

## PEOPLE/ANIMAL COUNTING – INTEGRATED SENSOR BASED AND WIFI/MACHINE LEARNING BASED SYSTEM

Radosveta Sokullu, IEEE Senior Member

radosveta.sokullu@ege.edu.tr

### GOAL OF THE STUDY

This project uses WiFi Signals and IR sensors to determine the number of people in a predefined area. To obtain the required raw data the system utilizes two main principles: the effect of humans on the WiFi signal strength and the entrance-exit control based on distance and LDR sensors.

### METHODOLOGY OF THE INVESTIGATION

Two different counting methods are realized, one based on sensor readings and one based on WiFi signal strength. This results in a flexible system which can easily be adopted for different situations – humans, cattle, animals etc.

**Sensor based method:** In the prototype 2 LM393 LDR sensor cards, 2 GP2Y0A21YK IR distance sensors and 2 KY008 laser modules that form the input and output lines by providing light to the LDR on the LM393 LDR sensor card were used. The reason why the sensors are used in pairs is to create an entry and exit lines to make a count with a higher success rate and to decide whether a human triggers these lines.

**WiFi based method:** The modules that realize the second - WiFi-based counting method - are the TP-LINK TD-W9970v3, the Wi-Fi router INCA - IUWA 150TX, the Wireless USB N Adapter and the Raspberry Pi 3B. Person counting is done according to RSSI values by processing the WiFi signals received. This method allows counting the number of people in a given area by using only a single pair of transmitter/receiver devices and estimating only the strength of the WiFi signal.

