

Design Bus Occupant Detection and Counting System Based on IoT

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Abstract—Automation transportation can be a solution to a public bus transportation in Indonesia, because seeing the social phenomenon that bus management suspects dishonesty from the operation of the bus. Suspicion in the form of payment income that is not in accordance with the number of passengers of the bus. From this case, bus management need a system to check the correct number of passengers, but still consider the passenger comfort. To solve this case a concept of automated system that count and detect the bus occupant based on Internet of Things (IoT) was created. This system would facilitate, ensure information accuracy and provide the accuracy of data for the bus manager so that it can minimized cheating on bus operational. This can also increase the profits of the bus companies and will raise automation in the field of public transportation in Indonesia.

Keywords—Occupant Detection, System Automation, IoT

I. INTRODUCTION

Social phenomenon that happens covertly known as “Syarkawi” or illegal passenger has made the bus management in Indonesia suspects dishonesty from their fleet [1]. This suspicion is in the form of income that is not in accordance with the number of registered passengers. The system of automation that can be the solutions to this problem is occupant detection and counting system based on IoT. Occupant detection functions to detect passenger sitting in a bus seat, this data can be used to verify the presence or absence of the passenger. Occupant detection can be designed using a capacitive sensing method by measuring the change in the value of dielectric between electrode plate placed on the bus seat. Changes in the value will be compared from dielectric or permittivity of the insulating material (ϵ_r) to the load that fills the bus seat to ensure the presence or absence of passengers. From this system, the bus management can also count the correct the number of passengers. This system would facilitate, ensure information accuracy and provide the accuracy of data for the bus manager so that it can minimized cheating on bus operational. This can also increase the profits of the bus companies and will raise automation in the field of public transportation in Indonesia.

II. SYSTEM MODEL

The concept of the system consist of three major part, they are Occupant Detection System (ODS), Data collector and Internet of Things (IoT).

A. Occupant Detection System (ODS)

Occupant Detection System (ODS) is a system created using capacitive sensing. Capacitive sensing is a sensing method that detect dielectric changes of an object [2]. ODS detects dielectric changes cause by the occupant touching the sensors, then the data will be processed by microcontroller. The process data then sent to the data collector via wireless connection e.g. bluetooth connection.

B. Data Collector

Data collector is a sub-system that collect the data from all of the ODS sensor. The data from ODS sensor is process to count the number of passengers. Data collector also collect the data from accelerometer, GPS and data from the bus door sensor. All of that data will be processed and then sent to the database via internet periodically to get the real time data.

C. Internet of Things (IoT)

Internet of things is a concept of “things” integration, sometimes consist of sub-systems that communicate and connected via the internet. Data that has been sent to the database from the data collector then procesed even further to check the legality of bus passenger. All of the important data then displayed on a website. The bus management then can view, record, and analyze the data to make important decision.

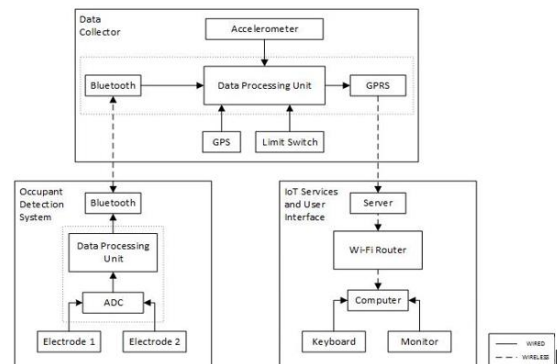


Figure 1. System overall

III. CONCEPT OF PROTOTYPE

The system overall built aims to monitor the number of passengers on the bus. The Occupant Detection System (ODS) is made by utilizing the working principle of capacitive sensing/ touch sensing. Hardware system of ODS is made with FR-4 plate stacking which is placed on the seat

holder (electrode “bottom”) as in figure 2, then under the seat there is a microcontroller as an Analog to Digital Converter (ADC) and also data transmitter to data collector. The capacitance values produced by FR-4 to detect the seat is in occupied or unoccupied condition.

