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Sensor Based Mobile Navigation Using Humanoid Robot Nao

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Abstract

This project presents a new approach of humanoid-operated 4-wheeled mobile platform. The robot used in this work is Nao by Aldebaran Robotics. Nao is chosen because of its versatility. Its wide range of movements allows it to perform various tasks such as steering through a simple programming algorithm. Arduino microcontroller target board is used to provide the interface between Nao robot and the mobile platform whilst humanoid robot NAO act as the main processing unit for the whole system. This project consists of several parts. This paper focuses in the development of a sensing system, integration of Arduino microcontroller programming with Nao's Choregraphe and navigation with obstacle avoidance. Several tests has been done to determine the best initial setting to the overall system. The implementation of sensing system in the mobile platform shows very good result as the platform able to avoid obstacles while navigating.

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Nomenclature

δ_0	Turning angle of opposite front tyre
δ_i	Turning angle of incline front tyre
w	Distance between both front tyres
g	Distance between front shafts to front bumper
l	Distance between front and back shaft
R_{max}	Maximum sweeping radius
R_{min}	Minimum sweeping radius
R_1	Turning radius of 4-wheeled car

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1. Introduction

The development and research of self-autonomous mobile platform that able to navigate without human help has become the center of attention in the robotic field. The develop platform will opened many chances of use in variety of fields in providing services to the human beings such as providing guide or tour, mapping of an unknown environment, delivery, healthcare and defense without any human interactions [1]–[4].

The aim in self-autonomous navigation mobile platform is usually to reach determined end point or goal of a certain coordinate in an environment starting from the certain start point in the environment. While it navigates, the mobile platform will encounter different type of obstacles that will hinder direct navigation to the end point. These includes cluttered environment structure such as scattered static objects, wall and bumps that need to be avoided or moving on different terrains such as moving up through stairs, or performing some tasks before continuing the navigation [1], [5], [6].

To gain information from the environment for navigation, sensing system development is important. Getting the right information is vital to ensure correct obstacles avoidance in order to reach the goal point. Different devices have been used to collect the environment information such as laser range finder (LRF), infrared sensor (IR), Camera (vision sensor) and sonar [3], [7]–[10]. These devices usually paired with their own errors that need to be looked at and considered. There are also sensing systems that use more than one type of sensor combined [9].

The work involved in this research aim to develop a suitable 4 wheel mobile platform that can be used by NAO, to develop an algorithm that take data feed from both sensing methods and then execute a set of feedbacks (such as left turning) when the platform navigates. To measure the performance of the implemented sensing system in navigating without collisions, several experiments or tests is have been conducted to understand further any limitations of the developed mobile platform.

2. Mobile platform development

Figure 1 Mobile platform

Figure 1 show the developed 4 wheel mobile platform (a modified kid's remote control car) for Humanoid robot NAO. Several parts of the mobile platform has been changed to suit humanoid robot NAO such as the steering wheel and additional motor was added to sustained NAO's weight of 7.0 kg, embedded microcontroller and sensor.

In this work, 3units of NODNA DF-SEN0164 Adjustable Infrared Sensor Switch are used to detect the front status of the mobile platform. The sensor is adjusted to sense any obstacle in the range of 50 cm from the sensor. The position of the embedded IR sensors in the mobile platform can be show in Figure 2(a) below, where the red circles mark the IR sensors.

To process the information received from IR sensors, Arduino Uno Microcontroller ATmega328 is used. The microcontroller is paired with a DC Motor Driver 2×15A to control the motor of the mobile platform. The microcontroller act as the controller unit of the mobile platform for both IR sensors and motor that act based on the command given by humanoid robot NAO. Interaction between the microcontroller and humanoid robot NAO occur using a serial link.

Two types of software are used to develop the mobile platform which is Arduino software for the microcontroller and Choreographe software for humanoid robot NAO. The main program however is run inside the Choreographe platform as NAO is used embedded central processing unit on the mobile platform. The interaction of this develop platform can be summarised in the figure 2 (b).