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TUNNEL INSPECTION ROBOT

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To my beloved father and mother.

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ABSTRAK

Projek ini adalah bertujuan untuk merekabentuk dan membina sebuah Robot Pemeriksa Terowong atau "Tunnel Inspection Robot" yang mempunyai saiz yang agak kecil disamping mudah untuk dikawal. Ia terdiri daripada sebuah kenderaan yang bertindak sebagai platform utama, set sistem kamera tanpa wayar, lampu dan sebuah "Turntable device". Robot ini juga menggunakan sepenuhnya sistem tanpa wayar atau lebih dikenali sebagai "Fully wireless system". Fungsi utama robot ini adalah untuk bertindak sebagai alat peninjau atau risikan bagi menggantikan manusia untuk melaksanakan tugas-tugas yang merbahaya dan berisiko tinggi seperti pemeriksaan system saluran paip bawah tanah, limbah beracun, kawasan runtuhan dan kawasan-kawasan yang di penuhi dengan bahan letupan. Selain itu, robot ini juga berupaya untuk menghantar isyarat vidio atau imej bagi sesebuah kawasan yang telah dilalui untuk dianalisa melalui computer.

ABSTRACT

The purpose of this project is to design and construct a tunnel inspection robot. The tunnel inspection robot should be small and easily controlled. The tunnel inspection robot is made up of a moving platform controlled by two dc motors. On top of the moving platform is a turntable controlled by a stepper motor via wireless system made up of a transmitter and receiver. On top of the turntable is a miniature camera connected remotely to a computer system for monitoring and manual steering of the robot. Together with the camera is a searchlight for lighting up dark areas. The whole platform should be able to move in rugged areas. This tunnel inspection robot is controlled by a fully wireless system to avoid wire entanglements. This robot can be used as a surveillance robot in dangerous areas.

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INTRODUCTION

Robotics is rapidly expanding into human environment and vigorously engaged in its new emerging challenges. Interacting, exploring, and working with humans, the new generation of robots will increasingly touch people and their lives. The successful introduction of robots in human environment will rely on the development of competent and practical systems that are dependable, safe, and easy to use. To effectively work, interact, and cooperate with humans, these robots must display abilities and skills that are compatible with those of humans. In the area of human-friendly robot design, focus is on new design concepts for the development of intrinsically safe robotic systems that possess the requisite capabilities and performance to interact and work with humans.

1.1 Project Objective

The aim of this project is to design and construct a tunnel inspection robot. The tunnel inspection robot should be small and easily controlled. It should also function as a surveillance or inspection system to replace human especially in dangerous or high risk situations. These robots are useful for use within collapsed structures, inspection and testing of complex pipe system, maintenance of hazardous structures such as in nuclear reactor, rescue operations in disaster prone areas. Sometimes we may be required to determine whether a partially collapsed or damaged building is saving to go into. The tunnel inspection can easily enter these damaged buildings. Tunnel inspection robots are designed to move in the rough terrain, cross obstacles, and move in narrow spaces that would be difficult or dangerous to be accessed by human inspectors. Further tunnel inspection robots can often do an inspection of a structure faster than human inspectors can.

1.2 The Tunnel Inspection Robot

Tunnel inspection robot is a small remote-controlled mobile robot that is capable of moving inside a small enclosed path that could be dangerous or inaccessible to human. Fig 1.1 illustrates what a tunnel inspection robot looks like.

