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The Events and Their Types in Geodetic Measurements

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Abstract. We all know that the main part of geodetic work is measurements with geodetic instruments. As a result of measurements, numerical values are obtained, and numerical values are repeatedly measured in geodesy. To improve the quality of the measurement, in addition to the necessary values, excess values are also measured. It is carried out due to the presence of excess measurements, due to measurement errors. The presence of measurement errors forces us to carry out additional measurements and resort to probability theory.

Key words: random variables, their distribution laws, numerical characteristics, probability theory, random event, probability of an event, simple and complex event.

Probability theory – is a mathematical science that studies the numerical regularity of many random events.

A random event is an event that may or may not occur when a set of conditions *S* is fulfilled. However, when a random event occurs, some clear law applies: when a coin is tossed, the coat of arms and the number side fall approximately equally, when a bullet is fired, it hits the center of the target more than the edge, etc.

Try it results can be expressed quantitatively and qualitatively. A qualitative characteristic of any test is called an event. For example, when shooting at a target, two events can happen: hitting the target and not hitting the target.

Any numerical characteristic of an experiment is called a random variable. Examples of random quantities are the result of measuring some quantity, the coordinates of a shot, etc.

Events are conditionally divided into simple and complex events. Normal events are events that cannot happen. Complex events include several simple events. For example, the occurrence of one error in one measurement is a simple phenomenon, and the occurrence of 5 errors in 10 measurements is a complex phenomenon. The initial letters of the Latin alphabet of events are designated as A, B, C or A_1, A_2,...,A_n.

When fulfilling certain complex conditions, events are divided into: reliable, impossible and random.

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An event that is sure to happen is called a certain event. For example, if one ball is drawn from a box filled with white balls, it is a reliable event that a white ball comes out. Reliable events are marked with the letter U.

Events that never happen are called impossible events. For example, if we take one ball from a box filled with white balls, it is impossible to get a black ball. Impossible events are marked with the letter V.

The occurrence or non-occurrence of an event when certain conditions are met is called a random event. For example, when we toss a coin, it is a random event that it lands with a coat of arms or an inscription.

Types of random events:

1. Coincidental events occur at the same time as a result of experience. For example, the emission of light from an electronic total station and its impact on the reflector are simultaneous events.

