DEVELOPMENT OF A LOCALIZATION MAPPING FOR CLEANING ROBOT USING RSSIWIRELESS ROUTERS

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Abstract- Cleanliness is one of the important things in human life and one of the conditions of healthy living. Along with the development science and technology, robot is used for solving problems. Various cleaning robots are created for example a vacuumrobot and a sweeping robot and so on. Although many cleaning robots had been created, some of them are not been able to locate whether the robot has taken the cleaning path. This poses a problem where there is a floor that had not been clean by the robot. Therefore, to improve cleaning, author took the initiative of using wireless internet RSSI for a beacon for locating the robot. The proposed is to detect the distance between each beacon and becomes a coordinate for the robot to reach the maximum cleanliness of the room.

Index Terms- Wireless Internet, RSSI, Cleaning Robot, Raspberry pi, Internet of Things.

I. INTRODUCTION

Cleanliness is one of the most important things in human life. Cleanliness also the requirements for a healthy life. A dirty environment is not healthy for humans and can also reduce human concentration and also will make human feel uncomfortable

To maintain cleanliness itself can start from the smallest environment, namely home environment. One of the things that can be done to maintain the cleanliness of the house is to clean the floor. But for some people, cleaning up the floor is time-consuming, boring, repetitive homework. But It is an important job to keep the house clean and avoid carious diseases [1]. One solution offered to overcome this can be used in home automation system. This home automation system can cover many things, one of which is in the field of home hygiene. one form of automation in home hygiene is the development of cleaning robots that can clean the house automatically [2].

Although the development of this floor cleaning robot is more advanced, the cleaning robot that is circulating today, in general still has some weaknesses. One of them is still can'tdeterment the robot path. Some of them still going randomly on the floor. This makes the robot use more energy but not all the floor is clean

Localization is required for searching a position of an object. Usually GPS were use for locating an object position. However, GPS required a satellite. In buildings, sometimes, signal for satellite are gone because of the building walls [3].

To overcome this problem, the author took the initiative to make localization mapping for the robot by using 3 wireless routers for the beacon and using the distance between router for determent the coordinates of the robot current location.

II. RELATED WORK

There has been a significant-research regarding localization for cleaning robots. Studies in [4]showed using 2.5D elevation mapping using 2 robots. The first robot is a drone to calculate the depth of the room and the second robot is the ground robot for the experiment mapping robot. The weakness from this method is to expensive and required both robot to operate.

The study from [5] showed that the cleaning robot can navigate to room at night with visual localization. Using the visual from day time, at night time, the robot tries to match the picture from the daytime. The weakness is only works if the lights is turn on at night time. Only little information can be gathered when the light is because of the darkness.

Reference [6] proposed that using a system to construct a path for navigation map and the shape of the object present in an area by using a robot. The robot moves around the area and give the map of the area and the position of the object. The weakness of this program is the robots need to scan the area first and then calculate the path. The more possibility of the path, the more time it takes to calculate the perfect path.

Some of the studies use a filter for filtering noise from the routers. Studies is [7] show that using a filter will show more accurate result rather than not using the filter.

III. PROPOSED SYSTEM AND ARCHITECTURE

The authors propose a system where using 3 wireless internet routers for a beacon for localization where the 3 WIFI's will sent signals and that signal will be converted into distance that allow the robot to save the coordinate so that the robots know that it already been to this coordinate.

A. Environment

The environment for this experiment needs to be a finite indoors geographical location like a bedroom or a living room which are surrounded by some form of boundary and 3 WIFI routers (doesn't has to be connected to internet) place it on the corner of each

side of the room.

Fig. 3.1. show an example of the system setup. 3 routers were place on the corner of the room. Raspberry pi is the brain of the robot.

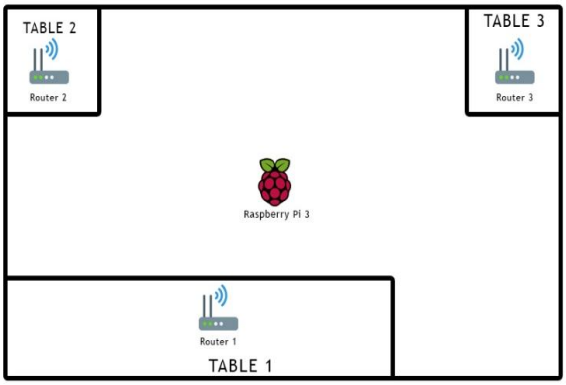


Fig. 3.1. Diagram of Environment System Setup

B. Hardware

This section discusses the schematics of the system.Robot cleaner supposed to be low and small so it can go anywhere. Raspberry pie is use in this project because it is cheap and it is small and compact so it can fit to a small robot. Raspberry pie can be seen in Fig. 3.2



Fig. 3.2. Raspberry Pi 3.