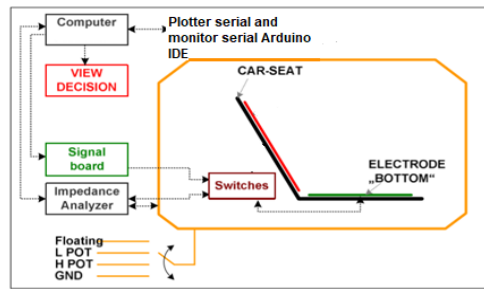


Fig. 2. System design of ODS

The ADC value is determined from the following formula:

$$\text{Float V} = \frac{\text{Analog Read}}{\text{Max ADC Value}} \times \text{Vin} \quad (1)$$

Float V = Voltage Output (V)
 Analog Read = Value from Arduino
 Max ADC Value = Maximum ADC Value (1023)
 Vin = Voltage Input (V)

While the capacitance formula on parallel plates is:

$$C = \frac{\epsilon_0 \cdot \epsilon_r \cdot \chi A}{d} \quad (2)$$

C = Capacitance (F)
 ϵ_0 = Vacuum permittivity ($8,854 \times 10^{-12} \text{Fm}^{-1}$)
 ϵ_r = Relative permittivity (Fm^{-1})
 A = Cross-sectional area (m^2)
 d = Distance between plates (m)

ODS detects dielectric changes cause by the occupant touching the FR-4, this also cause the capacitance value to changes. ADC in microcontroller convert the capacitance value from analog data to digital data and then the data ready to be sent to data collector.

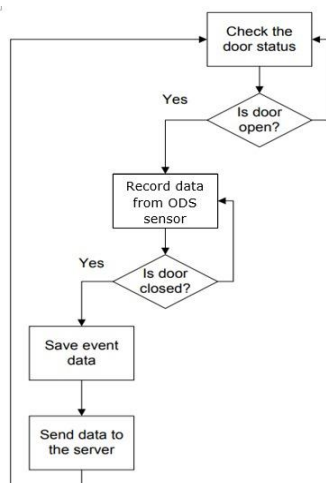


Fig. 3. The algorithm of passengers record

ODS sensors are placed in every seat but we just use four seat for data sample. ODS sensors communicated with data

collector via bluetooth, but we can also use wifi. Data collector read the data from each seat and count the passengers data by adding all the seat data.

Figure 4. show the algorithm of passenger record [3]. If the bus door opened, the system will record the passengers and save the data after the door closed. Then the counting process will start and check the bus position by using GPS. After the data has been processed, the seat status, the number of passengers, and bus position will be sent to the database via internet. Every recorded data will be compared to the previous data and check the changes of the data. If there is a changes of passengers number not at the right stop direction, system will send the warning to the database.

The IoT part of this concept are consist in three section, the database, the data processor, and display or user interface [4]. The database that we are using have the capability of realtime data storing, that data then can be called, in this case the data from data collector that is stored in the database can be procesed even further in other application, in this concept that data processor is google sheet.

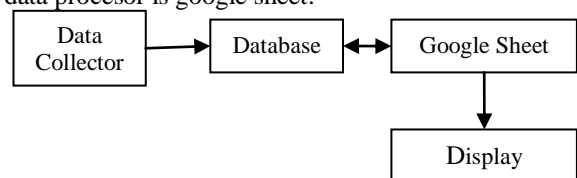


Fig. 4. Data Flow

The data that has been called to the google sheet can be procesed using the google sheet formulas. In this concept, the data will be compared from the ticket data and the data from data collector, if there is a match between those data, it will be labeled “Penumpang Legal”, if the seat is empty but the ticket data exist it will be labeled “Penumpang Tidak Check-in”, if the seat is filled but the ticket data does not exist it will be labeled “Penumpang Gelap”. The procesed data then can be published on a website or stored as a file for documentation.

IV. CONCLUSION

From measurements and simulations, it can be seen that the dielectric ratio of the above values is obtained that the body's capacitance values are in different ranges with open (natural) conditions. This automation system as an occupant detection and counting system based on IoT can be the solutions to bus management problem in Indonesia. This data increase the accuracy of information on the number of bus passengers.

REFERENCES

- [1] Bryan, “Mengenali Lebih Dalam Fenomena "Syarkawi" di Bus Malam,” 11 Maret 2014. [Online]. Available: <https://www.kaskus.co.id/thread/531eb61c1e0bc336058b46ac/mengenali-lebih-dalam-fenomena-quotesyarkawiquot-di-bus-malam-ente-tau-gak--realbro/>. [Diakses 9 Februari 2018].
- [2] H. Zangl, T. Bretterkieber, D. Hammerschmidt, and T. Werth, “Seat occupancy detection using capacitive sensing technology,” SAE Technical Paper, pp. 01–0908, 2008.
- [3] O. Boreiko dan V. Teslyuk, “Structural Model of Passenger Counting and Public Transport Tracking System of Smart City,” dalam *MEMSTECH*, Polyana-Svalyava, 2016.
- [4] Z. K. A. Mohammed and E. S. A. Ahmed, "Internet of Things, Chalanges and Related Future Technologies," *World Scientific News*, vol. LXVII, no. 2, pp. 126-148, 2017.