

Smart cane with location detection using RF module

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ABSTRACT

To be able to move freely like normal people, the blind people need a tool that can help to identify a location and travel safely to the destination independently. This research develops a smart cane which is designed to help the blind people in outdoor area locations. This cane embeds with module NRF24L01 as transmitter and receiver that can configure and detect the building around their area as the location notification. This solution gives a simple design, low cost and easy to implement. The result stated that the range between transmitter and receiver is about 40 m. The maximum transmitter in each building is depend on the shape of the building, the environment area (loss or no loss), and the land area in m² of the building.

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1. Introduction

Blind, is a condition in which a person experiences visual impairment or even totally loss of vision at all. In daily life, the blind need tools to make a travel from one place to another place. Sometime they need helps from human guidance who always standing next to them. Like normal people, blind people also have an area that often passed by every day to do daily activities. The place can be a mall building, office building area complex, or a school area complex. A school area complex consists of several building that placed in scattered and separated landscape area from one to another building. Although the blinds have been familiar with the surrounding area, the blind still need the information to convince themselves about their surrounding area whether they are had already in the destination or not because they are sometimes meet difficulties to recognize the building or a place.

The basic research to do the study about the aid tools to enhance the ordinary cane such as a navigation module to avoid the obstacle and inform the blind with voice announcement has already doing for indoor area (Thumma et al., 2017). This research then developed and enhanced concerned with a specific mobile vision task: the detection of "landmarks" in the environment, along with mechanisms to guide a person towards a detected landmark without sight (Manduchi, 2012). This

research is doing also in the indoor area. Another research on indoor location then do and develop a BLE-based indoor location awareness system to provide blind and visually impaired people with better accessibility to build environment (Hyun and Ravishankar, 2016). There is also a research which proposed guidance system for indoor area using navigation mapping the RFID along aisle. Based on that, the blind can recognize the place and guidance to the destination area (Khine et al., 2014). The guidance of a wearable indoor navigation system for blind and visually impaired also has been done with integrated system between audio module, wireless communication module, sensor module, database module and also path finding subsystem and signal processing (Bai, 2014).

Besides indoor area, there is also a research to assist visually impaired person in an outdoor area. Some research proposed the study to build an outdoor navigation system to assist Visually Impaired person's navigation independently in urban areas, regardless of the person's hearing status (Chaudary and Pulli, 2014). They used an augmented cane magnetic point and serialized vibration braille to encode guidance system. Another research also proposed detects the obstacle and dangers, and navigation using GPS based on speed of movement (Šimunović et al., 2012).

However, all the research still cannot give the clear information about the building's position to the blind. The blind still need a system which can inform them the place where they are standing, and inform them clearly whether they are in a right destination. Therefore, the blinds can have any confidence to make sure the correct building destination without assist from human guide.

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This research, proposed a prototype that can embed in a cane to enhance the functional of a cane as location awareness, which can help the blind to configure the building destination. NRF24L01 module will be used as a transmitter and a receiver embed with Arduino nano in transmitter part and Arduino Uno and module WTV020M01 in a receiver part. Module NRF24L01 is a single chip radio transceiver which running in 2.4 – 2.5 GHz ISM band (Pothirasan and Rajasekaran, 2016). Arduino Uno and Nano is a microcontroller or breadboard-friendly board based on the ATmega328 in small size. Module WTV020M01 is an mp3 module that can be compatible with Arduino. This research will help the blind to recognize the place or building destination. In this research, this system will be tested and implemented in certain building in Telkom University building area.

2. The proposed system

2.1. System requirement

Before design the architecture of the system, we do some list about system requirement. This system requirement is divided into two categories, the functional of system requirement and the non-

functional of system requirement. The functional of system requirement is consists of:

- input prototype that come from a broadcasting signal of RF transmitter that installed in the building or a place then the receiver that embedded in the cane will received the signal from the transmitter,
- prototype process which is the process of received signal from the transmitter and processed it into microcontroller in order to recognize the building or a place,
- output prototype which can be describe as the information from the microcontroller part to the user through a speaker or headset.

