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REAL-TIME INTER-ROW TREE DETECTIONAND TRACKING TECHNIQUES FOR UNMANNED VEHICLE-BASED ON SIMULTANEOUS LOCALIZATION AND MAPPING APPROACH

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledged that I have been supplied with the academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

In this work, an inter-row tree detection and tracking techniques based on Simultaneous Localization and Mapping (SLAM) method is developed specifically for a well-structured agricultural field where the trees are planted uniformly with certain distance that leaves it with number of inter-row spaces. The existing rows has created opportunities for an autonomous vehicle to navigate in between the trees to perform the plantation activities such as scouting, monitoring, rowing, pesticide spraying and others. Unfortunately, the complicated conditions in the farm impair this solution. Such conditions like large canopy of leaves covered the top of the farm has led difficulty on the Global Positioning System (GPS) signal to penetrate the field and set a stable communication with the autonomous vehicle. In addition, a dark environment is created around the farm which could worsen the usage of image as artificial lighting must be added to distinguish the landmarks from the background. Therefore, a new approach to detect the landmarks and navigate in the farm based on the lightweight sensors and less computation effort is proposed. In this method, the tree detection and diameter estimation techniques implement the modified tree-triangle diameter technique by using innovative technique based on infrared sensors. Then, in substituting the GPS signal problems during the navigation and localization problems, a curve-based navigation approach is formulated. The path is planned based on the third-polynomial Bezier curve by projecting series of waypoints to create a solid path from one point to another. Then, the trajectory plan is derived for the autonomous vehicle to follow these waypoints during the navigation. At the same time, the mapping technique implements the memory utilization method in order to ease the localization process as well as landmarks mapping in the visual map which is oriented in two-dimensional coordinate format. These functions are created, formulated and tested thoroughly in the embedded microcontroller development board platform by using dsPIC30F6014A chip on the omnidirectional vehicle platform. A positive result was found in tree diameter estimation, navigation techniques and landmark mapping with the average error of 0.61 cm, 4.0 cm and 8.9 cm, respectively. These results are compared with the previous research work from other researchers and showed remarkable and promising results to be implemented in the agriculture field with further enhancement and recommendation.

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CHAPTER ONE
INTRODUCTION

1.1 MOTIVATION

Agriculture is a most demanded sector that supplies human with the basic need in life as well as supporting the economic growth of industrialized and developed countries. Based on a research done by the Global Perspective Studies Team in the world agriculture pattern in 2050 [78], the overall demand for agriculture products is expected to be increased by 1.1 percent per year from 2005 to 2050. The factors that lead this increment is the growing of population as well as changes in diets such as more consumption on livestock and others agriculture products, for example, cereals and others. Figure 1.1 shows the projection of the food consumption per person throughout the world.

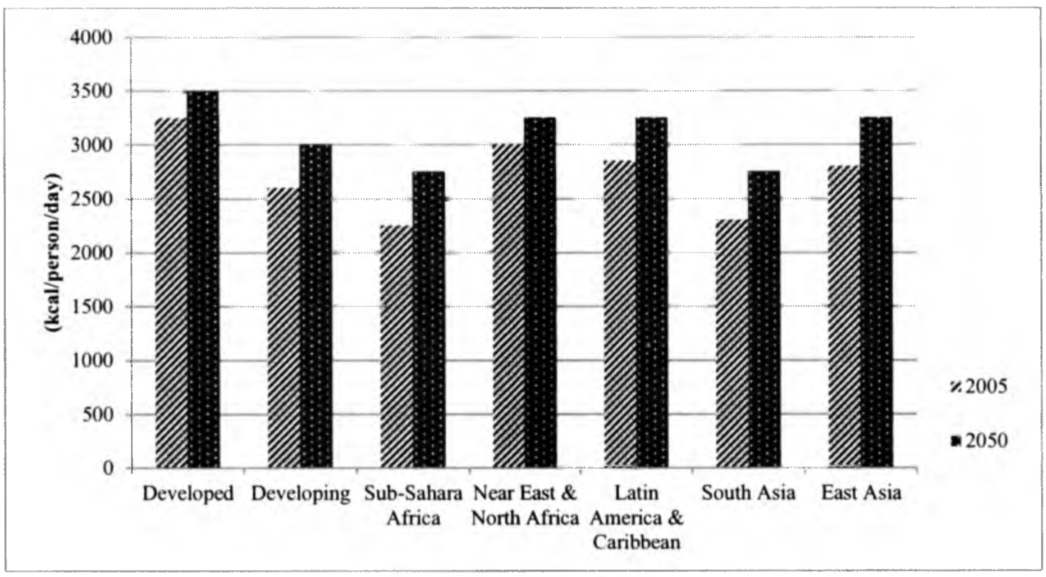

Figure 1.1: Per capita food consumption (kcal/person/day) [78]