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A review on different types of autonomous agriculture machines

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Abstract
The main purpose of this article is to discuss all the digital and modern farming technologies which are using in agriculture fields. This paper reviews most of the latest success technologies in agricultural autonomous machines, specifically those are used for remote controlled and autonomous weed control, spraying and harvesting etc. But currently farmers are facing a lot of problems while working in fields like chemical contacting with pesticides and danger from animals and insects. Autonomous and remotely controlled technology helps the farmers in reducing drudgery, less time taken for working in field and also provide the protection to the farmers. In this article different types of autonomous vehicles like sprayers, weeders and harvesters and their benefits are reviewed. Thus, the automatic machines are economic, easy to operate for all types of farmers and it works as a high efficiency machinery for improving the status of advanced technology.

Keywords: autonomous and remote controlled vehicles, different types of machines, challenges of autonomous machines

Introduction
Nowadays, working in agriculture fields is very problematic task and the general trend is that agricultural employment has been diminishing rapidly due to cumbersome work, migrant workers, growth in the service industry, and other factors. This had a negative impact on national food security, which is reflected in the rapid increase in the balance of payments of agriculture in international trade. In addition, most of the labour force employed in the agricultural sector is women. Agriculture practices have been revolutionized by the introduction of remotely operated machines, automatic navigation of tractors and combine harvesters. There are different types of Autonomous machineries which play unique role in all aspects- Tillage, sowing, weeding, spraying, harvesting etc. Autonomous machineries create unique way of benefits like timely operations, increases in yield, reduces drudgery etc.
Some unique characteristics such as precision agriculture, in-time agriculture operations and less energy consumed from human makes automatic machines certainly better than a manually operated machines.
Autonomous agriculture machineries are not only correlated to one operation, it works a complete all agricultural operations. The potential benefits of automated agricultural vehicles include increased productivity and accuracy, together with enhanced operational safety. Research on autonomous agricultural vehicles has become very popular, and the autonomous machinery industry has developed a vast range of remarkable machines. In the near future, farmers will be using affordable, dependable autonomous vehicles for agricultural applications. Some research stations have recently developed robot vehicles and tractors for agricultural resolutions. An autonomous guidance operation and automated rice transplanter were developed. More advanced research has been executed towards the development of semi-robot vehicles and agricultural robots (Ilker and Mehmet 2015) [12].

Factors considering while designing and choosing of Autonomous agriculture machines:
- Size- small (and therefore unmanned)
- Weight- less
- Able to behave in a safe manner, even when partial system failures occur
- Capable of being co-ordinated with other machines
- Able to exhibit long-term sensible behaviour
- Capable of receiving instructions and communicating information

- Capable to bring out a range of useful tasks.
- Damage to the crop is at least as low as with manual operated machineries.
- Energy efficiency at least as high as mechanical operations.
- Complexity of operation not higher than other machines.
- Reliable functioning.
- Suitable as research platform

Different aspects of Autonomous agriculture machines

- Types of automatic operated agricultural machinery
- Challenges of Autonomous agriculture machines for precision agriculture

Different types of automatic operated agricultural machinery

There are different types of automatic operated agricultural machinery. Because of the use of different combinations of agriculture operations it has developed. And those are discussed below.

Liggett (1982) [16] designed and developed a dual steering system for use on a material handling vehicle having a chassis with front steerable wheels and an upper structure movably supported from the chassis for rotary movement about a connecting center pin. The vehicle has a main truck cab on the chassis, whereas the vehicle may be driven over road to a selected site, and an operator cab on the upper structure from which the excavator vehicle may be operated and also driven for short distances. When the vehicle is driven over road, the vehicle is steered from a steering wheel in the main truck cab, and hydraulic power is provided by a hydraulic power supply mounted on the chassis. When the excavator is controlled from the operator cab, the vehicle is steered with a joystick and hydraulic power is supplied from an alternate hydraulic supply on the upper structure. Thus, two alternate but interconnected sources of hydraulic fluid are utilized to provide power to a hydraulically powered, mechanically controlled steering gear. Operatively connected to the mechanical input of the chassis steering gear is the output of a tee gear box which has two rotary mechanical inputs for controlling the output. One rotary input to the tee gearbox is from the steering wheel located in the main truck cab on the chassis. A second rotary input to the tee gear box is provided by a hydraulic torque motor which is controlled through the joystick steering device in the operator cab on the upper structure.

