

## Design and Development of Agricultural Robots for Plantation Crops

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### Introduction

The production of our primary commodities, namely oil palm, rubber and cocoa, is very labour intensive. Labour problem is said to be one of the contributing factor for the higher cost production and deteriorating agro-based industries. One major problem currently faced by agricultural and plantation industry in Malaysia is the inadequate technology input. Technology input will reduce the dependence of labour and thus increase the utilization of labour and thus increase the utilization of natural resources. Engineering inputs in the agricultural sector are very essential. Automation system, artificial intelligence, dynamic and kinematics for agro-robot, machine vision and image processing and instrumentations and controls for agricultural machines are among the new technology that must be introduced in the agro-based industries. To shape the agro-based industry in Malaysia, new technology such as automation and robotics, information technology, nanotechnology, space technology, energy and agro-ecological must be develop and introduced. Automation and robotics must be developed immediately to solve the harvesting, collection and transportation of fruits, cocoa and oil palm.

### Materials and Methods

The machines developed and designed will be based on the principle of robotics technology available in industry with remote control and electronic sensing. Automation of mechanical component will also develop. Emphasis will be to develop a robot that can utilized robust condition and able to carry out heavy operations. As such hydraulic power will be used as source power. The concept of manipulators will be applied to the hydraulic crane, which will act as robot arm. The com-

puter control system and hydraulic control system will be applied to the robot arm. This system will be used for oil palm harvesting and collection. Machine vision and image processing will also be used to identify the object.

Initially, a prototype robot will be designed and fabricated in the laboratory. The prototype robot will consists of robot arm or hydraulic crane to pick the object, the robot arm will utilized the hydraulic fluid as power source, the vision system consisting of camera with computer CPU will be instructed to the prototype robot. Laboratory testing will be carried out to enable the prototype robot to visualize and pick the right object. After success the whole system will be transferred to the agricultural tractors.

An engine driven tractor will be modified for the purpose of turning the machine into a robot. The hydraulic system will be modified and upgraded for multi purpose functions. Hydraulics crane or robot arm will be built and installed to the engine driven tractor. This special robot arm must be able to maneuver like human arms and enable to cut and pick the ripe oil palm FFB, or cocoa. Machine vision and sensors will be introduced so that robot will select only the ripe fruits to harvest. Research was also carried out to develop robot using pneumatic system for harvesting and collection of cocoa pod. The principle will be the same as hydraulic control robot. Research was also carried out to introduce the gantry system for crop production. Automation will be the main criteria in this research. This system will ensure productivity of agricultural production in a limited area and for high value crop.

### Results and Discussion

The development of hydraulic robot arm and also pneumatic robot arm was successfully achieved. Numbers of

prototypes of oil palm harvester, FFB collector, cocoa pod harvester and transplanter has been developed. Each prototype has a different kind of control system and sensor system. Computer system to control the robot arm was successfully designed using Hydraulics, Pneumatic, genie, C, PLC and Visual basic assist with interface card sensors, and camera vision. The robot that was incorporated with the camera vision can be able to determine the colors of the ripe fruit and determine the X and Y Axes of the fruits locations. The visual basic based software called Virtual Motion Pneumatic Interface (VMPRI), is user interface software to control the pneumatic robot. User just needs to use mouse to click the target that virtually appear on the monitor. The robot arm will move to clicked target and the simulations of the robot movement appear on the monitor screen. We also develop a traveling device for the robot, and a remote control system to control the traveling device and the robot arm *on-line* via Internet line. Research was also successfully in the development of the automation system in high value crop production. A gantry system was designed and developed.

### Conclusions

The designed of the automation and robotics for agricultural industries need to be improved. To replace the human the designed machine must be robust, heavy-duty, also able to withstand with various weather conditions. From the research result, hydraulic system was a suitable power for agricultural robot, which need high working load, while pneumatic system for less working load. The hydraulic system is easy to control compared with the pneumatic system. The critical task in the research was the development of the end-effectors and sensors system for harvesting and collection of the various

kinds of fruits shapes, colors, weight, also fruits positions and heights on the tree. The sensor system need some degree of intelligent to differentiate the ripeness of the fruits, obstacles such tree branches, leafs and etc. further research need to be carried out to increased the efficiency of the designed machine.

#### Benefits from the study

This research successfully sponsored 24 projects carried out by graduate and undergraduate students. From the project various kind of new finding and new technology such as automation and robotics, information technology, nanotechnology, space technology, energy and agro-ecological were introduced into the agricultural industries. The new technologies will expend the agricultural activities, which makes it more interesting

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None.

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#### Graduate Research

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