This project also uses 3 routers. The router the author use is 2MikrotikRouter boardand Mydlinkas shown in Fig. 3.3.



Fig. 3.3. MikrotikRouter board.

C. Software

This project is using python programming language. This programming language were use in Raspberry Pie 3.

1. *Getting RSSI From Routers*
   The first step is making the program to get the RSSI from 3 of the routers. Using the parsing iwlist scan, we can determent their RSSI in dBm.
2. *Calibration Program*
   The next step is calibrating the program. To determent an accurate distance, the program need a signal strength in dBmat 1M from the Raspberry Pie. After you program the raspberry pi to get the dBm from the network, set your routers to a distance of 1m. next, save the dBm of the 3 Routers. The dBm in the 3 routers is shown in Fig. 3.4.

```
Name            Signal          Dbm
MikroTik-0920A3 1.0             -43 dBm
MikroTik-0852F4 1.0             -49 dBm
Kezia Wifi      1.0             -31 dBm
Name            Signal          Dbm
MikroTik-0920A3 1.0             -43 dBm
MikroTik-0852F4 1.0             -49 dBm
Kezia Wifi      1.0             -31 dBm
Name            Signal          Dbm
MikroTik-0920A3 1.0             -43 dBm
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Name            Signal          Dbm
MikroTik-0920A3 1.0             -43 dBm
MikroTik-0852F4 1.0             -49 dBm
Kezia Wifi      1.0             -31 dBm
Name          Signal   Dbm
```

Fig. 3.4. WIFIs dBm in 1 meters

3. *Conversion From dBm to Distance*

To change from value of dBm to distance, a logarithm math formula (1) is used.

$$RSSI(dBm) = -10n \log_{10}(d) + A \quad (1)$$

Where A is the received signal strength in dBm at 1 meter, D is for Distance, N is the propagation constant or path-loss exponent. The author program is using 3for path-loss exponent because base on the diagram in Fig. 3.5, the room is furnished.

TABLE I. ENVIRONMENT OF PATH-LOSS

Environment	Exponent n
Corridors	1.4 – 1.9
Large open rooms	2
Furnished rooms	3
Densely furnished rooms	4
Between different floors	5

IV. RESULT

D. Research Result

The research is carried out at Taman Anggrek Apartment, Jakarta Barat, Indonesia from 1st April

2018 – 14thApril 2018. From Fig.4.1 we determent the 3 dBm from the 3 WIFI Routers. We do 1 hour of testing to see if the signal isstable. After we receive the dBm for every router we put it in the program formula for calibration. After the calibration is complete, we position the 3 routers as shown in Fig. 3.1.

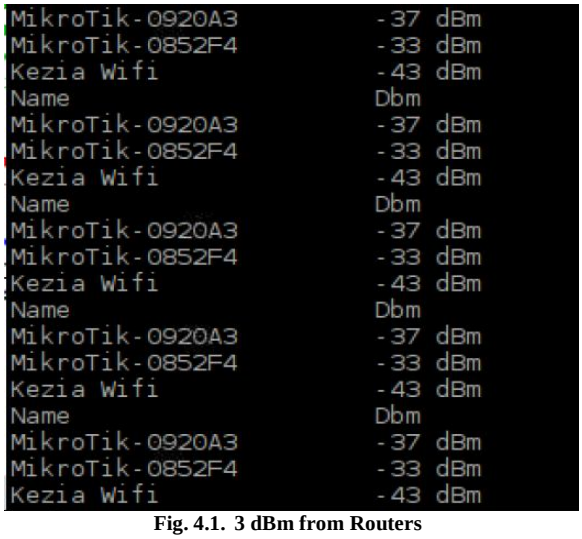


Fig. 4.1. 3 dBm from Routers

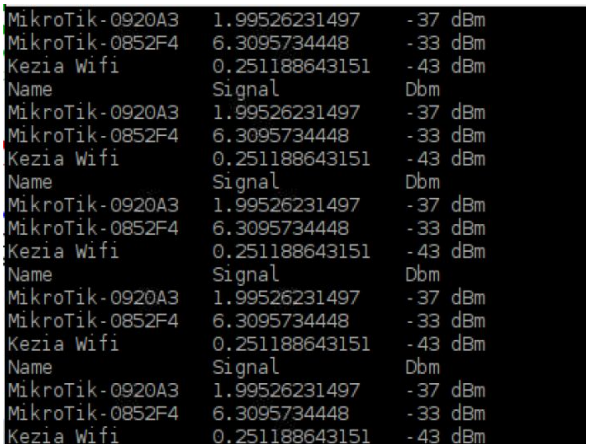


Fig. 4.2. Raspberry Output First Position

Fig.4.2 shows the data that come from the Raspberry pie. As you can see the distance between each router is shown and it save on the program. We assume that the robot will start from the middle. On Table 1, the data is shown what is the distance between the 3 routers and will act as the coordinates for knowing where the exact location of the robot is.

