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Navigation systems for agricultural machinery for adaptive-landscape farming

Umida Nasritdinova[1*], *Boburmirzo* Ko‘kiyev[2], *Svetlana* Ataxanova[2], *Ismail* Ozodboyev[2], and *Samat* Seytimbetov[2]

[1]“Tashkent Institute of Irrigation and Agricultural Mechanization Engineers” National Research University, Tashkent, 100000, Uzbekistan
[2]Chirchik State Pedagogical University, st. Amir Temur, street house 104, Chirchik city, Uzbekistan

Abstract. The GLONASS navigator is a versatile tool with diverse applications spanning air, sea, and land navigation. In agriculture, it facilitates adaptive-landscape farming by tailoring practices to specific soil and climate conditions, reducing search costs, and enhancing accuracy for surveyors and farmers. Beyond agriculture, GLONASS technology revolutionizes transportation by enabling shorter flight times, optimizing traffic flow, and even supporting aircraft control with autonomous landing prototypes. Its integration into various devices like watches, mobile phones, cars, and GPS-equipped dog collars further extends its utility. The widespread adoption of GLONASS in navigation and traffic management promises enhanced efficiency and safety across industries, including agriculture. As this technology evolves and becomes more accessible, its potential applications are poised to expand, offering exciting prospects for the future of adaptive-landscape farming and navigation across land, water, and air. While GLONASS is a powerful tool for navigation globally, it may face limitations in signal reception in underground areas like parking lots, caves, and chambers.

1 Introduction

GLONASS-navigator can be used in a variety of ways on land, in the water, and in the air. In essence, a satellite navigator aids in navigation and lets you mark or record a location on the surface of the globe. The Glonass Navigator can be utilized anywhere, with the exception of areas where the signal is not received, such as subterranean parking lots, caverns, chambers, and caves [1-4].

GLONASS is primarily utilized for navigation in the air and on water, and it has a wide range of uses on land. GLONASS navigators are used by scientists for a variety of tasks. The GLONASS navigator is used by surveyors for the majority of their job. Both great accuracy and a large reduction in search costs are ensured by this [5-6].

Accuracy with search equipment is often one meter. Systems that are far more costly can offer accuracy to the nearest centimeter. The GLONASS navigator is used in a wider variety of recreational activities the more types there are. The GLONASS navigator is gaining

* Corresponding author: jaxongirqosimov7@gmail.com

popularity among travelers, hunters, climbers, skiers, and other outdoor enthusiasts. If you play sports or engage in any other activity where you need to maintain location awareness, pinpoint the precise path to a destination, or determine which way to go and how quickly, then GLONASS navigator will be beneficial to you [7].

Additionally, GPS/GNS navigation is quickly becoming standard in automobiles. Certain installed systems offer safety support by instantly sending the vehicle's current location to the dispatch center during roadside emergencies.

With the use of an electronic card and more sophisticated systems, drivers can control traffic direction and look up addresses, hotels, restaurants, and other amenities. The location of the automobile can also be displayed on the display. A route can be automatically chosen and next directions to the destination can be provided by certain GLONASS/GPS navigators.

2 Methods

To explore the potential of GLONASS navigators in adaptive-landscape farming the following research methods were employed.

An extensive literature review was conducted to gather information on the existing applications and benefits of GLONASS navigators in agriculture and other industries. This review helped us identify the knowledge gaps and research opportunities in this area.

Several case studies of GLONASS navigator usage in agriculture, focusing on the impact on farming practices, cost reduction, and accuracy improvement were analyzed. These case studies provided valuable insights into the real-world benefits and challenges of implementing GLONASS technology in agricultural settings.

The authors collected data on GLONASS navigator usage in agriculture, including search costs, accuracy, and time savings. We analyzed this data using statistical methods to quantify the benefits of GLONASS technology in agricultural applications.

We compared GLONASS navigators with other navigation systems, such as GPS and GNS, to determine their relative advantages and disadvantages in agricultural settings. This comparative analysis helped us identify the unique features that make GLONASS navigators particularly suitable for adaptive-landscape farming.

3 Results and discussion

Transport is one of the most significant sectors that the GLONASS technology has opened up entirely new possibilities for. Specifically, it is anticipated that radio guidance would eventually allow for shorter "plane" itineraries and shorter flying times. The worldwide navigation system will be functional everywhere a signal is received. In aircraft control, for instance, on-board GLONASS/GPS receivers are frequently utilized. This system's prototypes, which enable autonomous aircraft landings, are undergoing testing. Nevertheless, this calls for more ground-based stations that can identify the liner's whereabouts in orbit.

