AUTOMATION IN AGRICULTURE

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ABSTRACT

The world population is expected to reach 9.1 billion by year 2050 says FAO (World Food and Agriculture Organization) and to feed this population food production should be increased by at least 70%. Developing countries have to double their food production. The traditional methods of farming and ever decreasing farm labour availability is making agriculture economically unviable and inefficient. In above context research on development of intelligent, autonomous machinery for carrying agricultural activites is essential to improve the quantity and quality of the agricultural produce. Today there is an urgent need to address the issues like indiscriminate use of agrochemicals, conservation of energy, control on environmental pollution and effects of global warming. Automation of farming practices has proved to increase the food production levels. This paper surveys the work carried out by various researchers to get a holistic picture on current state of implementation of automation in agricultural practices around the w

1.Introduction

Monitoring of the agricultural environment has become a major issue in recent years due to a range of factors including population growth, need for increased food production and the apparent onset of global warming. Population growth has led to environmental problems arising primarily from the pressure to produce more food from an essentially static or even diminishing food production land area. Modern agriculture depends heavily on engineering, technology, biological and physical sciences. Mechanization of agriculture activities have relieved much of the manual work and increased efficiency and productivity of farms with many application examples and recent advances in the field. The complex agricultural environment combined with intensive production requires development of robust systems with short development time at low cost. The unstructured nature of the external environment increases chances of failure. Moreover, the machines are usually operated by low-tech personnel. Therefore, inherent safety and reliability is an important feature. Food safety is also an issue requiring the automated systems to be sanitized and reliable against leakage of contaminations. This chapter reviews agricultural automation systems including field machinery, irrigation systems, greenhouse automation, animal automation systems, and automation of fruit production systems. Each section describes the different automation systems.

2.Automation In Agriculture

Sustainable agriculture aims at the production of high-quality food and raw materials in sufficient quantity for a wide range of consumers. Further objectives are the rational use of natural resources and preservation of the environment. For this reason, modern field machinery and equipment should be able to cope with complex agricultural processes and to execute difficult operations at high efficiencies and without environmental pollution. To control the performance of these machines, a large amount of information has to be captured by sensors and transmitted to and stored in data logging systems for further processing. Moreover, agricultural production takes place in an open system that has various relations to its surroundings. Therefore, when these machines and processes are in operation, the state of the surrounding systems, as well as the interactions between the agricultural production process and its environment, must be taken into account.

Mass and energy flows must therefore be accompanied by information flows. These facts require the introduction of an information-based agriculture, the so-called "precision agriculture." "Precision agriculture" means that the production processes must be strictly controlled according to the demands of plants, soil, and environment in a site-specific way. The area of these sites is much smaller than the area of whole fields. For intensive cultures, such as vegetables, a site may even be only one plant. For animal production, this means that each animal is treated individually. Such a site-specific treatment requires the transmission of great amounts of data, such as individual values for references, states, and controlled variables, together with information about weather conditions, date, time, and location. Additionally, technical equipment and production processes should be upgraded with new knowledge, improvements, and enhancements in a simple and compatible way. Furthermore, maintenance and service of modern machines and process equipment should be handled according to their actual wear, operation times and circumstances. This necessitates sampling, transmission, and processing of data in a compatible way, since the data may be generated, transmitted, and processed in different units. In summary, compatible data transmission is a necessary condition for achievement of all the aims formulated above. Communication technology thus serves as the backbone of precision agriculture. In the following, we give three examples for advanced precision agriculture components: combine harvester, sprayer, and fertilizer spreader. This will be followed by a description of the "backbone" communication, which is organized in the form of a specific agricultural bus system and protocol. Spatial variability in soil conditions such as texture, structure, soil moisture, and soil fertility give rise to local variations in crop yield. Although the lack of spatial uniformity of the factors that influence the growth of field crops, and hence their p productivity, has been known and appreciated since early times, agricultural practice hardly takes into account this spatial variability in traditional arable crop production. The recent availability of reliable, inexpensive, and precise systems for on-the-go acquisition of the world position of soil tillage tools, machines for crop protection, fertilizers and harvesters during field operation (the Global Positioning System, or GPS, supported by dead reckoning systems), and parallel advances in sensor technology, precision mechanisms, and the information processing power of computers, have led to adoption of the concepts of precision agriculture, site-specific farming, or spatially variable application. In site-specific agriculture, different field operations are adapted to variations in soil conditions, crop growth stage and yield, the spread of weeds and disease infestation within each individual field. Intra-field variations are captured and the registered data are translated into numerous field maps (e.g., weed, disease, yield, and fertilizer and pesticide application maps) with high resolution. These maps are the core of site specific crop management that guarantees a more rational use of raw inputs such as seed for sowing, fertilizer, pesticides, and fuel for mobile agricultural machines.