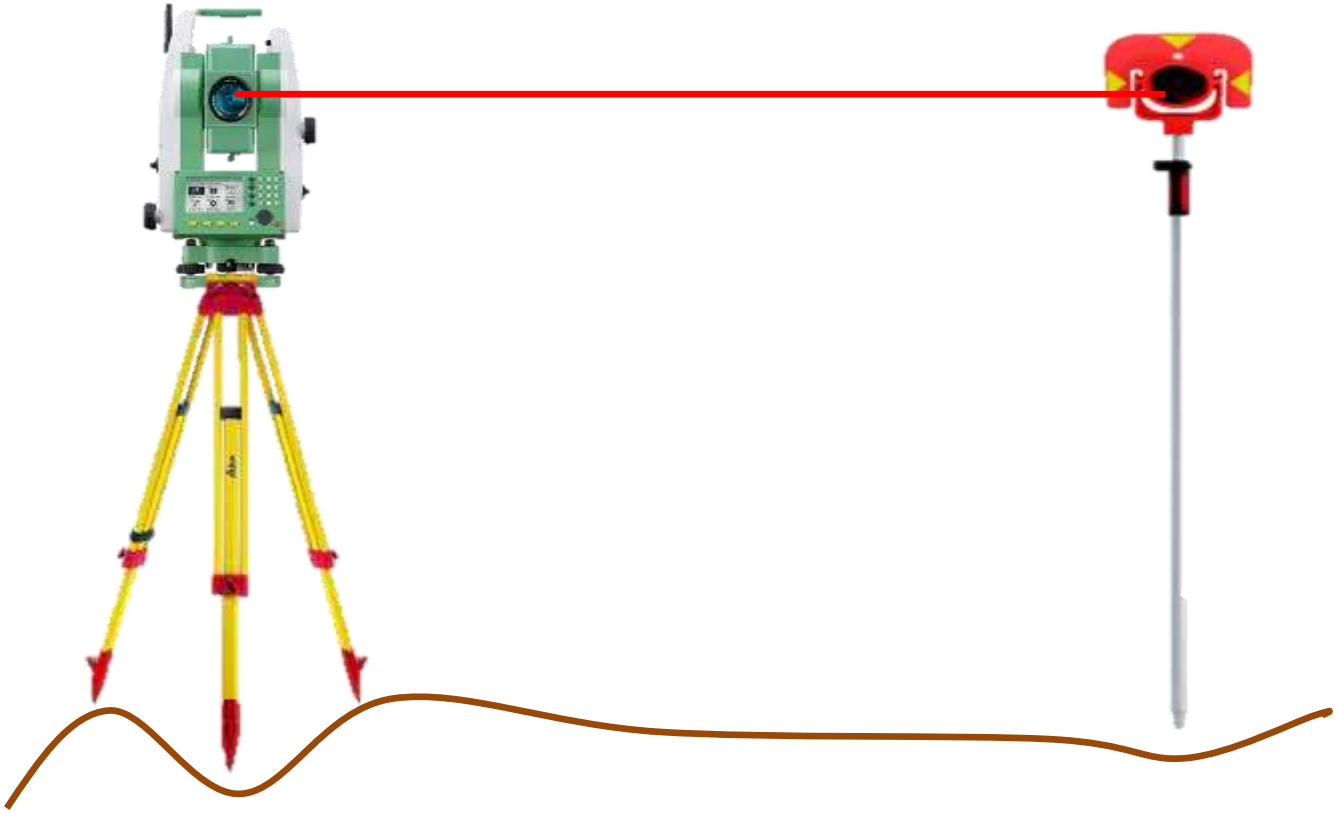

Fig.1: A co-incidental event

2. Discrete (disjoint) events are events that never happen together. For example, in geodetic measurements, when the count is taken, the plan and height coordinates do not appear at once from the digital level. Because digital levels are designed to measure height coordinates only.

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Fig.2: A separate (non-joint) event

3. An even chance event is an event that has the same chance of occurring. For example, the plan and height coordinates appear on the screen of the device at the same time when taking measurements using an electronic total station. Because electronic tacheometers are designed to measure both horizontal and vertical coordinates.

Fig.3: An equal opportunity event

4. A complete set of phenomena is the inevitable occurrence of the phenomenon during the experiment. For example, in the process of taking measurements from a theodolite, the horizontal and vertical angles appear in the viewing tube of the theodolite anyway.

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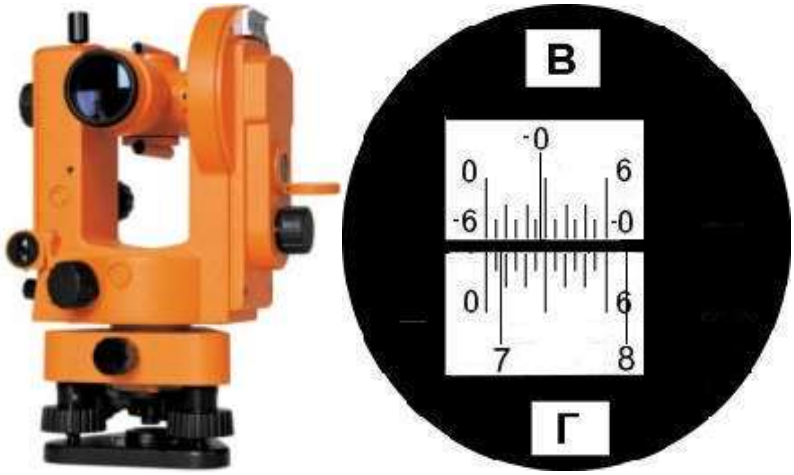

Fig.4: The full group of the event

5. A conflicting event is a complete set of two events that do not occur together. The event opposite to the event ***A*** is denoted as $\overline{A}$. For example, ***A*** is the incident of electromagnetic waves coming out of the rangefinder hitting the reflector, $\overline{A}$ –the event of electromagnetic waves coming out of the rangefinder not hitting the reflector.