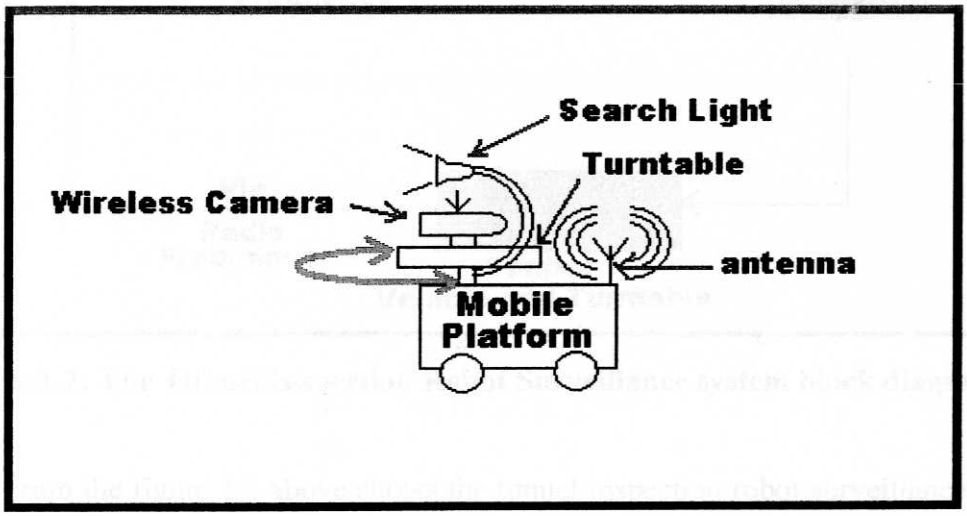

Figure 1.1: The Illustrates of Tunnel Inspection Robot

It consists of a movable platform fitted with a searchlight and a mini wireless video camera. The camera and searchlight are both mounted on a turntable. The turntable is remotely controlled to look at specific directions. To avoid wire entanglements both the robot and the turntable are controlled using a fully wireless system. Tunnel inspection robot is normally fitted with a camera for surveillance purposes. For this tunnel inspection robot the wireless camera was used. The camera will transmit and receive video signals using radio frequency systems formally know as RF. It can allow the operator to visual the situation inside the tunnel via computer. Basically, the search light also provided on the tunnel inspection robot as an equipment for lighting up dark areas when it going inside the tunnel.

1.3 Structure of Tunnel Inspection Robot Surveillance System

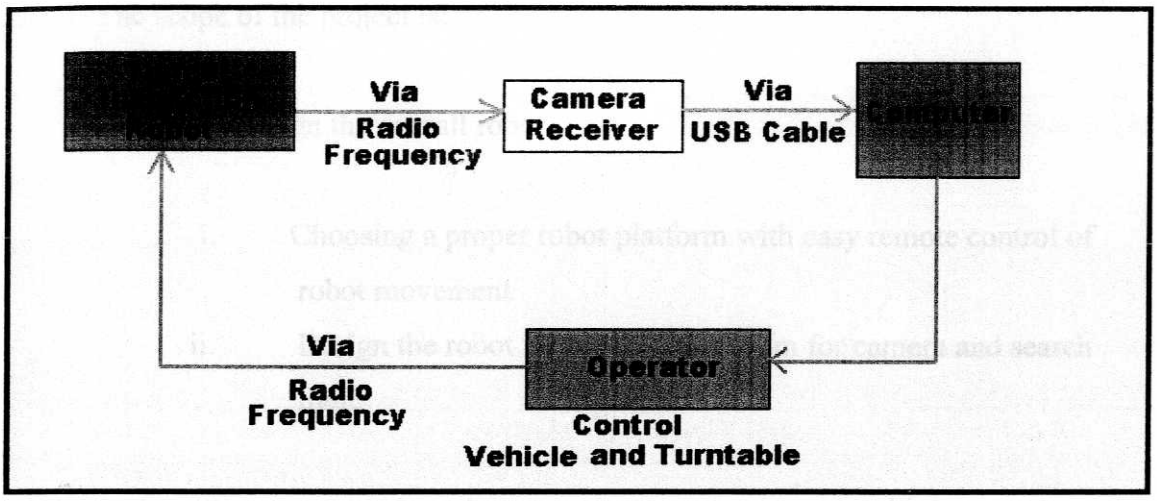

Figure 1.2: The Tunnel Inspection Robot Surveillance system block diagram.

From the figure 1.2 above shows the tunnel inspection robot surveillance system where the camera is sent the signal via radio frequency to a camera receiver interface. The camera receiver interface is connected to computer via USB cable and function to convert the analog video signal to USN port. From the computer, the operator can receive the picture and analyses the situation inside the tunnel. The operator also can move the robot via wireless remote to another destination base on visual from the computer. The angle movement of wireless camera also can adjust by the controller to get the specific position.