Blackmore *et al*. (2004) [8] proposes some system requirements for a small autonomous tractor that includes some physical attributes as well as behavioural traits in certain conditions or contexts. The tractor should be physically small, lightweight, reliable, have good real time communication facilities and be managed easily, especially under fleet management. Five internal and thirteen external contexts have been recognized that can be used to trigger different behaviours. Four operational modes for the tractor have been identified. Field scouting and mechanical weeding have been recognized and described as the first two niche tasks likely to become autonomous.

Pedersen *et al*. (2006) [19] adapted on the commercial possibility of applying autonomous robotic vehicles compared to conventional systems in three diverse applications: crop scouting in cereals robotic weeding in high value crops (particularly sugar beet) and grass cutting on golf courses. The estimation was based on a systems investigation and an individual economic possibility study for each of the three applications. The results exhibited that in all three circumstances, the robotic applications are more economically possible than the conservative systems. The less capacity of the vehicles and high cost of real time kinematics Global Positioning System (RTK-GPS) are the main constraints that increase the cost of the robotic systems.

Tijmen Bakker (2009) [24] is reported that the result of the design is a versatile research vehicle with a diesel engine, hydraulic transmission, four-wheel drive and 360 degrees four- wheel steering. The robustness of the vehicle and the open software architecture permit the investigation of a wide spectrum of research options regarding solutions for intra-row weed detection and weeding actuators. The result of the plan is a reliable concept for an autonomous weeding robot in a research context.

Ardit *et al*. (2014) [5] as focused on to compare the mathematical and physical results conducted in accordance with the properties of radio-controlled car with the results that appear from the simulation (motion analysis) in CAD software. As we mentioned, these results will be subject to the physical properties of radio-controlled car (e.g. mass, torque of stepper motors, the radius of wheels, angle of slope of wheels) and the properties of the environment, (e.g. plan surface, angle of slope plan). In order to have successful result which leads to proper operation (desired movement) of a radio controlled car we must choose the appropriate electrical component (e.g. Arduino, stepper drivers, stepper motors and batteries) and the suitable electrical component for a safe movement (e.g. camera, led).

A robotic control system having a chassis and a drive system for self-driving the robot. The robotic control system including a controller configured to control the drive system. The controller being further configured to at least one of auto-load the vehicle onto a trailer, preclude tipping of the vehicle, stabilize yaw of the vehicle, simulate Ackerman steering, balance the vehicle on two wheels, retrieve another vehicle, transfer a payload from the vehicle to the other vehicle, coupling of at least one other vehicle to the vehicle, retrieval or movement of a container using either relative sensing or absolute position referencing, profile cutting of plants, and 3D print cement Ashby (2015) [6].

A study on the determining variations in fields is important for precision farming applications. Precision farming is used to determine, analyse, and manage factors such as temporal and spatial variability to obtain maximum profit, sustainability and environmental protection. However, precision farming is excessively dependent on soil and plant test processes. Furthermore, test processes are time-consuming, laborious and expensive. These processes also cannot be performed quickly by humans. For these reasons, autonomous robots should be designed and established for the detection of field variations and variable- rate applications. In this study, a remote-controlled and GPS-guided autonomous robot was designed and established, which can be controlled via the 3G internet and is suitable for image processing applications. The joystick is used to manually remotely control the robot movements in any direction or speed Ilker and Mehmet (2015) [12].

Yomesh *et al*. (2015) [25] said that now-a-days generally the knapsack sprayer is used by the Indian farmers. This type of sprayer consists of tank 10-20 litres capacity carried by two adjustable straps. In this knapsack sprayer developing adequate pressure is laborious, time consuming and it increase

the drudgery of the farmers. In order to overwhelmed these difficulties a battery-operated sprayer has been proposed based on the general principle of spraying. This system is operated by direct current of battery. So we use pressure pump whose flow liquid capacity is 7.5LPM at pressure 120PSI (8bar). The developed multipurpose battery operated wheel sprayer comprises of 12V and 12AH rechargeable battery; 12V, 5AH pressure pump; charging unit and control switch.

