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A Model Case of Intelligent Data Management and Decision Supporting System of Monitoring Green Leafy Vegetables

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Abstract: SMART farming is an important undertaking as increasing demand in agricultural industries in the Philippines is notable. Smart farming in the country could empower local farmers with the decision tools and technologies needed for their livelihood. However, this technology is not yet available in the country. For sustainable agriculture in midst of climate change, monitoring of plant health and detecting its diseases is critical. The need to effectively grow a plant and increase its productivity should be given emphasis. In addressing these concerns, monitoring and grading the plant at its growth and at the time of its harvest is necessary. The purpose of this paper is to provide a model of monitoring the plants and suggest solutions to the farmers for healthy yield and productivity. In this work, the proponent proposed a model to be used in monitoring the identified vegetables during farming. The model for grading vegetables is divided into three complex phases: a) design and development of a plant disease detection system using machine vision, b) design and development of an artificial intelligent system in vegetable grading, and c) notification to the farmer of plant grade and status. Two vegetables have been selected. The images are to be interpreted numerically and it will be classified in linguistics. This paper will demonstrate effective algorithms for vegetable monitoring and grading. Practical implementation of fuzzy logic will be done using MATLAB. For this purpose, Sugeno-style of fuzzy inference system will be used.

Key Words: SMART farm; intelligent monitoring; data management system; vegetable grading; fuzzy logic

1. INTRODUCTION

Every year, local farmers experience huge losses due to pest infestation in their crops (Rupanagudi et.al, 2015). Crops are being affected by uneven climatic conditions leading to decrease agricultural yield, which affects local and global agricultural economy (Bhangea et.al, 2015). Moreover, condition becomes even worst when the crops are infected by any disease. This is where modern agricultural techniques and systems are needed to detect and prevent the crops from being effected by different diseases (Bhangea et.al, 2015).

In this work, the proponent will provide a novel approach of solving this problem by constantly monitoring crops using image processing, decision support system and cloud computing. Also, an insight of how "Internet of Things" will be elaborated and modelled to facilitate data management system (Rupanagudi et.al, 2015).

In developing countries like the Philippines, agricultural industries including farming, constitute major part of the country's economy (Rupanagudi et.al, 2014). This is because a lot of money is spent each year by the government in preventing crop reduction due to pests, natural calamities and drought (Rupanagudi et.al, 2014). Not to mention the country's endeavors for utilizing new technologies and discovering new methodologies and techniques of farming (Rupanagudi et.al, 2014). Accordingly, the production of a good quality yield will not only directly benefit its consumers, but will economically benefit the farmer who toils hard (Rupanagudi et.al, 2014). In farmer's perspective, the better the quality, the more the income, considering that agricultural output is not only used by people for their direct consumption, but by the food industries as well (Rupanagudi et.al, 2014). In due course, the farmer is compensated only if the fruits and vegetables are in good condition and fit for processing. Thus, quality checking of fruits or vegetables is becoming a need not only for manufacturing industries, but most importantly for the farmers (Rupanagudi et.al, 2014). Another added advantage of detecting the ripeness stages of green leafy vegetables (in this proposed), is to decide the expiry or shelf life of the vegetables (Rupanagudi et.al, 2014).

Smart farming pertains to empowering today's farmers with decision tools and automation measurement technologies aimed at integrating products, knowledge and services for better productivity, quality and profit (Kaewmard et.al, 2015). This "Smart Farm" or "Intelligent Farm" is expected to clear up the farming problems discussed earlier. Smart Farm could perceive changes on information derived from semi-automatic microprocessor, setting alarms, notifying plant status to a connected personal computer. The farm monitoring could be conducted via application programs on smart phones for convenient use, time saving and labor reduction (Jindarat et.al, 2015). It is known for a fact that farm's productivity will greatly increase if there are applied smart farm operations. These intelligent operations, includes but not limited to, monitoring, evaluating, controlling and managing everything that, directly or indirectly, compose or influence the farm, such as crops and environmental conditions (Apostol et.al, 2015). More so, agricultural plants are extremely sensitive to climate change. Higher temperatures eventually reduce yields of desirable crops while encouraging proliferation of weeds and pests (Kameoka et.al, 2014). Ergo, quality evaluation and control of agricultural products are very vital in gauging desirable outcomes for the purposes of cultivation and post-harvest management and marketing (Kameoka et.al, 2014). The data acquisition of growth in an environment and the utilization of the data using Information and Communication Technology (ICT) will lead to stable production and productivity improvement (Kameoka et.al, 2014). Thus, the proponent believed that it is significant to address these issues by incorporating smart farm in the Philippines.

