1	270022831492	Increment	1	Not full
8	2	27002284F978	Increment	2	Not full
9	3	27002284C948	Increment	3	**Full**
10	3	27002284C948	Decrement	2	Not full
11	2	27002284F978	Decrement	1	Not full
12	1	270022831492	Decrement	0	Not full

Table II depicts the distance between reader and tag in centimeters and the number of successful reading of the tag from that distance. The EM-18 RFID reader scans the RFID tags of frequency 125 kHz. It shows that the distance between the reader and tag should be less which will increase the probability of successful reading of tags.

TABLE II SUCCESSFUL READINGS

Number of Tags	**Distance between reader and tag (cm)**	**No. of successful read hits**
	5	3
	1	3

3	0	
	15	3
	20	2
	25	1
	30	1

Thus to get the accurate results the scanning done by RFID reader is successful when the distance between the reader and tag is shorter. When the reading is successful the data is updated and the count of passengers in the bus is displayed on the LCD on the bus stop. In our study, we capture real-time videos using quantum 495Lm camera specifically positioned at a particular angle on the bus stop. The Optical flow concept is applied to trace a human using OpenCV. Optical flow includes determining the features to track and then computing the flow of the features. In this experimental study, a bounding box is used to indicate the detected heads. Multiple humans in the scene are identified using multiple bounding boxes. The pixel locations of the bounding boxes are obtained to trace the person. In every frame, the pixel values of the edges of the bounding box are registered and stored. It is vital to examine for accuracy of the people counter on varied environmental stipulations such as Angle of the Camera concerning ground, Height of Camera, also Luminescence in the frame. Table III shows the impact by the angle of the camera to the ground and the consequent occlusions that are formed on the area calculation. The area of blob gets unrestrained values as the angle of the camera is increased (either way), and thus thwarts the accuracy of the counter.

TABLE III
EXPERIMENTAL RESULTS OF CAMERA ANGLE

Angle (In degrees)	**Maximum Blobs**	**Accuracy Percentage**
2O	2	93.45%
8O	2	89.34%
8O	4	83.12%
14^{O}	2	78.97%

The height of the camera from the ground is another crucial determinant of the person counter. Table IV depicts the camera performance with varying heights.

TABLE IV
EXPERIMENTAL RESULTS OF CAMERA HEIGHT

Height (measured in feet)	**Maximum Blobs**	**Accuracy Percentage**
6	4	74.56%
6	2	79.50%
8	4	82.00%
8	2	87.30%

1 2	2	93.00%

The approach produces high-grade count estimations despite challenging illumination and crowdedness contingencies.

Fig.6 represents that the information of the RFID and the camera is collected via raspberry pi. It shows the count of people on the bus and the bus stop. When the threshold value at the bus stop is exceeded the mail is sent to the bus depot to send the spare bus on that particular bus stop.

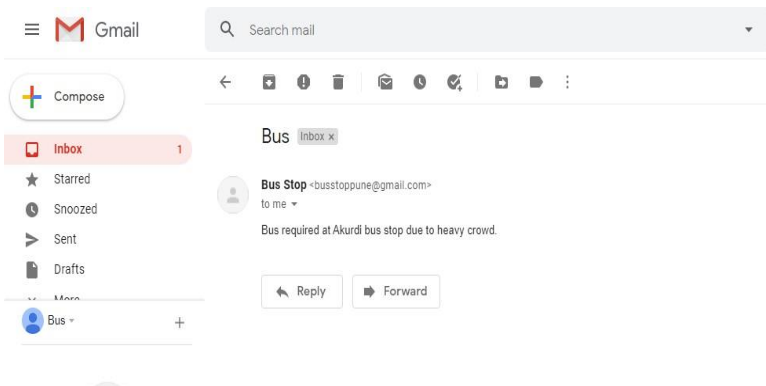


Fig.6 Mail sent to Bus Depot

CONCLUSION

The coordinated collaboration of RFID and computer vision technology in order to obtain information on passenger boarding and alighting in buses is expected to promote greater efficiency in activities related to the management of bus services, both in the planning and programming services, in controlling and regulation functions that will improve services to transport users and enhance the travel experience.

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