Businesses that provide a high volume of traffic are in need of the activity of using satellite navigation to regulate motor vehicles, particularly in different regions. The monitoring system helps to efficiently coordinate traffic flows of various sizes and offers the ability to control any vehicle's traffic from a distance with excellent quality. It is possible to install GLONASS/GPS receivers in watches, mobile phones, and automobiles. Every marine craft has a GPS receiver installed.

It has been suggested that dog collars be fitted with GSM modules with tiny receivers and chips that have GPS and GLONASS capabilities. For instance, AVID Identification Systems, an American business, has created a rice-sized GPS microchip. They are all given different numbers. Such a microchip makes it possible to locate a lost dog fast. Additionally, travelers from all over the world, tourists, hunters, anglers, and extreme sportsmen can rely on the GLONASS/GPS system as a trusted guide.

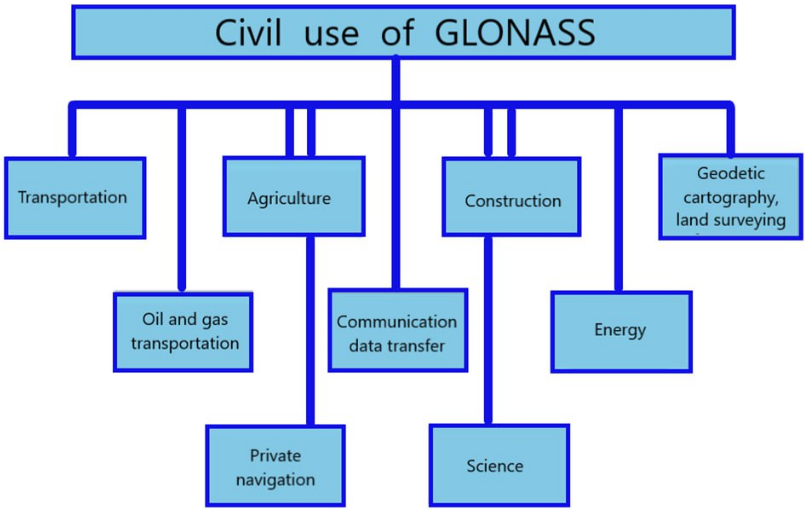

Fig. 1. Application of GLONASS in civil works.

The possibility of using GLONASS as a source of accurate time is interesting for many scientists and researchers, because the idea of determining the transit time of a radio signal is based on the idea of GLONASS. For this purpose, the receiver's internal clock is constantly synchronized with the satellites' atomic clocks. This allows you to provide time accuracy from micro to nona second. Consequently, it will be able to have perfectly exact time stamps everywhere when doing scientific investigations.

Usually, when fields are processed in traditional ways without the use of navigation systems, residuals and transitions occur, as a result of which the processed field looks like this.

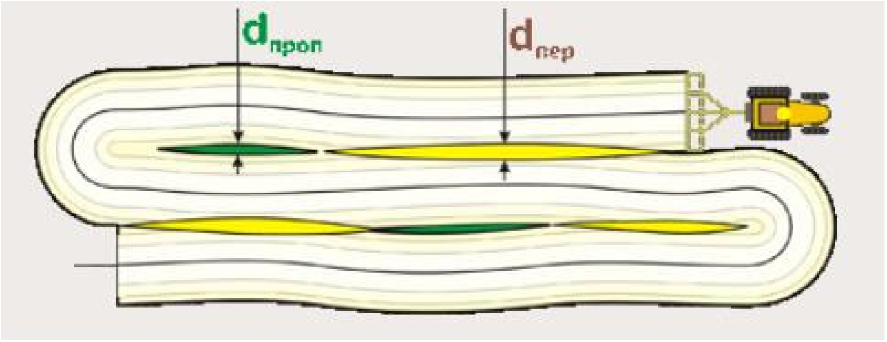

Fig. 2. The occurrence of residues and carryovers when processed in traditional ways.

There are several types of solutions to ensure the trajectory of the tractor across the field with a specified distance between adjacent passes in the required position:

1) installation of guides (veshkas) that are visible while driving, that the mechanic can catch while working;
2) Use of removable or foam markers;
3) Utilizing satellite-based navigation systems.

Even an experienced and dedicated mechanic cannot get the exact distance of the correct pass without the help of markers or signaling assistants when working with extensive machinery. The problem of accurate movement of machine-tractor units deepens as the range of modern agricultural machines increases.