TABLE I.FIRST POSITION DATA

Name	dBm	Distance
Mikrotik – 0920A3	-37 dBm	1,99526231497
Mikrotik – 0852F4	-33 dBm	6,3095734448
KeziaWifi	-43 dBm	0,251188543151
Mikrotik – 0920A3	-37 dBm	1,99526231497
Mikrotik – 0852F4	-33 dBm	6,3095734448
KeziaWifi	-43 dBm	0,251188543151

Next, we move the raspberry to a random place to see if the data will change. Note that why random, because we assume that the robot just moves freely. From Fig. 4.3. that the distance change depends on the raspberry location. The more you move towards the router, the distance is smaller and the more you move away from the router, the farther the distance gets. The data is shown from Table 2. One of the problem in this prototype is that is not vey accurate. The problem is caused by interference from the wifi around the building.

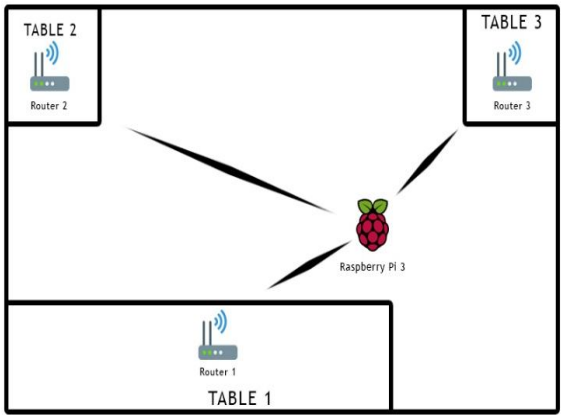


Fig. 4.3. Moving the Raspberry Pi randomly

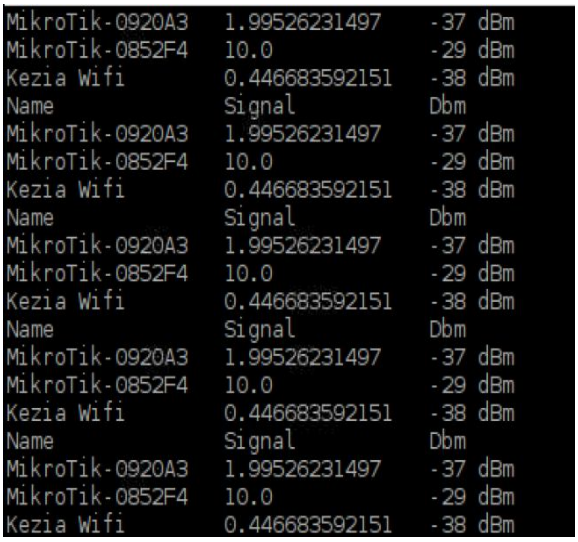


Fig. 4.4. Data Change Output

TABLE II. DATA CHANGE

Name	dBm	Distance
Mikrotik – 0920A3	-37 dBm	1,99526231497
Mikrotik – 0852F4	-29 dBm	10,0
KeziaWifi	-38 dBm	0,446683592151
Mikrotik – 0920A3	-37 dBm	1,99526231497
Mikrotik – 0852F4	-29 dBm	6,3095734448
KeziaWifi	-38 dBm	0,446683592151

E. Future Developments

For the future development, we can put it in a cleaning robot. There is a couple of drawback for the program. First is the time it took for scanning took 2.5 seconds to refresh for new dBm location. Secondly, sometimes the WIFI can't be detected around 5 seconds until it shows up again. This program works well with the WIFI routers but not so great for smartphone hotspot because of the weak signal

We hope in the future, we can combine this algorithm with an obstacle avoidance cleaning robot it safe time and get the floor clean equally. Secondly, changing some of the program to become faster so it always updated the coordinate quickly. Lastly finding out the problem of disappearing signal for the raspberry pi and using smartphone WIFI hotspot

CONCLUSION

To conclude this research, we found that the proposed system is proven that using WIFI signal as a beacon is much cheaper and it can be done rather than buying a GPS for the robot that cost much more expensive. By looking from the distance between raspberry pi and the 3 WIFIs in the tables, we can locate the exact coordinate where the robot might be and the robot can determent whether the robot had taken this coordinate before therefore it will not take the same path as before.

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