Whereas the non-functional of system requirement is the user, the RF receiver and the RF transmitter. Other system requirement is the specification of hardware and software system. It shows in Table 1, there are the specifications of hardware and software system that will be used in this research. Besides that, the functional specification of the hardware and software is also mention in that table.

Table 1: System specification

No	Spec	Tools	Function
1		NRF24L01	as a transmitter and receiver
2		Arduino Uno	as a microcontroller to process the system, installed in the receiver
3		Arduino Nano	as a microcontroller to process the system, installed in the transmitter
4		WTV020M01	as voice module to play the audio file
5	Hardware	Lithium Battery	as a power resource
6		Speaker/ headset	as a tool to output the audio
7		LED	as a sign to inform the system is "on"
8		SD Card	as a memory to save the audio file
9		Jack Output Audio	as a plugin for audio
10		Push Button	as an on/off button
11		Arduino IDE	to make a source code for system
12	Software	Audacity	to record and edit the audio
13		AD4 Converter	To convert an audio format
14		Windows 10 Pro	as a software system on computer

2.2. Architecture system

Based-on the system requirement, we design architecture the system. The system is divided into 2 parts. The transmitter part which is installed in the building and the receiver part embedded with a smart cane. The block diagram of receiver system can be seen in Fig. 1.

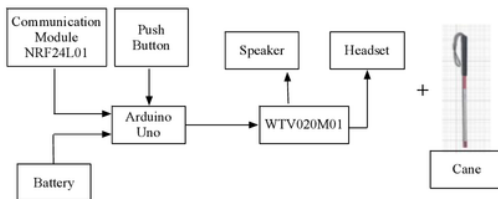


Fig. 1: Diagram block receiver

Fig. 1 shows a diagram block of receiver using battery as a power resource. A NRF24L01 as a receiver embedded on ordinary cane. The receiver

functions to receive a transmitter signal which is broadcasting from the transmitter in a building. The speaker or headset is needed to give the information to the blind. The WTV020M01 is a module to process the sound. In the receiver, Arduino Uno is using to process the receiver system. Meanwhile, the diagram block of the transmitter system can be seen in Fig. 2.

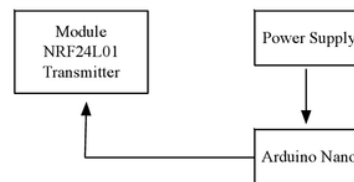


Fig. 2: Diagram block transmitter

On Fig. 2 we can see that there are a Power Supply functions to give the supply energy to Arduino Nano and activated the transmitter module NRF24L01 signal. The Arduino nano triggers the transmitter NRF24L01 to broadcast the signal

surrounding the building area. According to that system, the smart cane around the building will receive the transmitter signal.

Both, the transmitter and receiver system will be implemented in each building in Telkom University Building Area. The architecture system shows in Fig. 3. A blind person tries to do a travel to a Mosque. The blind will make a travel and press the button in certain area to make sure the place that he passed by. Based on that guidance, the blind will find the Mosque, as the building destination. Flowchart of the system can be seen in Fig. 4.

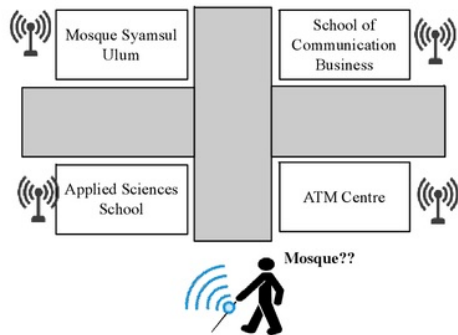


Fig. 3: Architecture system

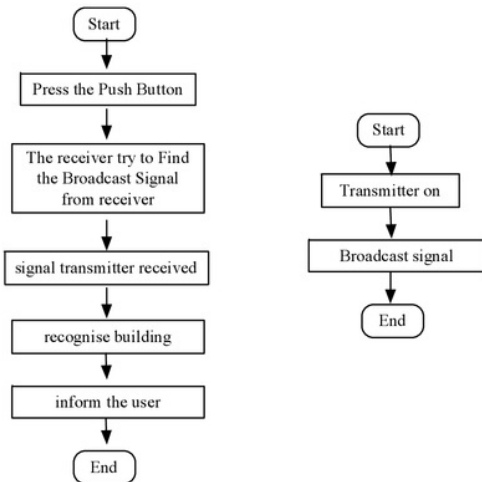


Fig. 4: Flowchart system

Based-on the Fig. 4, the transmitter will be activated and broadcasted the signal surrounding area building. In the receiver part, the user does the travel and presses the button in the certain area. While the button pressed, the receiver will receive the transmitter signal and recognize the detected building around the blind. The system then informs the blind the name of the building. If the building is not the destination, the blind will continue walking to the destination.