1.4 Scope of project

The scope of the project is:

a) To design the overall robot.

   i. Choosing a proper robot platform with easy remote control of robot movement
   ii. Design the robot fixture to make room for camera and search light.

b) Choose a suitable and cheap camera system

c) To design a turntable control circuit for the camera

   i. Implement and constructs of transmitter and receiver circuit.
   ii. Implement and construct of stepper motor driver circuit.
   iii. Design of turn table device.

d) Putting all this together and connect to a central PC for viewing and movement control.

1.5 Scope of Thesis

The scope of this thesis consists of:

Chapter II explains the development of the Tunnel Inspection Robot. Discussions will be base on the robot platform selection, the surveillance system, transmitter and receiver theory as well as the mechanical movement of the robot.

Chapter III, explain the actual implementation of the robot. It includes implementation of the transmitter and receiver circuit the stepper motor drive circuit, power supply voltage regulator and relay circuit. For the mechanical part, discussion is based on the overall robot implementations which include the design of the platform for the camera and search light. These include the movement of the robot as well as the move of camera turn table.

Chap IV discuses the test performs on the robot. Consist of camera testing, transmitter and receiver testing and whole project system testing.

The last chapter summarizes the whole project and includes suggestion for future development.

CHAPTER II

DEVELOPMENT OF TUNNEL INSPECTION ROBOT

2.0 Introduction

In this chapter, explains about the overall of the theory and the project development concept. The objective of this explanation is to describe the perspective and the procedure that is use in previously research and want to know how this project related with the exist theory. Other than that, this chapter also will show how the theory and concept is used to solve the project problem.

2.1 Literature Review

A variety of robotics platforms are used in a number of industries for different purposes. Most of the robots that are in current production fulfill one basic function for the user they go places that humans cannot or will not go, and do tasks that humans cannot or will not complete. For industrial maintenance like duct cleaning basically air duct cleaning is an important industrial maintenance that ensures the cleanliness and quality of air supplies to large, commercial buildings. Accumulated dust creates a basis for bacteria and fungi. These might, within time, free themselves from ducts and be transported into the ventilated rooms causing illness for the occupants. Despite the large number of robots available for pipe inspection, there are fewer systems on the market for air duct inspection. Air ducts have characteristics very different from underground pipes air ducts have many curves, have a strong air flow, normally do not have water in them and can have square or circular sections. To inspect this type of ducts there is a need for small and agile systems.

Civil engineering maintenance like building inspection is a good job opportunity for a tunnel inspections robot would be in partially collapsed or damaged buildings where there is still some structure remaining and you need to get in real fast to determine whether the building is stable. Robots can easily enter these damaged buildings, move in the rough terrain, cross obstacles, and move in narrow spaces that would be difficult or dangerous to be accessed by human inspectors. Tunnel inspection robots can often do an inspection of a structure faster than human inspectors can, and do so without risk to human life. Shipping and Maritime like hull inspection is the importance of maintaining hull and lining integrity of oil tankers is clear. Residual oil, small space and overall toxic environment make remote visual inspection very attractive.

2.2 Robot Platform Selection.

To begin the project, it was decide whether to design a mobile platform or buy an existing platform. On this platform, the wireless camera, turntable device, stepper motor, transmitter and receiver circuit and search light will be mounted. For this project, a mobile robot would be rugged enough for the outdoors, yet still have the capability to maneuver in tight areas. Since the focus of the project was not to build the platform, but to design and construct transmitter and receiver circuit to control the turn table. It was decide the remote control (RC) car is bought.

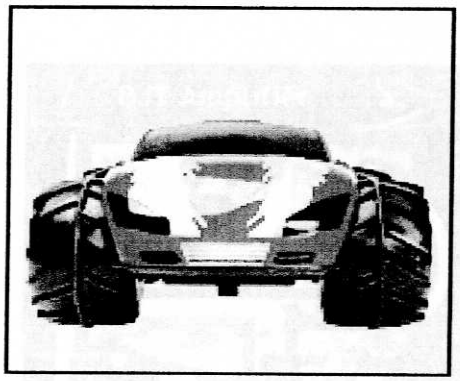

Figure 1.3: Taiyo RC car

For the main body of this tunnel inspection robot, the ready made radio control vehicle model A532 manufacture by TAIYO KOGYO made in Japan was considered suitable. The car came with a hand-held transmitter, chassis, motors/gears/wheels, and a circuit board for the electronics. It also capable to transmits the signal with frequency 27 MHz.