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Autonomous Robot for Chilli Pesticide Control

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AUTONOMOUS ROBOT for Chilli Pesticide Control

Nutrition, fungicides and pest control are the most important factors to consider in the farming industry. Approximately 30–35% of crops are affected by pesticides, causing health-related issues. At the moment, Malaysia is seriously developing its agriculture sector, especially in the wake of the 4th Industrial Revolution (IR4). Government policies on IR4 have enabled farmers to boost their production and market visibility using IoT. Smart and systematic systems have been introduced. The revolution of artificial intelligence has taken place in the agriculture industry, ensuring good measures to confront issues like climate crisis, unemployment and food security.

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CHALLENGES IN AUTONOMOUS PESTICIDE CONTROL

Our project is to develop an autonomous pesticide control (APC) robot. There are four core technologies involved, namely: (i) robust design, (ii) intelligent guidance (autonomous) & mapping, (iii) pest vision in-row weed control & target detection, and (iv) Internet of things (IOT).

Robust design and development

The development of an autonomous pesticide spraying robot would enhance the efficiencies of both labour and crop yield. This project mainly focuses on the design and development of an adaptive and practical robot that can support multiple functioning systems. The aim is to have an autonomous pesticide spraying capability with an IOT integrated control system. The operation time of pesticide application will be optimised by having a larger pesticide carrying capacity without sacrificing the manoeuvrability of the robot in the small spaces between chilli plants. An analysis on kinematics, stability and strength is needed to come up with a compact, strong and highly efficient self-driving robot, in a way that problems such as exposure to hazardous materials and tedious spraying works can be eliminated or at least reduced appropriately.

Multiple constraints autonomous guidance for APC

Accurately moving along narrow crop rows is a crucial requirement that the pesticide spraying robot must fulfil. While the most common solution to guide vehicles along pre-planned routes is to use global navigation satellite systems (GNSS), its high cost and the lack of availability in certain agricultural environments (Vázquez-Arellano et al., 2016) have led to investigations on the use of computer vision as an alternative (English et al., 2014). Global positioning systems (GPS) are the key tool utilised for positioning and maintaining maps for precision agricultural tasks, yield mapping and variable chemical applications. An intelligent row guidance method is used so that the robot can move independently between each row of crops. The crop recognition and row guidance will use machine learning.

Modular pest spatial detection system using deep learning

One of the main challenges to pesticide reduction using robotic sprayers is target detection. Intelligent devices and systems of unmanned vehicles such as autonomous robots and drones will enable farmers to efficiently spew agrichemical using automated identification systems, which will allow for precise chemical application and pest elimination (Chen et. al, 2007; Waltera et. al, 2017). However, in Malaysia, the use of such intelligent systems is relatively small. Enter the DPest - a modular (i.e., plug-and-play) device which is able to detect pest spatial location in a farm. The device consists of a power unit, a processing unit and controller, an RGB camera, an infrared depth camera, a GPS, and an accelerometer. The idea is to deliver precision pesticides at identified locations in the farm. The system will first acquire RGB photos of the plants, detailed photos of the area, the GPS location, and the movement of the pests. Then, it will do segmentation, classification and identification of the pest through a machine learning approach. Next, it will reconstruct the area map based on the GPS location and photos. The system will then locate the infected area and create a heat map to suggest the type of pesticides to be used for treatment purposes. Instead of applying agrichemical for the all the crops, the right pesticides can be delivered at the right crop location in the right quantity. This will no doubt reduce the cost of pesticides and will result in healthier plants.

With consumers now increasingly demanding foods with less pesticides (King, 2017), this project, which offers a systematic and efficient pesticide dispersal system, is timely indeed. There are 2500 Ha chilli farms across Malaysia, which produce approximately 24,000 Mt chillies annually (MAFI, 2020). An autonomous system is needed to sustain the production in an efficient manner. This is where the APC comes in handy.

Analysis of APC on productivity and ROI in agriculture

The interplay and balance between productivity, growth, structure, manual labour cost, cost of technology, and return on investment (ROI) are often contemplated. For this purpose, an analysis will

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be conducted. The objective of the analysis is to identify the factors that contribute to productivity in order to optimise the process. Figures relating to productivity will be calculated using statistical methods and the Maynard Operation Sequence Technique (MOST). Subsequent calculations of productivity and ROI will be used as the base to make long-term production planning control decisions.

