SATELLITE-BASED STEERING SYSTEM FOR AGRICULTURAL PURPOSES

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The development of agricultural sector is closely connected with the evolution of technical hardware and methods. This paper proposes a method of solving one of the harvesting problems – precise cultivation using parallel driving. In addition to it there are some optimization methods provided to upgrade this technology to achieve higher quality of its performance.

Agriculture is one of the most significant parts of Belarusian economy. To correspond its meaning agriculture requires regular improvement. In conditions of progressive technical development there are many opportunities for automatization of different agricultural operations that can upgrade its quality.

Harvesting is a huge agricultural sphere the automatization of which provides huge potential for optimization and development of its processes.

The annual amount of collected harvest depends on many factors. It's important to point out one of them such as cultivating precision. The harvest collecting or cultivating is performed using the parallel driving, that means the usage of special combine-harvesters and tractors to perform field work while moving along parallel paths. Such driving is accompanied by harvest skips or repeated work on cultivated areas that lead to unnecessary economical spendings.

A satellite-based steering system is developed to minimize skips or repeating. The main task of this system is to correct harvester (tractor) direction by affecting steering column.

The system contains navigation hardware, that calculates current harvester position and direction, processing module, that estimates harvester deviation from specified track and forms signal for an electric drive, that performs rotation of steering column to a desired angle.

The navigation hardware is based on the global satellite systems such as GPS and GLONASS. The using of both of these systems makes possible to obtain navigation information from a bigger number of satellites, that provides higher precision of harvester spotting [1]. The navigation hardware contains three receiving antennas. One of them is called a base or a base station and it is set at a point with known coordinates somewhere near the field when two others are fixed on a harvester roof.

The first step of hardware performance is calculating base coordinates using a geocentric coordinate system and comparing them with known coordinates. As a result we have a correction that is used to calculate harvester coordinates.

The next step is computing this coordinates relatively the base. Such technique provides more spotting precision due to the abstraction from ionospheric error by considering that all antennas coordinate calculations have the same error. This consideration takes place because of close location of harvester relatively the base station (less than 30 kilometers).

The calculating of harvester direction is performed by using an interferometric method [1] that presumes the computation of different angles formed between "satellite-antenna", "antenna-antenna" lines and coordinates axis. Such computing requires known "antenna-antenna" distance that's why harvester antennas must be fixed on specified constant places.

After acquiring the navigation information the processing module starts its work. Its task is calculating differences between current harvester position and points on a specified track. This computing algorithms require information about needed position in different time points. So it is necessary to use prediction methods to optimize correction path. This information is used to form signal for an electric drive that rotates the steering column.

The rotation is controlled by a processing module. To make the drive rotate the steering column module sends a signal of appropriate magnitude. This magnitude depends on the needed rotation angle and the type of used electric drive. There are some special rotating algorithms that are often used to optimize the rotating process.

Modern agricultural development is strongly connected with automatization process. The usage of such satellite-based technology makes the things better but it is necessary to point out the importance of optimization algorithms for this technique. But still the system contains several parts, the optimization process must affect all of these parts individually to provide global increment of the quality of system in general.

References:

1. Shebshaevich V. S. and others, "Network satellite radio navigation system", Radio and connection, 205-208, 1993.