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Desing And Modeling On Agriculturalrobots

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***ABSTRACT* :** Agricultural robot or "Agribot" is a robot used for agricultural purposes. The advent of bots n agriculture drastically increased the productivity and output of agriculture in several countries. Further, the usage of robots in agriculture reduced the operating costs and lead time of agriculture. The current paper reviews the success stories of robotic agriculture in different areas of agriculture. The work also throws light on the future scope of robotic agriculture especially in developing *countries.*

Key words: *Robot, RIA, Mechanization, Weed Mapping, Seed Mapping*.

I. INTRODUCTION

The Robotic Industries Association (RIA) defines robot as: "A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks." [1]. Robots have been successfully used in several industrial applications like material handling, material transfer, processing, inspection & quality control. The idea of mechanization (usage of automated equipment and robots) of agriculture was most obvious in recent years and there are many success stories of robotic agriculture. The reasons for usage of robots in agriculture are to improve food quality and productivity, reduce labour costs and time. One more important reason for robotic agriculture is the unavailability of sufficient skilled man power in agricultural sector and it affects the growth of developing countries. Robots have successfully been used in agricultural activities like seeding, harvesting, weed control, grove supervision, chemical applications, etc. In India, about 70% of population is dependent on agriculture [2]. Therefore, if the farmers are empowered with support of robots, the agricultural output of the nation can improve radically.The primary agricultural activity done by the support of robots today is at the harvesting stage. Possible emerging applications are robots or drones for weed control [3]. Developed agriculture needs to find new ways to improve efficiency. One approach is to utilize available information technologies in the form of more intelligent machines to reduce and target energy inputs in more effective ways than in the past. Agribot is a robot designed for agricultural purposes [4]. As one of the trends of development on automation and intelligence of agricultural machinery in the 21st century, all kinds of agricultural robots have been researched and developed to implement a number of agricultural production activities in many countries [5]. The advent of autonomous system architectures gives us the opportunity to develop a complete new range of agricultural equipment based on small smart machines that can do the right thing, in the right place, at the right time in the right way. Environmental problems are also steadily gaining importance in the political stakes of industrialized countries, especially with respect to agricultural activities. In particular, one way to be more environmentally friendly is to design automatic systems for farm vehicle guidance. Such developments can increase the accuracy of a task during long periods of work, and hence reduce negative impacts on the environment linked to agronomic activities [6]. When using an automated guidance device, spraying can be achieved more accurately, so that areas with too much fertilizer can be reduced. Pollution and the time needed to perform farming tasks are then both reduced. Furthermore, such automation can improve the farmer's comfort, as the tracking task is performed by the vehicle itself .

II. BEGINNING OF AGRIBOTS

The idea of robotic agriculture (agricultural environments serviced by smart machines) is not a new one. Many engineers have developed driverless tractors in the past but they have not been successful as they did not have the ability to embrace the complexity of the real world. Most of them assumed an industrial style of farming where everything was known before hand and the machines could work entirely in predefined ways, much like a production line. On a global scale the need for more food is a serious issue. The world's population is expected to reach 9.6 billion people by the year 2050. The world population today is 7.4 billion. The increasing opportunities in other sectors is day-by-day reducing the man power availability in farming. As a matter of fact, the average age of a farmer in the U. S is age 58.

That is up from five years ago when it was 55. New generation just want to get away from farming. Usage of Agribots started slowly replacing the man power needed for agricultural purposes. As mentioned by IEEE Robotics and Automation Society, Robotics and automation can play a significant role in society for meeting 2050 agricultural production needs. For six decades robots have played a fundamental role in increasing the efficiency and reducing the cost of industrial production and products. With the limited land, water and labor resources, it is estimated that the efficiency of agricultural productivity must increase at least by 25% to meet that global demand for food grains. Hence, the use of robotics and automation in agriculture would become inevitable across the world in the near future.

III. SUCCESS STORIES OF AGRIBOTS IN SOME IMPORTANT AGRICULTURAL ACTIVITIES

They are used for many applications in agriculture as they are versatile. Some of the uses are;

3.1. Seed mapping

Seed mapping is the concept of passively recording the geospatial position of each seed as it goes into the ground. It is relatively simple in practice as an RTK GPS is fitted to the seeder and infrared sensors mounted below the seed chute. As the seed drops, it cuts the infrared beam and triggers a data logger that records the position and orientation of the seeder. A simple kinematic model can then calculate the actual seed position. The seed coordinates can then be used to target subsequent plant based operations [8].

Although a high accuracy positioning system was used, results from field operations were initially poor due to small dynamic inclinations during the sowing operation. In order to correct this effect, an inclinometer was attached to the GPS antenna pole for measuring pitch and roll. All logged data from GPS, inclinometer and the optical sensors were recorded and time labeled by the data logger at a resolution of 400 Hz. The GPS data in UTM coordinates were sampled at 20 Hz. In order to compute the position of each seed, a time interpolation was carried out based on time tagged seed detections and the 50 ms data intervals from the GPS. In the post processing of the data, a kinematic model provided the heading information, eliminated the inclination errors and calculated the seed drop positions.

