Wireless radio communication system for a pipe inspection robot

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Abstract: In this research, we studied the wireless radio communication system which can transfer stable and at high speed. And we developed some prototype robot systems and made some tests. In this system, we could make control the moving robot and inspect the defects from inside of steel pipe or ceramic pipe. We could transfer the image information of inside pipe with the defect in real time.
Keywords: Radio Communication system, Pipe inspection robot, Steel pipe, Ceramic pipe, plant and sewer.

I. INTRODUCTION

Recently many plants become old and pipe lines in the plant also become old. For this, we have developed a flexible wireless pipe inspection robot.

In this research, we studied the wireless radio communication system which can transfer the image data stable and at high speed in the pipe. We developed a prototype system and made some tests. In this system , we can inspect the defects from inside of steel pipe or ceramic pipe. We could transfer the inside image information of the pipe in real time.

II. BASIC RADIO COMMUNICATION PROPERTY AT INSIDE PIPE

1. Transmit Test at Steel Pipe

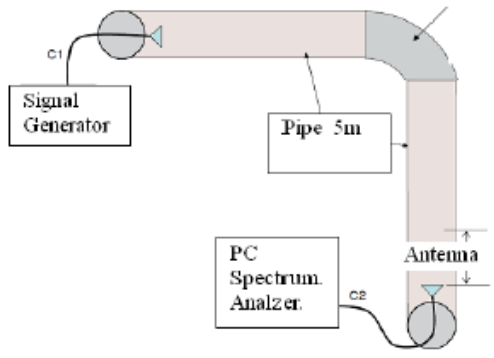

Fig.1. Radio communication property test at Steel Pipe

At steel pipe with 30cm diameter and 10 m length in shown Fig.1, the transmission loss from transmitting antenna input to receiving antenna output was $14 \pm 6dB$ in 2.4GHz band, $23 \pm 7dB$ in 5.2GHz band. So, we can transmit the large data at more high speed than 10Mbps.

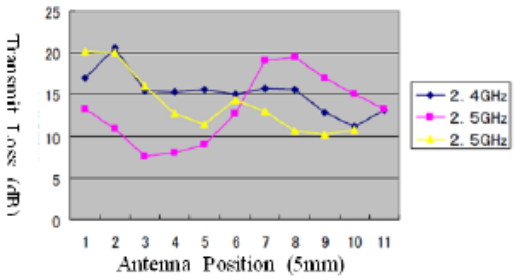

Fig.2 Radio communication property (Transmit Loss) at Steel Pipe (2.4 GHz)

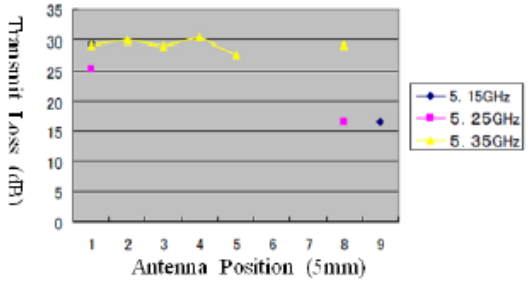

Fig.3 Radio communication property (Transmit Loss) at Steel Pipe (5.2 GHz)

2. Transmit Test at Ceramic Pipe

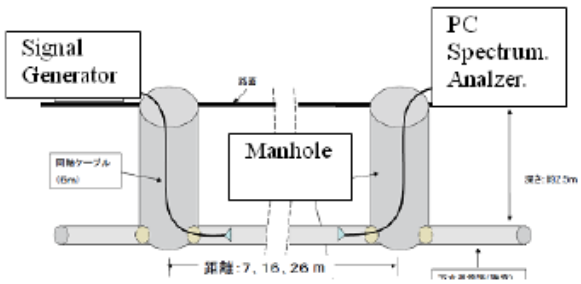

Fig.4 Radio communication property test at Ceramic Pipe

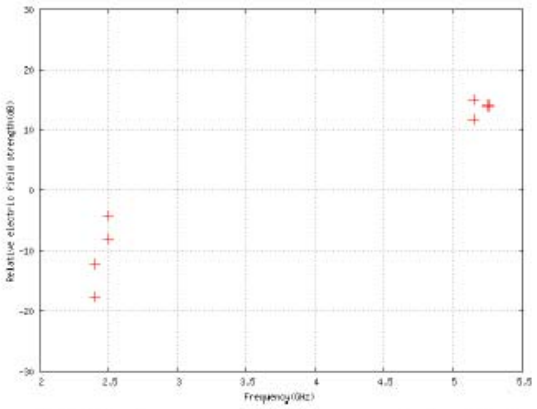

Fig.5 Radio communication property Result at Ceramic Pipe

At ceramic pipe with 25cm diameter and 7m length, the transmission loss was $84 \pm 2.5dB$ in 2.4GHz band, $52 \pm 1.5dB$ in 5.2GHz. Fig.5 shows the relative electric field strength between ceramic pipe and free space.. 5.2Ghz band have a good performance in ceramic pipe.

III. RADIO COMMUNICATION SYSTEM

1. Radio communication system Prototype

The specification of the radio communication system is as follows.