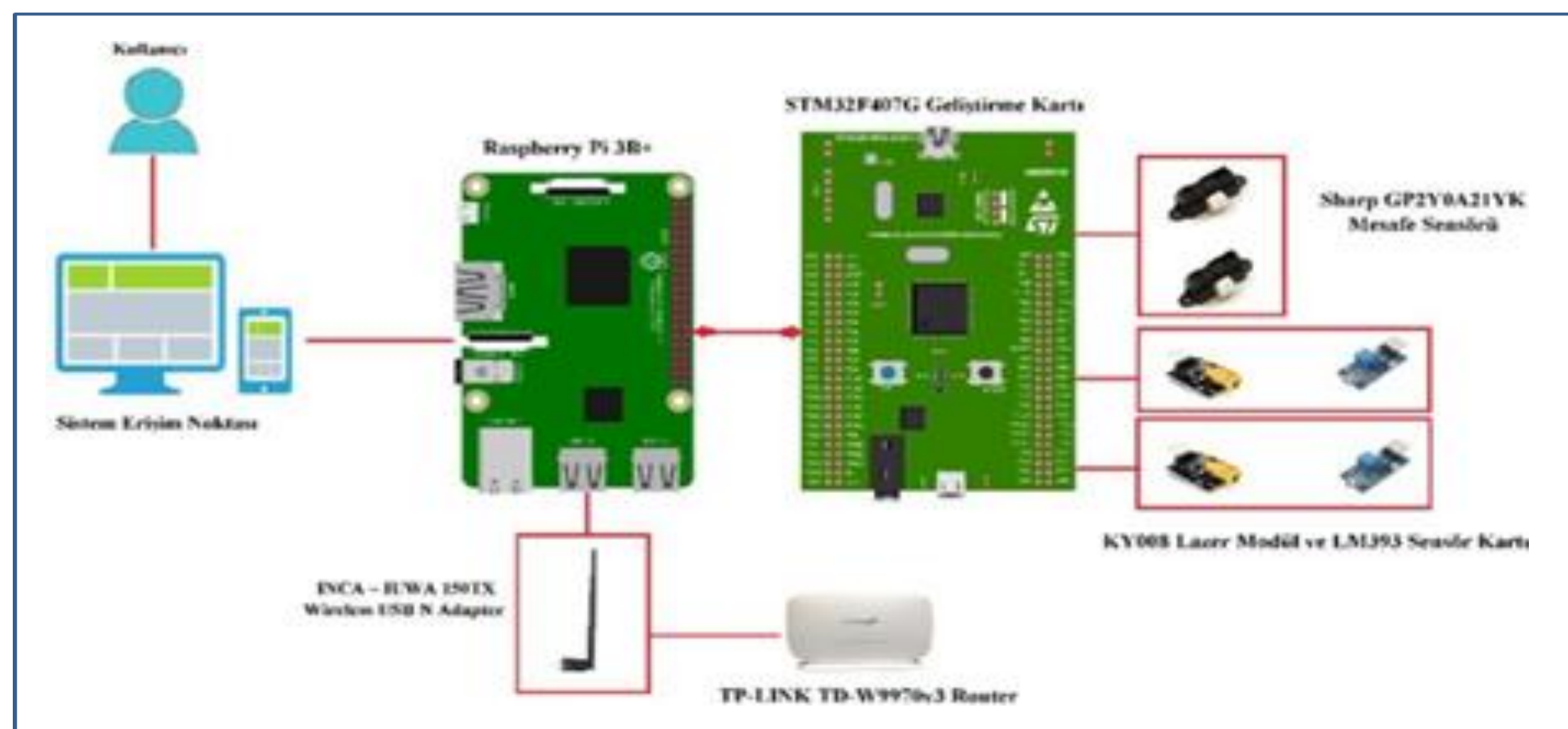


Fig. 1. System General Block Diagram

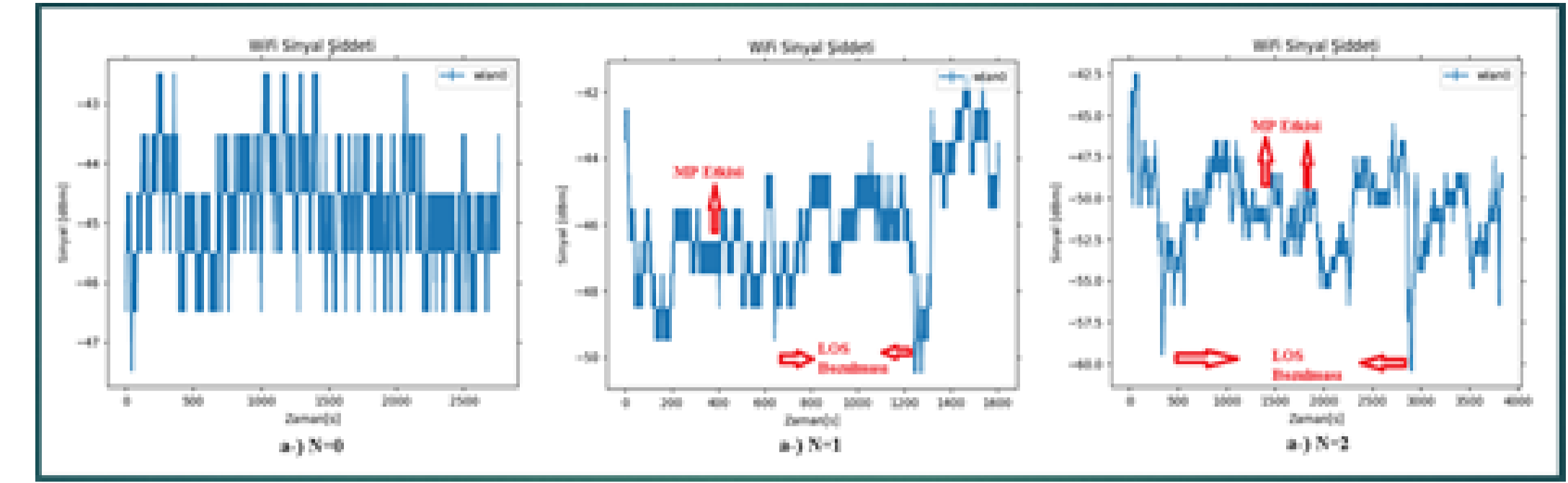


Fig.2. Measured RSSI for different situations (N – number of people)

### RESULTS AND DISCUSSION

The developed prototype actually incorporates two separate methods used for counting: a sensor based method, utilizing IR and LDR sensors and a WiFi signal RSSI based method. Tests have shown quite high detection accuracy. High variations in the transmitted and received signal values at extreme points such as door corners and wall corners in square structures such as rooms have been observed. (Fig. 2) This can be avoided by properly locating the sensors at a distance from such extreme points. If required the number of sensors can be increased (in pairs) to achieve even higher detection success. On the other hand, the WiFi based method incorporates ML so the accuracy is proportional to the number of data samples collected.

The system is very flexible and can be successfully used for counting living subjects in closed areas – people, animals, cattle. The sensor based module can be easily tuned to the requirements of these various groups by adjusting the positioning of the sensors at the entrance. On the other hand, the WiFi-based method will operate using the collected data for the training so it does not require any specific adjustment for the different scenarios (people, cattle etc.)

### CONCLUSIONS

In this paper the prototype and operation of a people counting system for closed area has been presented. It can be used in rooms, classrooms, stores, restaurants, shopping malls etc. The system combines two different methods: the first one is sensor-based, while the second utilizes WiFi signal variations and machine learning. The proposed design is easy to realize, comprises low cost off-the-shelf sensor and boards. If required the accuracy of detection can be easily increased by increasing the number of sensor used (first method) or increasing the number of collected data (for the second method). In addition, the system can easily be diversified by increasing the variety of sensors (thermal sensors, weight sensors, etc.) and can be extended with additional algorithms suitable for these sensors and parameter restrictions. However, this will lead to an increased cost as well

### ACKNOWLEDGMENT

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