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INERTIAL NAVIGATION SYSTEMS

Tsumarev Y.D., student
Scientific supervisor – Samusevich A.S., lecturer
English language department №1
Belarusian National University of Technology
Minsk, Republic of Belarus

A GPS is very good at giving us directions and helping us with navigation. However, when you lose signal or it gets interrupted by something, Inertial Navigation System (INS) comes to help. This is similar to most of the basic principles compiled in order to do something not so simple.

If you need to calculate your movement, you need three things. First of all, you need to get your acceleration, which you can measure with accelerometer. Then you get direction of yaw, and we measure it with gyroscope. In flying vehicles, we also need to know pitch and roll, which are also measured with gyroscopes. From this data you will know how you are moving, but not where are you heading to. INS can't tell your position currently, but if you know it from maps or by other means, it can calculate that.

Let's take a closer look at the instruments, which INS uses to do all that work.

Accelerometer working principle is very simple. If we place a mass at the scales, it has some weight, which is calculated by acceleration times speed. When vehicle is not moving, acceleration is 9.8 m/s^2. But when accelerating, this number will be the sum of the acceleration of gravity and the acceleration of vehicle, and the weight will be increased. Measuring this increase, we can get the number we need.

The other method is two springs which balance the proof mass, and it works similarly. When vehicle moves, proof mass stays behind for some time [3].

Gyroscope's principle is like spinning top toy. It works on conservation of the angular momentum [2].

So, when the device or the entire plane tilts, the gyroscope remains in its place relative to the horizon. With several gyroscopes in different positions, we can measure yaw, pitch and roll.

Once we get this, we can learn other things. Just integrate the acceleration once, and you will get the speed, and then again – you will have the starting position [3].

Let's consider a few examples. Soviet INS named "Globus" was used to calculate the position of the spacecraft in orbit. It will be shown on miniature globe and with latitude and longitude indicators on the left and on the top.

On the globe there are dots with NASA tracking sites and big cities all around the world. Then there is another indicator under the globe – it shows when the spacecraft will enter the light or shadow.

"Globus" also provides you with information such as the landing angle, to calculate that you need to turn the switch using the "МП", "З" and "ОТКЛ" written above.

The first is to select a landing site, the second shows position over the Earth and the third is to disable it. This INS was used on "Soyuz" spacecraft in 1967 in the Apollo-Soyuz mission [4].

In conclusion, the Inertial Navigation Systems are astonishing examples of electromechanical engineering, and with the development of new technologies they are getting better and better. Some details change, but the principle remains the same.

Modern aircraft, spacecraft and sea transport cannot be imagined without this technology.

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