1) CPU board : Via Nano-ITX ($17 \times 17 \times 6cm$)
2) Battery : Lithium cell (7.2V ,4 unit)
3) Carriage : $20 \times 20 \times 35cm$

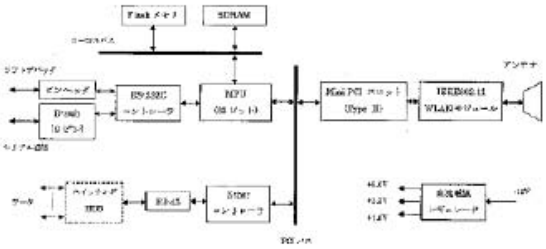

Fig.6.7. Prototype system of Radio communication system

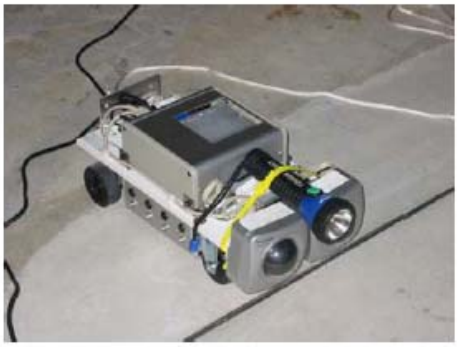

Fig.8 Radio Communication Test Car

Fig.9 Test at Steel Pipe

Fig.8 shows the radio communication test car. Fig.9 shows the test situation.

2. Pipe Inspection Test system

Fig. 10 Pipe Inspection Test Robot system

Fig.11 Test robot running situation at office

Fig.12 Real-time Image processing

3. Compact Radio Communication system

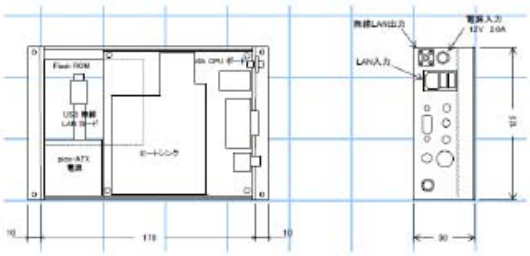

Fig.13 Compact Radio Communication system

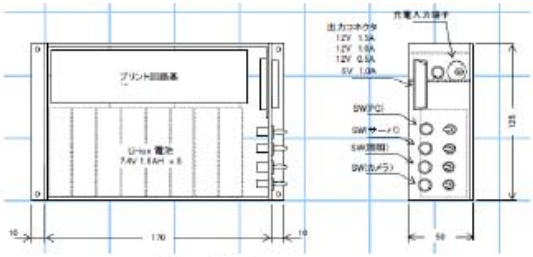

Fig 14 Battery system

Fig.15 Compact Radio communication system

Fig.13-15 showes the compact radio communication system and battery system.

IV. WIRELESS TEST MOVING ROBOT SYSTEM FOR SEWER

1. Robot system for drainpipe

Fig.16 Moving Robot for srainpipe

Fig. 17 Ceramic Pipe in Laboratory

Fig.18 Moving Robot in the pipe

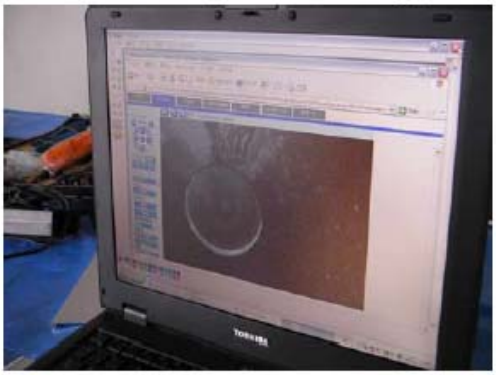

Fig.19 Inside monitoring by Web Camera

2. Pipe Inspection Test system

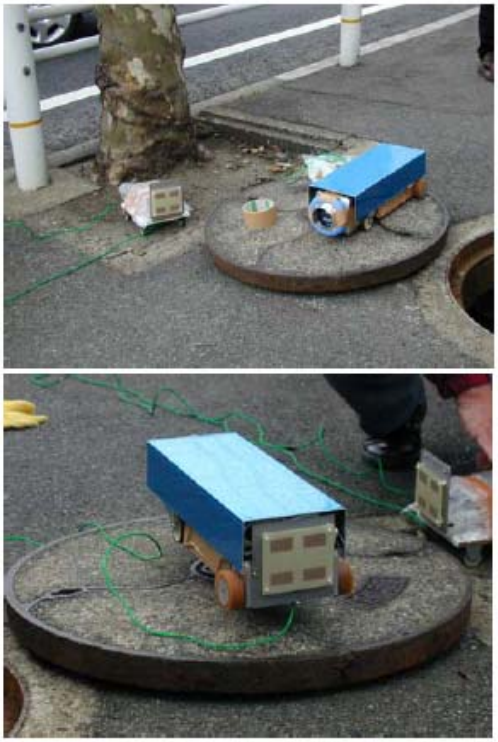

Fig.20 Moving Robot for Drainpipe

(a) Robot Input

(b) Robot Takeoff

Fig.21 Radio Communication Test at Drainpipe

We test the radio communication system in act ual drainpipe at Momozono Kitakyush city. The wir eless robot could run in the pipe with 20m length and transmitted the inside image data in real time.

V. CONCLUSION

We studied the wireless radio communication system in the pipe. We developed some prototype radio communication systems and test robots and tested it in actual drainpipe line successfully.

VI. ACNOLEGEMENT

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