2. REVIEW/SURVEY OF RELATED LITERATURE

In supporting the research endeavours of the study, the proponent gathered relevant literatures and itemized them in terms of its highlights, computational tools, methodologies and algorithms used. Based on the table of synthesis, it could be analysed that past studies conducted make use of computational tools such as fuzzy logic, artificial neural network and its types i.e. back propagation, image processing, video processing, cloud computing, robotics, web-based application, wireless sensor network, embedded system and smartphone application. In terms of hardware, they make use of Arduino microcontroller, Raspberry Pi, Programmable Logic Controller (PLC), sensors, computer, smartphone, camera and so forth. Programming languages, on the other hand, includes but not limited to, Java, Python, C/C++, VB.Net and Matlab. Smart farm applications include the following: disease identification and classification, image databases for training and query images, automation of agriculture, irrigation system, optical sensing methods, real-time monitoring and alarming system, decision support system, control system and notification and so forth. The proponents of studied researches focused on limited and common plants such as tomato, apple, grapes and pomegranate. In this work, the proponents will make use of green leafy vegetables. Moreover, most of their researches focused only on single or limited smart farm application. In this work, the proponent will consider

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combining these smart farm applications to come up with a big system, which focuses on intelligent monitoring of green leafy vegetables, image processing, data management and decision support system. This will be made possible by implementing the concept of web-based data analytics in cloud computing.

3. CONCEPTUAL FRAMEWORK OF THE STUDY

Fig.1. Proposed General System Architecture

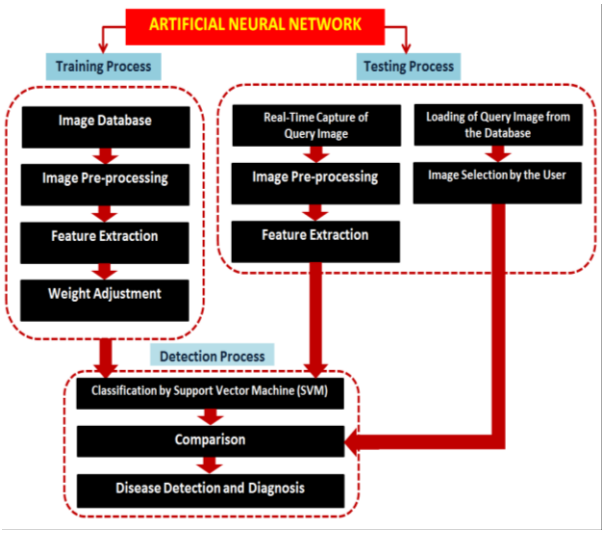

Fig.2. Block Diagram of ANN Framework

3.1 Statement of the Problem

Considering that the study of plant trait/disease requires visual observation of particular plant patterns, the proponent will conduct rigid and comprehensive study on plant behaviours and characteristics in understanding the plants and recognizing its critical parameters. After gathering needed data and information, the proponent will propose a model to be used in monitoring the identified green leafy vegetables during farming. The model for grading vegetables will be divided into four complex phases: a) capturing of images to identify green leafy vegetables and presence of human-beings, b) design and development of plant disease detection system using machine vision and neural network, c) design and development of an artificial intelligent system for vegetable grading and decision-making, and d) notification and information dissemination of plant grade and status to the farmer. Two green leafy vegetables will be used for research in this paper namely: Baguio cabbage (repolyo) and Chinese cabbage (pechay). Selected infected diseases are as follows: a) Leaf Spot (Black spot, gray spot) and b) Powdery/Downy mildew. Plant diseases are because of climate change, water availability, temperature and many more (Jhuria et.al, 2013). The captured images using camera are to be fed to the system and it will be interpreted numerically and will be classified in linguistics. Effective algorithms for vegetable monitoring and grading will be developed.

