Outdoor Position Estimation of a Mobile Platform for Precision Farming and Agriculture Automation

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***Abstract*— Precision farming is a topic that is gaining attention due to its potential to increase efficiency and reduce labor workload in the agriculture industry. Automation using mobile robots is expected to revolutionize the industry. however, a few technical challenges remain. This research is a test of a low-cost position sensor for the application of position estimation of a mobile robot. The objective is to measure the error produced by an ultra-wideband position sensor and to develop a mobile robot system using the Robot Operating System (ROS). The error generated is analyzed based on the measurements taken in outdoor and indoor experiment environment settings. The Root Mean Squared error method was performed to evaluate the performance of the position sensor. The result of the experiment shows that the installation layout of the sensors and the surrounding environment affects the error generated. It is concluded that the low-cost sensor has sufficient reliability for use in the agriculture setting.**

Keywords*— Ultra Wideband, Position Estimation, Mobile Robot, Precision Farming

I. INTRODUCTION

A. Project Background

Recently, there has been an increase in the adoption of automation technologies in production lines of factories in Malaysia. In the agriculture sector, automation of labor-intensive tasks has also gained attention due to the increasing challenges in maintaining a constant workforce. In agriculture automation, precision is one of the factors that affect the efficiency of the system and the quality of the product [1]. The quality of the product determines the sales, which will affect the profit of the industry. Thus, the industry itself requires a management system to solve this problem [2]. Therefore, precision farming is introduced to solve the problem regarding precision control as well the other factors such as the cost of the overall production in agriculture automation [3].

Precision farming is a farm management system that used information and technology to solve the problems of the system in fields for profit in the industry [4]. In precision farming, various challenges can be mitigated by optimizing system efficiency. Among the parameters that are involved in a precision farming system includes the physical positions of the crops, the nutrient content in the soil, the watering and soil humidity, and soil acidity [5]. This paper will try to tackle the problem of position estimation of a mobile robot by using a wireless active sensor when the mobile robot is ordered to move autonomously to a specific coordinate.

The position sensor that is used on the mobile robot is the Ultra-Wide Band position sensor. Ultra-Wide Band, also known as (UWB) is a technology that has been used in the industry to measure positions with centimeter accuracy [6]. The UWB uses radio frequency-based technology to determine its location which uses the time of flight method to measure its location by transmitting the radio frequency [7].

B. Case Study

Since position estimation is the main problem in this paper, the goal of this paper is to study the position estimation error of the UWB position sensor device. In position estimation, the environment of the testing area will interfere with the position sensor. Aside from the environment, the ability of movement of the mobile robot affects the position error due to the limitation of mechanical parts [8]. The main concern in this paper would be the environmental effects.

In the environment situation, there are two types of environment needed to be determined; the first case would be the line of sight environment, also known as (LoS). This case shows that there is no obstacle between the UWB position sensor when it is communicating between the transmitter and receiver device. Contrary to the first case; is no line of sight environment, also known as (NLoS). This case shows that there is an obstacle between the UWB position sensor.

The case study of this paper is to study the position estimation of the Ultra-Wide Band position sensor in the outdoor environment for precision farming systems. Also, develop a system integration for a four-wheel mobile robot using a Raspberry Pi system.

II. METHODOLOGY

A. System Integration Design

The experiment is to measure the position estimation error produced by the UWB sensor, and the result will be analyzed to determine which experiment layout would

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