2.3. Design hardware system

The design hardware construction in receiver system is show in Fig. 5.

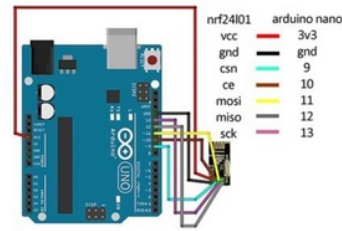


Fig. 5: Design of main receiver system

Beside the connection in Fig. 5; the system shows the simple connected construction between communication module NRF24L01 and Arduino Uno.

There is another construction design in the receiver system. The connection shows in Fig. 6. It is a wiring cabling between WTV020M01 and Arduino Uno. The function of this connected module is to connect sound module and speaker in order to inform the blind information about the recognize building near the blind.

The design system in transmitter part shows in Fig. 7.

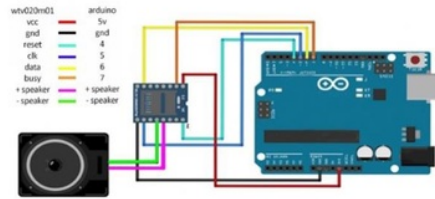


Fig. 6: Design of sound module

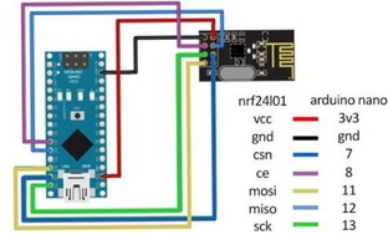


Fig. 7: Design of transmitter system

In Fig. 7, it can be seen that the Arduino nano is designed to connect with NRF24L01 Module communication and Power supply. This transmitter system will be implemented in each part area of the building.

3. Result and discussion

After design and construct the prototype, the next step for this research is doing the testing and analysis. This system will be tested to find range area transmitter broadcasting and build a maximum transmitter in each building in order to get the best performance in system to recognize the building. This system is testing in a several building in Telkom University area. The building is Syamsul Ulum Mosque, ATM Center building, School of Communication Business building, and School of Applied Science building.

Fig. 8 shows the result of a broadcasting signal from one transmitter in Syamsul Ulum Mosque building. While in Fig. 9, Fig. 10, and Fig. 11 are the result of a broadcasting signal from one transmitter in ATM Centre building, School of Communication Business building and School of Applied Science building.



Fig. 8: Testing transmitter in syamsul ulum mosque



Fig. 9: Testing transmitter in ATM centre building

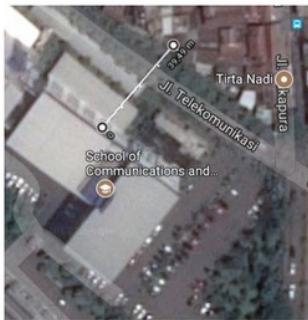


Fig. 10: Testing transmitter in school of communication and business building

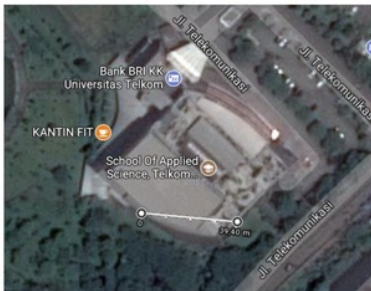


Fig. 11: Testing transmitter in school of applied science building

transmitter signal in each building, then we do a measurement about the dimension and land area of the building. This measure is required in order to have how much transmitter that should we implant in each building.