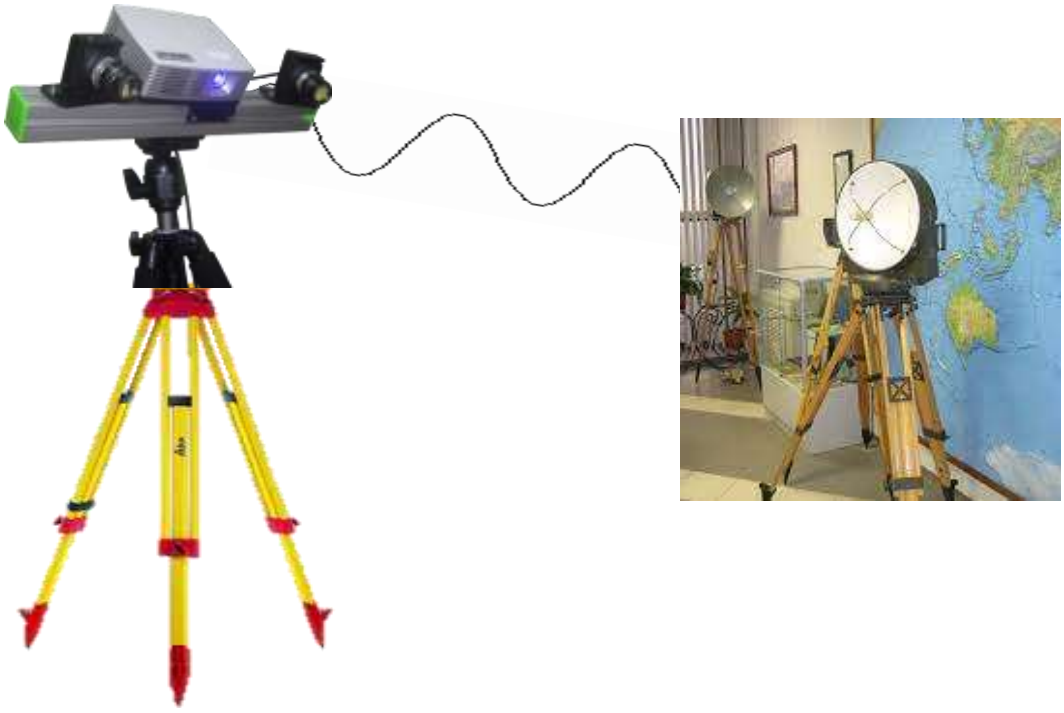

Fig.5: The opposite event

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6. Independent events – An event that has the ability to occur regardless of the occurrence of another event. For example, at the same time, when comparing the results of land area measurements using the ***An-2*** aircraft and the drone, the results obtained by the drone do not depend on the results obtained by the aircraft.

Fig.6: Independent events

7. Related events. The probability of occurrence depends on the occurrence of another event. For example, when connecting to the state geodetic networks for the purpose of carrying out geodetic surveying, the use of Earth satellites and receiving devices can be used as an example. The reason is that the realization of one event is closely related to the second event.

Fig.7: A related event.
Earth satellites, receivers and the state(local) geodetic network

The concept of the probability of an event is introduced to numerically compare the probability of an event.

If we take the probability of a reliable event as 1, the probability of an unlikely event is taken as 0.

$$P(U) = 1$$
$$P(V) = 0$$

The limit of change of the probability of any event is determined by the following expression:

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$$0 \le P(A) \le 1, \qquad (1)$$

at the same time $P(U) = 1$, $P(V) = 0$.

Events can be divided into **practically reliable** and **practically unreliable** events. That is, events with a probability of ***1*** and **0**. The degree of convergence to ***1*** and ***0*** is determined in terms of practical implementation.

For example: 99 out of 100 shots will hit the target, or 1 out of 100 shots will miss the target.

If the probability of an event is arbitrarily close to unity, it is called practically certain, and if it is close to zero, it is practically impossible.

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