Below is a space image of the treated area using satellite navigation systems.

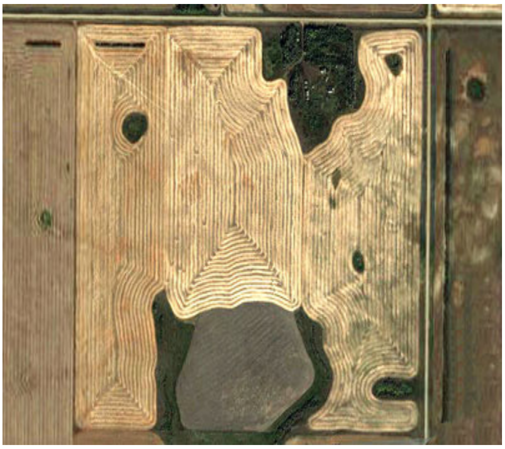

Fig. 3. A space image of the treated area using satellite navigation systems.

The following are the benefits of using satellite navigation to guarantee the necessary tractor movement trajectory:

- It is not required to carry out preliminary marking of the area;
- Additional materials are not required for marking rows;
- Aggregate width is used to the maximum; the overlap of neighboring rows is minimized;
- There will be no residual spaces between adjacent rows;
- The technical employment rate will increase;
- Ability to work even in low visibility conditions;
- Ease of operation increases and driver fatigue decreases.

Here are some ways to process fields using satellite navigation systems:

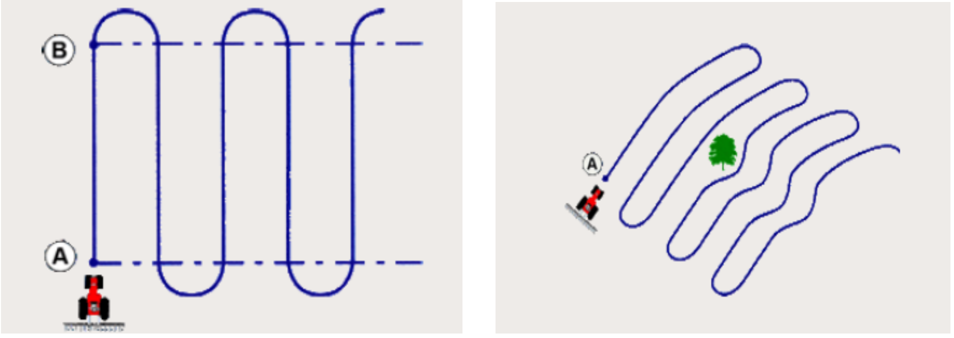

Fig. 4. Basic mode (left) —AB is parallel to the base, Adaptive curve mode (right) follows the previous transition path.

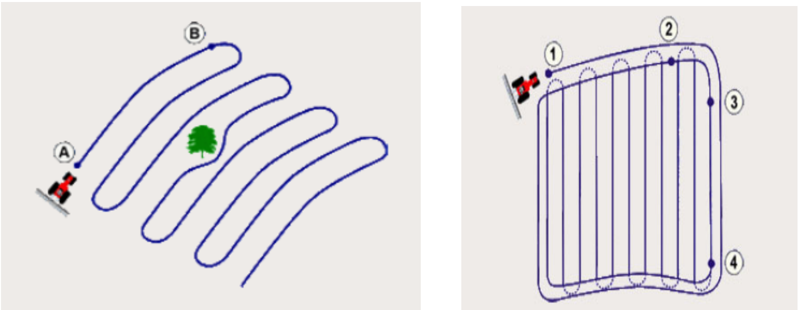

Fig. 5. “Adjusted curve” (left) - then all passes repeat the initial curve AB, the contour lines are pretreated (right) and then driven parallel to the main direction (CAM PILOT) optical sensor in operation.

4 Conclusion

The requirement for regional agro-geographical information systems is demonstrated by the existing experience of agro-ecological land evaluation and design of adaptive-landscape farming systems for major agricultural operations in various natural-agricultural zones and regions. These works were sourced thirty to fifty years ago from a variety of scientific suggestions and their generalized collections in the form of "zonal farming systems" and "agricultural systems." These compilations are released for every republic, region, and administrative division. They functioned as a set of methodological guidelines for land development initiatives that were developed both inside and between farms. These instructions are currently required, but due to environmental constraints, the requirements for both their shape and content have increased dramatically.

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