The building shape of each building can be seen in Fig. 12, Fig. 13, and Fig. 14. The building shape of ATM center does not determine because it is only a small building that only has total land area around 45m² and 25 m circumference. Based on that information, it can be stated that ATM center building only need 1 transmitter to be implant in this building area. While the other building has more than 100 m² of total land area and circumferences, and it is need to improve the total transmitter that should be implant in each building. The result of all the testing can be seen in Table 2.



Fig. 12: Building shape of syamsul ulum mosque building



Fig. 13: Building shape of school of communication and business building

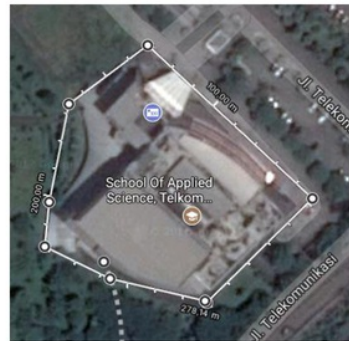


Fig. 14: Building shape of School of applied science building

In Table 2, it can be seen that the range distance of broadcasting signal from transmitter is about 40 m away from the building transmitter. The number

After doing the testing which is aim to measure how far the performance range of a broadcasting

of transmitter that should be implemented in each building is different, according to land area in m² and

the circumference of the building area (m).

Table 2: Testing result

Name of Building	Range distance Tx-Rx	Area (m ²)	Total Distance (m)	A number of Tx
ATM Center	39.40	45.50	25	1
Mosque Syamsul Ulum	39.88	1,503.3	155,15	2
School of Communication and Business	39.49	3,484.8	259.71	2
School of Applied Sciences	39.40	5,222.05	278.14	3

In order to get the best performance of this system, the bigger a land area of a building the more transmitter that should be placed in this building. For example, the School of Applied Science has a total land area 5,222.05 m², the total distance of the building is 278.14 m, and the shape of building is pentagon, need 3 transmitters to have the best performance.

We do also the measurement about the delay in the system. The result from the testing is stated that the system has average delayed about 5 s, to inform the user about the detection building after detect the transmitter from the building.

Fig. 15, Fig. 16, and Fig. 17 shows the running module tested on outdoor area. Fig. 15 shows a user testing a smart cane which is embed with receiver module NRF24L01. Fig. 16 shows the transmitter implemented in a building area and Fig. 17 is a figure of module receiver when the button pressed to trigger the information for the user.



Fig. 15: The user tested the receiver system



Fig. 16: Implemented transmitter module tested in a building area



Fig. 17: Receiver module when button pressed

In indoor area the performance of module communication NRF24L01 is not as good as in outdoor areas. It can be seen in Table 3, the receiver only can detect the transmitter in about 9 meters in loss area indoor and 7 meter in no loss area indoor. Based on the result, we can state that module communication NRF24L01 have a good performance while used on outdoor area.

Table 3: Range distance indoor

Name of Building	Area (m ²)	Total Distance (m)	Range detected max (m)
ATM Center	45.50	25	9
Mosque Syamsul Ulum	1,503.32	155,15	9
School of Communication and Business	3,484.85	259.71	7
School of Applied Sciences	5,222.05	278.14	7

4. Conclusion

This system can be a solution to help the blind to recognize the building near or around their circumstance area. The design and the construction of implementation module communication NRF24L01 is very simple. RF-based location awareness for blind sends the communication using NRF24L01 module by sending the data signal from the transmitter in a building and received by the receiver in the smart cane.

This module communication NRF24L01 should be better implemented in the outdoor area, whereas this module can reach distance range around 40 m away from the transmitter while this module can reach only 7 meter away from transmitter if implemented in indoor area. The using of module audio WTV020M01 is should be better using .ad4 formatted form file and mode track audio mono; it is because Module audio WTV020M01 only running in .ad4 formatted file audio. Delay yields by the system to process the signal received until the information heard by the blind is stated around 5s. The total of

implemented transmitters in that area building in Telkom University area testing are 8 transmitters and 1 receiver embed with ordinary cane. The implementation of the transmitter in each building is different. It is depending on the shape of the building, the environment area of the building (loss or no loss), and the land area in m² of the building.

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