R&D OF THE r, ϕ SCANNER MECHANICAL CONSTRUCTION FOR THE SCINTILLATOR DETECTOR BACKGROUND RADIATION MEASUREMENTS*

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The aim of this project is the introduction to research and development of a prototype drive system for various sensors in the r, ϕ coordinate system. The device was designed for extensive solutions, but in this case, the focus was particularly on the cosmic ray measurement system. An extremely important issue was the easiest possible adaptability to various applications, therefore, the proposed solution was mostly made in the technology of aluminum profiles. For these above-mentioned reasons, the designed solution is expected to cover areas up to 1 m in length and 2π angle. After auspicious prototype tests and meeting the primary assumptions, the final device is assumed to examine the expanse up to 3 m in length and 2π angle. The continuation and further progress of the project will consist of the manual preparation of the measuring device, software development and real cosmic ray measurements performance.

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1. Introduction

To present the idea of the project, one must first familiarize with the potential complications in the construction of the MPD complex, resulting from the nature of cosmic rays.

Cosmic radiation is complex radiation reaching the Earth from the surrounding space. Primary cosmic radiation falls on the outer layers of the Earth's atmosphere at a speed, close to the speed of light in a vacuum [1].

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Then, collisions of primary radiation particles with atoms of the atmosphere create a stream of high-energy electrons, protons, muons and photons — this is called secondary cosmic rays [1].

Currently, scintillation counters are widely used to detect cosmic rays [1], which will be used in the prototype. Then, thanks to the use of a network of ground detectors, it is possible to reconstruct the direction of cosmic radiation reaching the Earth, and thus reducing its impact.

For these reasons, the device has been designed in the r, ϕ coordinate system, because the radiation varies depending on the angle of incidence [1], and by moving the detectors placed on the main guideway, the solid angle is changed, enabling effective particle detection.

The assumption goal was to design a device, in which two sensors are mounted on the guideway and perform a symmetrical sliding movement, relative to the centre of rotation of the whole guideway in r, ϕ coordinates. Another assumption was to create the prototype mainly with the usage of aluminum profiles, which allows modifying it in various ways.

Moreover, the prototype is supposed to have a working arm with a total length of 1 meter and rotate in the whole range, *i.e.* 2π.

During the designing phase, the key point was to provide mechanical protection for keeping it in undamaged condition.

2. Results

2.1. Rotation mechanism

The toothed belt mechanism was used (Fig. 1). The large-toothed wheel has 80 teeth and the small toothed wheel has 20 teeth, so the speed decreases fourfold and the torque is fourfold greater.

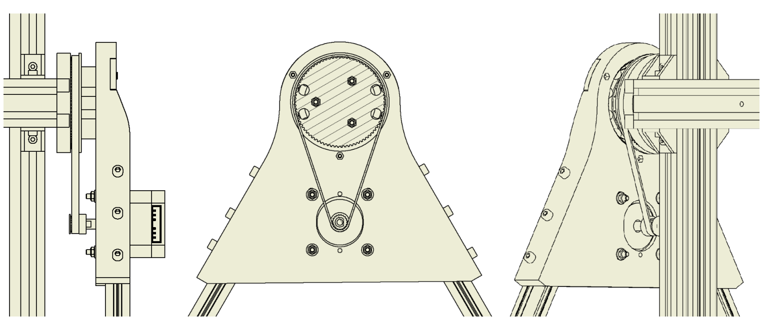

Fig. 1. The method of rotary motion realisation.

The distance from the axes of the gears has been assumed to be 100 mm. For such a distance, the belt was 358.05 mm. Since the belts have a standardized length, the closest one to the result had to be chosen. It was

357 mm long. This allowed calculating the target distance between the axes and it was 99.46 mm. The clearance in the gearbox is removed by moving the motor, which increases the belt tension.

2.2. Sliding motion mechanism

The sliding motion mechanism was taken from the mechanisms of 3D printers and the V-Slot article [2]. The basic feature, that distinguishes it from most solutions, is the use of two motors at each end (Fig. 2).

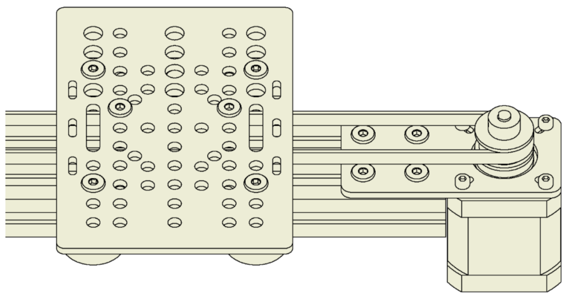

Fig. 2. The method of stepper motor fastening.

Such a solution, however, does not result from the need to construct a sliding motion, but from the need to overcome the problem of the counterweight and keep the whole guideway as well balanced as possible, so that it does not interfere with the rotational motion. For the same reason, both cars move synchronously, while maintaining the same distance from the axis of rotation (Fig. 3).

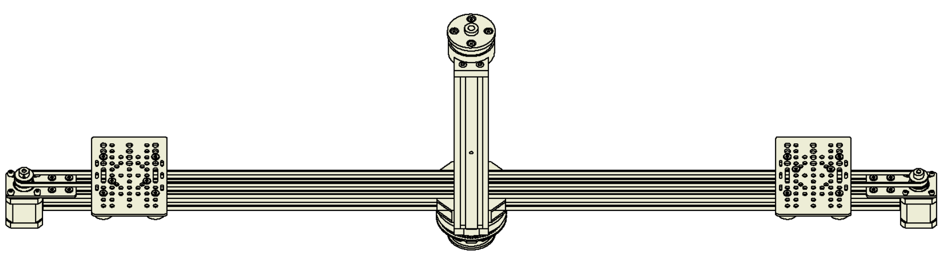

Fig. 3. The method of sliding motion realisation.

2.3. Cable routing

To achieve multiple rotational movements, a rotary union was decided to be used, which allows rotation of the guideway virtually infinitely in one direction. Thanks to this element, it is possible to avoid damage to the cables.

3. Conclusions

Naturally, the next stages of this project will be the assembly of the device and its programming. After successful trial tests and meeting the primary assumptions, it is planned to create a device with a longer arm. It will have a total diameter of 3 meters. This is how the designed prototype looks like (Fig. 4).

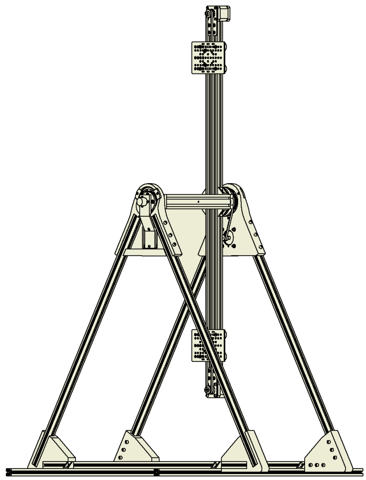

Fig. 4. Final construction.

The use of trivial construction solutions reduces the susceptibility to potential complications and mechanical damage. In addition, the use of elements obtained thanks to 3D printing, reduces production costs. In turn, thanks to the use of V-Slot mounting plates and aluminum profiles of appropriate strength, it is possible to attach various sensors, which implies the versatility of the structure.

REFERENCES

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