Ahalya and Muktha (2017) [2] developed a semi-automatic pesticide sprayer system which operates using solar power. The semiautomatic sprayer is a 3 wheeled vehicle which sprays pesticide in any given vineyard with almost nil human assistance. The vehicle is electrically powered using an on-board solar powered battery which brings down the running cost. In this they are trying to make a prototype model for cultivators and farmers for whom spraying of insecticides is destructive and hazardous. The control of the vehicle is successfully using an inbuilt microcontroller unit which is programmed to respond to the zigbee wireless device.

Tom Duckett *et al*. (2018) said that autonomous systems and robotics are now commonly using for milking animals International Federation of Robotics (2017). These systems are preliminary to execute works around the farm, such as eradicating waste from animal cubicle pens, moving and carrying feedstuffs, etc. There are further opportunities to apply more advancement technologies, combined with more autonomous systems, to perform tasks on the field. This applies to both widespread production and intensive (indoor) systems. A further submission for robotic systems associated to the managing of farmed animals, such as dairy cattle, chickens and pigs, where contribution via the providing of suitable and appropriate information can help to diminish waste and environmental pollution as well as progression in animal welfare and productivity on the farm. Woefully human monitoring includes many limits, including pollution and farm-worker health risks, and providing of only inadequate frequency, determination and reliability of data. It is also a costly, slow and labour-intensive process. Automation provides the probable for allowing more timely, continuous data capture, effective involvement, condensed production costs and enhanced animal welfare.

Luciano *et al*. (2019) [17] has developed a solution based on a reconfigurable vehicle with a high degree of automation for the distribution of plant protection products in vineyards and greenhouses. The collaboration among the vehicle and the spraying management system we created is an inventive arrangement with high technological content, for the field of agricultural techniques. The targets of this frame work are the development of an autonomous vehicle and a spraying management structure that permits safe and accurate autonomous spraying operations.

Rahul *et al*. (2019) [20] said that currently its dealing with a great deal of complications due to non-utilising of advanced techniques. Additionally different issues are chemicals contacting with pesticides and danger from bugs and animals. The drone can be helpful for crop protection and spraying pesticides. This should be done by the individual person stand up at a safe distance and by controlling the UAV. This aids them farmer in reducing the time taken and also deliver the protection to the farmer. This drone system mainly works on the principle of thrust. The drone contains four arms and each arm four motors are involved along with the propeller which make available the lifting impact. The movement of the drone is regulated by the radio controller and the speed of the drone is also controlled by it. The anticipated work in the research paper is for the operation of the automated aerial vehicle for spraying the pesticides in agricultural area.

Saadfathalla and Abdallah (2020) developed a field sprayer to be constrained and measured by remote control for spraying chemicals currently, agricultural sprayers are the most extensively used equipment's to perform pesticide applications. A few categories of sprayers have been established from hand-operated, hydraulic sprayers to boom/speed sprayers or aircraft sprayers with the progress of agricultural engineering. Typically, the spray proficiency, which frequently be predictable by cost-income of agricultural industry, intensifications from hand-operated sprayer with low application rate, small coverage section in a detailed time intermission and low travel speed to massive sprayers which could apply pesticide with a lot higher application rate, greater exposure area in a specific time span and furthermore higher transportable speed.