3.2. Weed mapping

Weed mapping is the process of recording the position, density (biomass) and preferably species of different weeds using machine vision. For automatic weed detection, several studies have been performed applying different discrimination and classification techniques. Weed mapping is a hypothetical scenario in the sense that most farmers do not conduct systematic field scouting in their cereal fields today. Farmers either practice conventional farming with conventional spraying or they conduct organic farming with mechanical weeding. In this comparison, we assume that the alternative to autonomous weed mapping is manual weed mapping, which implies that the farmer has to register and map the weeds in the field manually with a handheld GPS. There are numerous methods that can confiscate unwanted plants without using chemicals. These can range from total removal down to simple retardation. A classic example would be to promote the wilting of the weed plants by breaking the soil and root interface by ploughing the soil within the root zone. In principle, there are three main areas within the crop environment that require different types of treatment: The inter-row area (the space between the crop rows), the intra-row area (the space between the plants within the row), and the close-to-crop area that is within the leaf and root envelope [9].The inter-row area is relatively easy to keep free of weeds as it is an open strip in line with the direction of travel. The intra-row area is more difficult to manage as it is an intermittent space delineated by irregular spacing of crop plants. The close-to-crop area should not have any soil disturbance as this would lead to possible wilting. Weeds within this area are likely to incur the most competition of all as they are so close to the crop plant's resources.

Usage of weed maps results in the following advantages;

1. Strategic control work and protecting the good bushland.
2. Understanding the distribution of weeds in bushland.
3. Monitoring the spread of established weeds and the effectiveness of control programs.
4. Setting accurate distribution of weeds.

3.3. Micro spraying

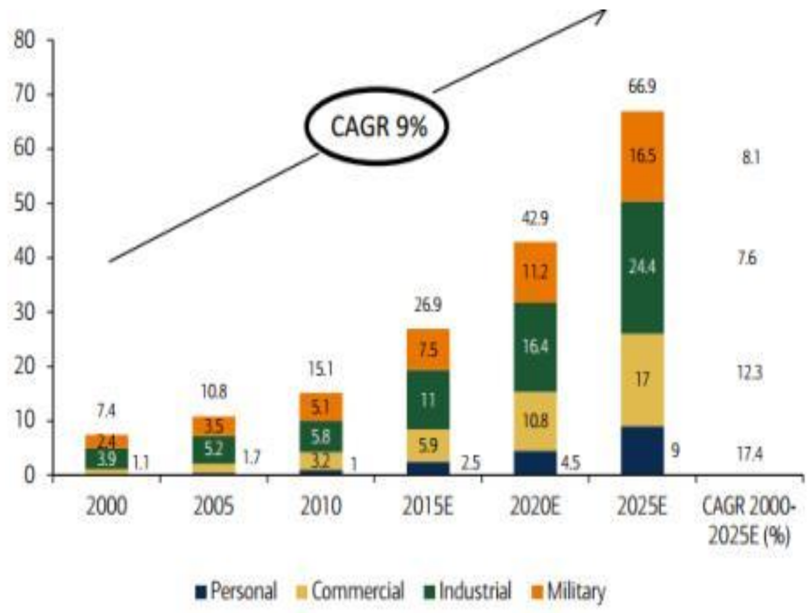
Micro spraying takes the concept of a spray boom down to the centimeter level. It applies highly targeted chemicals and can treat small areas by selectively switching the jets on and off. It is part of a larger system that can recognize individual weed plants and locate their leaves for treatment. Within the close-to-crop area, great care must be taken not to damage the crop nor disturb the soil. One method of killing weeds close to the crop plants is to use a micro spray that delivers very small amounts directly on to the weed leaf. Machine vision can be used to identify the position of an individual weed plant and a set of nozzles mounted close together can squirt an herbicide on to the weed. Tests have shown that splashing can be reduced when a gel is used as a carrier rather than water [9].

IV. FUTURE OF THE AGRIBOTS

Today's agriculture has transformed into a high-tech enterprise that most 20^{th} century farmers might barely recognize. After all, it was only around 100 years ago that farming in the US transitioned from animal power to robotic power. Over the past 20 years the global positioning system (GPS), electronic sensors and other new tools have moved farming even further into a technological wonderland [11].Automatic guidance, whereby a GPS-based system steers the tractor in a much more precise pattern than the driver is capable of is a tremendous success story. Safety concerns currently limit completely driverless capability to smaller machines. Fully autonomous or robotic field machines have begun to be employed in small-scale high profit-margin agriculture such as wine grapes, nursery plants and some fruits and vegetables.High-throughput plant phenotyping (HTPP) is an up-and-coming precision agriculture technology at the intersection of genetics, sensors and robotics. It is used to develop new varieties or "lines" of a crop to improve characteristics such as nutritive content and drought and pest tolerance. HTPP employs multiple sensors to measure important physical characteristics of plants, such as height; leaf number, size, shape, angle, color, wilting; stalk thickness; number of fruiting positions. These are examples of phenotypic traits, the physical expression of what a plant's genes code for. Scientists can compare these measurements to already-known genetic markers for a particular plant variety [11].

Agricultural Robots market to reach $16.3 Billion by 2020. Robots meet stringent hygiene and safety regulations, work tirelessly 24 hours a day, and relieve humanworkers of physically ard uous tasks. Robots contribute to the freshneess, variety and quality of food. By 2050, world population is expected to rise to nine billion, but the amount of arable land meeant to grow food will remain mostly the same as it stands today. As such, a 25% increase in productivity is mandated to sup port not just a growing populace, but also a wealthier one – as income inequality is coming down in developing countries.We're also seeing a shharp increase in meat consumption, for instannce. Genetically time, productivity stems from agricultural processes and some modern farmers are already integrating the latest technology to increase their yields and cut costs. Twenty years from now, oranges and corn could be 100% sown, grown and harvested by robots [11].

The graph shows the rise of the robotic market in the coming years [12];



V. CONCLUSION

The current review presented the necessity, advantages, applications and success stories of using Agribotss in agriculture. This paper has presented the usage and outcome of using robots in agriculture. This paper tries to enhance knowledge on using Agribots instead of farmers especially in developing countrries like India, Paraguay, Albania, Guinea etc.

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