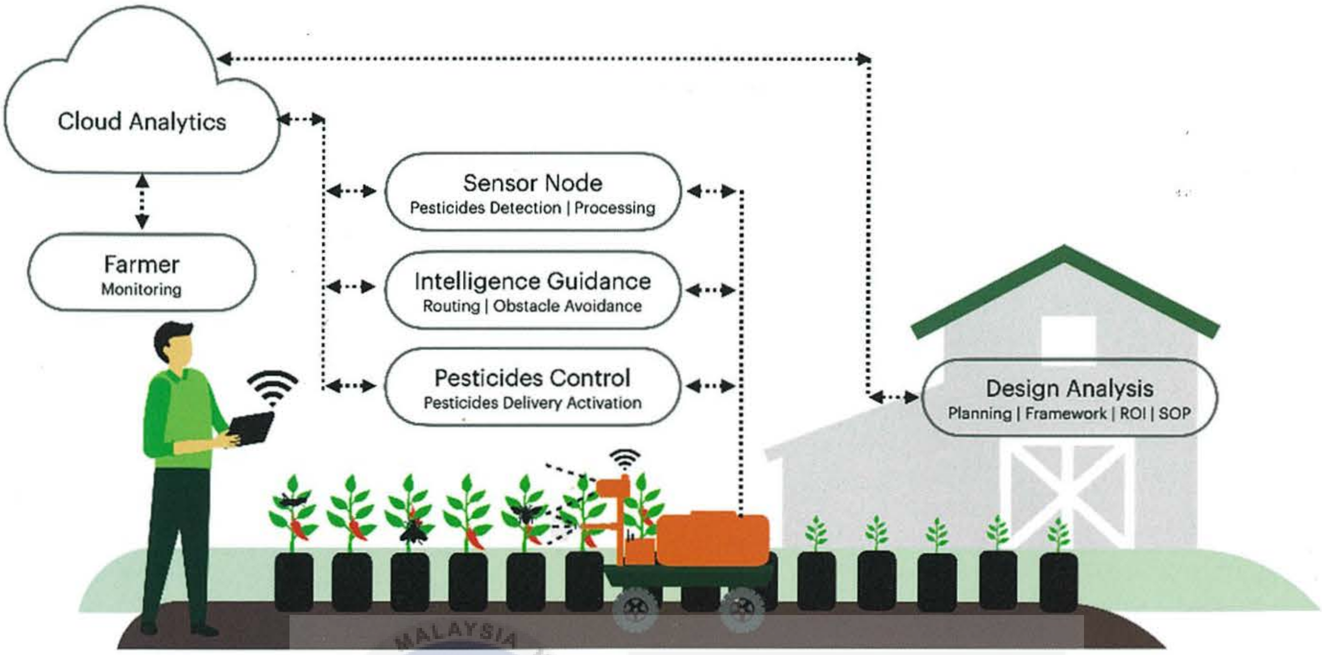
Design and implementation of an IoT-based monitoring and management systems for APC

Crop and pesticide control in chilli is carried out based on manual capture of data (e.g., type of pest, area of plant, etc). It is a slow process since the crops are located in remote and distributed locations. As result, the data collected is relatively poor and might even be invalid. On the other hand, precision agriculture uses emerging technology to increase yield and profit, as well as to reduce adverse impact on the environment. IoT makes it possible to cater for huge and complex number of data streams from various sensors onto scalable IoT platforms. The platforms collect, process, and analyse information in real-time, hence enhancing the decision-making process by providing more factual support and prescribing smart solutions. IoT makes it possible to go for huge processing capacity, reliable network security, efficient communication protocols and timely performance.

Since there are a multitude of challenges to overcome, and a host of technologies to develop and use simultaneously, the APC requires an efficient and effective integration strategy. Each component of the bigger system must be in-sync with one another in order to produce a workable and proficient overall structure.

Field visit at chili farm in Melor Agricare PLT in Alor Gajah, Melaka.

INTEGRATION STRATEGY TO OVERCOME CHALLENGES



Integration strategy in autonomous pesticide control (APC).

WAY FORWARD

The agricultural industry is facing a myriad of problems including worldwide population growth and ageing (Gerland et al., 2014), climate change, and mass migration of people. Field robots may help humanity cope with some of these difficulties. The question is - in the midst of all the challenges - how well will the APC fare?

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