4. METHODOLOGY

The main purpose of this paper is to monitor diseases on the identified green leafy vegetables and suggest solutions to them for healthy yield and productivity. The proponent will make use of image processing as a tool to monitor diseases of identified green leafy vegetables during farming, right from plantation to harvesting. For this purpose, neural network concept will be used. For training of this neural network, a database of diseased images has been created. The system will make use of two image databases, one for training of already stored disease images and the other for implementation of query images.

Back propagation concept is used for weight adjustment of training database. The images are classified and mapped to their respective disease categories on the basis of three feature vectors: color,

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texture and morphology (Jhuria et.al, 2013). First the image will be resized and then its features are to be extracted on parameters and the image will be classified as infected or non-infected. Out of three features extracted, the proponent will determine which will give the best result. In the process of mapping original features, the proponent will make use of Euclidean distance concept.

Moreover, the concepts and principles of Statistical Process Control (SPC) will be utilized to help the farmers identify and monitor vegetable diseases. The vegetable images and video recordings will be uploaded to the system and it will be plotted on SPC control charts with tolerance limits (specification and control limits). It will store periodic data for real-time monitoring of vegetables. The system has an already trained dataset of images for green leafy vegetables stored on the database. Input image given by the user (captured real-time using camera) will undergo several processing steps in detecting the severity of disease by comparing with the trained dataset images using fuzzy logic. For this purpose, Sugeno-style of fuzzy inference system will be used. In the decision support system, the program will know if the vegetable is lacking sunlight, needs to be watered or fertilized, and so forth. It will also suggest water and needed amount of sunlight. Moreover, occurrences of Out-of-Specs (OOS) and Out-of-Control (OOC) limits will be monitored with respect to tolerance limits of input and output parameters. An alarm mechanism will be incorporated with notification through pop-up, SMS and e-mail. An intent search technique is also provided which is very useful to find the user's intention.

Practical implementation of neural network and fuzzy logic will be done using C++ and MATLAB. Data management system and decision support system will be facilitated using Visual Basic.Net. Embedded system and communication methodologies of the wireless sensor network will also be utilized. Python programming will be used for Raspberry Pi and C/C++ for Arduino Microcontroller. Also, the proponent will develop Smartphone application on Android operating system using the Java programming language and it will interacted with the Raspberry Pi through the wireless network (Kaewmard et.al, 2015)(Jindarat et.al, 2015). Moreover, considering that an important issue in farm management and control systems is data security, the proponent will provide secure mechanism to store and access the data. Each user will be delimited with certain level access according to its assigned role: administrator, farmer, client, user, etc. (Apostol et.al, 2015). Most importantly, experimental evaluation of the proposed approach will be determined and it will be tested for accuracy and reliability in vegetable grading and identifying diseases.

5. CONCLUSION AND FUTURE DIRECTIVE

This research is purely a modeling a framework for intelligent data management and decision supporting system of monitoring green leafy vegetables using digital image analysis. The established framework and methodologies must be expedited to a real working system. It was assessed that smart/intelligent system is possible in Philippine setting and it is believed that the proponent's framework will address issues on farming system in the country. Thus, it is highly recommended to conduct more comprehensive and rigid studies on this course and discipline. The proponent of this study will be working on a larger system that comprises the complex phases discussed on the previous sections. The tool will be assessed and evaluated as well in terms of its accuracy, reliability and effectiveness. Once the testing and evaluation phase was accomplished, then it will be implemented.

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