However, no review has yet investigated on an autonomous unmanned vehicle that is both engine controlled and remote assessed, and which can be performing field applications like weeding and spraying. This study tends to this research gap and developed for field works

Challenges of Autonomous agriculture machines for precision agriculture

Avital and Clement (2016) [7] reported agricultural robots require the development of advanced technologies to deal through complex and highly variable environments and produce (Nof, 2009). Furthermore, seasonality of agriculture varieties it difficult to achieve the high level of utilisation found in manufacturing. However, even if the technical and economic feasibility of most of the field robotics applications is not reached in the adjacent forthcoming using the existing knowledge and technologies, partial autonomy will add value to the machine long before autonomous production robots are fully available. For many tasks, the Pareto principle applies. It claims that roughly 80% of a task is easy to adapt to robotics and/or automation, but the remaining 20% is difficult (Stentz, Dima, Wellington, Herman, & Stager, 2002). Therefore, by automating the easy parts of a task, one can diminish the required manual work by 80%. Furthermore, the development of partially autonomous robots is an excellent transitional path to developing and experimenting with software and hardware elements that will eventually be integrated into fully autonomous systems.

Redmond and Cornelia (2018) [21] Digital farming is the practice of modern technologies such as sensors, robotics, and data analysis for shifting from tedious operations to continuously automated processes. This paper reviews some of the latest achievements in agricultural robotics, specifically those that are used for autonomous weed control, field scouting, and harvesting. Object identification, task planning algorithms, digitalization and optimization of sensors are highlighted as some of the facing challenges in the situation of digital farming. The concepts of multi-robots, human-robot collaboration, and environment reconstruction from aerial images and ground-based sensors for the creation of virtual farms were highlighted as some of the gateways of digital farming. It was shown that one of the trends and research focuses in agricultural field robotics is towards building a swarm of small scale robots and drones that collaborate together to optimize farming inputs and reveal denied or

concealed information. For the case of robotic harvesting, an autonomous framework with several simple axis manipulators can be faster and more efficient than the currently adapted professional expensive manipulators. While robots are becoming the inseparable parts of the modern farms, our conclusion is that it is not realistic to expect an entirely automated farming system in the future.

Tom Duckett *et al*. (2018) said that the aquaculture production is already a vertically combined and proficient supply network, but activates in an atmosphere with a number of challenges and numerous difficulties that limit production, where robotic systems and sensors can play a role. The environment for aquaculture is unfavourable and hard to admittance by human operatives with remote areas and severe environment, with access only by small boat, prompting high operating expenditures and important health, security issues and safety. The utilization of independent sensing and remote operation could suggestively reduce the requirement for an on-site human occurrence making such conveniences safer and easier to achieve. Major challenges contain health and environmental problems, for example gill diseases, sea lice and algal blooms, also controlled by autonomous vehicles.

Kassim and Termezai (2020) [14] study anticipates to implement a flexible sprayer arm to spray the pesticide under the crop's leaves. This review comprises the enhancement of automated pesticide sprayer that can be accumulated independently. It is on the grounds that the pesticide is an unsafe part that can be affected human health in the future if it is uncovered during manual spraying method particularly in a closed area such as in the greenhouse. The flexible sprayer boom also can be deftly controlled in the greenhouse and outdoor climate for example open space farms. It is expected to have a successful pesticide management system in the fertigation based farm by using the automatic pesticide sprayer robot. Moreover, the proposed autonomous pesticide sprayer additionally can be utilized for different types of crops such as rock melon, tomato, papaya. pineapples, vegetables and so on.

Keeping in view, the challenging aspect of autonomous agriculture machineries are significantly high because of its high working efficiency as well as human drudgery reduction are balanced. The autonomous agriculture machines had a wide range of opportunity for utilization in development of advanced agriculture machines.

Conclusion

A remote controlled and autonomous machine was successfully designed and developed for use in precision agriculture applications. Autonomous vehicles can to reduce disease risk and drudgery for a certain group of farming people. farmers can already select from a wide range of remotely operated vehicles that contain functional components, those are high level of precision agriculture farming applications like soil sampling, sowing, weeding, spraying etc., Autonomous agriculture machine benefits may result from increasing the efficiency of work and timely operation. And these machines gave a good rate of agriculture operations and cost of operations is moderated as compared with manually operated agricultural implements. In another side the safety and farmer health is ensured by eliminating human labour from this working process. Further studies are needed to focus on adaption of different agriculture machines developing for all types of farmers. Remotely controlled machines are also help in improving the health of the farmers by providing advanced and functional components.

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