# The Probabilistic Model of Distortions of Agrosmart Data

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*Abstract*—**The monitoring of distortions that were obtained on using of modern digital applications, e.g. AgroSmart application, are basic concept of the work. In the furtherance of the solution of this problem this work is presented the new model of distribution of probabilities of data distortion. The research of this model is formed throw full cycle adopted in statistics, namely, the model was constructed and researched, methods to find of estimations of the parameters was proposed, among which are determined unbiased estimates with good asymptotic properties and a practical application of the model is shown. The proposed model is new and it wasn't described in research earlier.**

## I. INTRODUCTION

The digital technology is more active to find application in our each day. In particular, agricultural production needs a new search for economic development based on modern technologies that has more exact decisions. One of these solutions is the Agrosmart App, which has been gaining momentum in Kazakhstan in recent years [1-2].

From data of using of Agrosmart application it's following that the one from characteristics of its reliability are the data, the distortions of which depend on from external factors, causing distortions such as satellite GPS errors (ephemeris and satellite clocks), Earth atmosphere errors (ionosphere and troposphere), user error receiver (frequency drift, phase drift pseudo-noise sequence, signal detection time) [3].

To understand this risk, previous works [4–6] either estimate a theoretical error, or model attacks on the effect of external sources of error on synthetically created (small) data sets. At the same time, the authors of these works consider the spontaneous origin of the distortions and believe that there is some (non-existent) expert who will determine key indicators affecting the process, or simply assume as an assumption that there is some predictive transformation due to the continuous dependence of the process in question, There are external factors considered unimportant. In the issue of reducing navigation errors, this approach does not reach its goal. Therefore, it is necessary to conduct a qualitative analysis of the process of distortion measurement receivers.

Earlier, authors of the work [7] presented a probabilistic analysis of the erroneous reception of a signal element during coherent reception was considered. The main result of [7] is the description of the joint probability density of signal parameters and structural noise, which requires a static analysis. Thus, there is a need for the use of probability-statistical methods.

The main result of the work [7], authors of which spent a probabilistic analysis of the erroneous reception of a signal element during coherent reception, presents that the joint probability of density of signal parameters and the structural noise require a static analysis.

Recently many probabilistic models of data distortions is developed. So in the works [8] and [9] the multivariate probabilistic modes of data distortions for radiation processes and remote sensing was developed.

Nonetheless, there remain many problems in data. E.g. it is necessary to relate the distribution of distortions of Agrosmart Data with various external factors, which can be causing distortions such as satellite GPS errors (ephemera and satellite clocks), Earth atmosphere errors (ionosphere and troposphere), user error receiver (frequency drift, phase drift pseudo-noise sequence, signal detection time) and etc.

In the work the distribution of sums of independent identically distributed random matrices

$$\mathbf{l}_1, \mathbf{l}_2, \ldots, \mathbf{l}_d$$

is studied, where the sum of the matrices

$$\mathbf{l}_1, \mathbf{l}_2, \ldots, \mathbf{l}_d$$

is observable value and matrices

$$\mathbf{l}_1, \mathbf{l}_2, \ldots, \mathbf{l}_d$$

aren't observable values.

## II. MAIN PART

### *A. Multivariate discrete probability distribution generated by the sums of random matrices*

Consider a probabilistic model of the processes of distortions of the Agrosmart data. All possibly distortions which can be in cases satellite GPS, Earth atmosphere and receiver are random variable and accept values from set

$$\mathbf{l}_1, \mathbf{l}_2, \ldots, \mathbf{l}_d$$

with probabilities

$$p_1, p_2, \ldots, p_d$$

respectively, where

$$\sum_{i=1}^{d} p_i = 1.$$

In practice a distortion of the Agrosmart data has a form matrix **u**, which can present as

$$\mathbf{u} = \sum_{i=1}^{d} r_i \mathbf{l}_i, \quad (1)$$

where

$$r_1, r_2, \ldots, r_d$$

are a nonnegative integer number with a condition

$$\sum_{i=1}^{d} r_i = 3 \quad (2)$$

and for any $i$=1,…,$d$

$$0 \le r_i \le 3.$$

In other words, from a work [10]

$$r_1, r_2, \ldots, r_d$$

are elements of a vector of a partition of matrix **u** on matrices set

$$\mathbf{l}_1, \mathbf{l}_2, \ldots, \mathbf{l}_d.$$

Assume that $V_{\mathbf{u}}$ is the number of possible combinations of sum (1) with condition (2).

From result of the works [8-9] it is following that the probability that the distortion takes the value **u** is determined by the formula

$$P(\mathbf{U} = \mathbf{u}) = \sum_{j=1}^{V_{\mathbf{u}}} 3! \prod_{i=1}^{d} \frac{p_i^{r_{i_j}}}{r_{i_j}!}. \quad (3)$$

*B. The estimations of the probability of distortions of Agrosmart data*

In practice matrices

$$\mathbf{l}_1, \mathbf{l}_2, \ldots, \mathbf{l}_d$$

and their respective probabilities

$$p_1, p_2, \ldots, p_d$$

are not known. Therefore, formula (3) can't find to use in a realization, i.e. a construction of estimations for the probability (3) is the actual problem.

Assume that we have $n$ data of distortion

$$\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_n$$

which we taken by using the Agrosmart App. In other words, the set

$$\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_n$$

can be interpreted as a realization of a sample

$$\mathbf{X}_1, \mathbf{X}_2, \ldots, \mathbf{X}_n$$

with volume $n$, whose elements have distribution (3). For each $k$=1,…, $n$ denote the vectors

$$\mathbf{r}_{1_k} = (r_{1_{1_k}}, \ldots, r_{d_{1_k}}),$$

$$\ldots,$$

$$\mathbf{r}_{V_k} = (r_{1_{V_k}}, \ldots, r_{d_{V_k}}),$$

where $V_k$ is the number of partitions of the matrix $\mathbf{x}_k$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \ldots, \mathbf{l}_d$$

and

$$\begin{cases} \sum_{i=1}^{d} \mathbf{l}_i r_{i_j} = \mathbf{x}_k, \\ \sum_{i=1}^{d} r_{i_j} = 3. \end{cases} \quad (4)$$

Suppose that for each $m$=1,…, $\mu$, where

$$\mu = \prod_{k=1}^{n} V_k,$$

there is a vector

$$\mathbf{z}_m = (z_{1_m}, \ldots, z_{d_m}),$$

which defined by

$$\mathbf{z}_m = \sum_{k=1}^{n} \mathbf{r}_{v_k},$$

and the indices on the right and left side are linked one-to-one correspondence, which is not unique.

The elements of

$$W(\mathbf{u}, \mathbf{z}_1), \ldots, W(\mathbf{u}, \mathbf{z}_\mu),$$

where for each $m$= 1,…, μ

$$W(\mathbf{u}, \mathbf{z}_m) = \frac{\sum_{j=1}^{V_{\mathbf{u}}} \prod_{i=1}^{d} \binom{z_{i_m}}{r_{i_j}}}{\binom{3n}{3}},$$

are unbiased estimations for the probability (3).

Consider the problem to choose a estimation from set of unbiased estimations

$$W(\mathbf{u}, \mathbf{z}_1), \ldots, W(\mathbf{u}, \mathbf{z}_\mu)$$

for probability that the distortion takes the value **u**.

Let the realization of the statistics $\mathbf{z}_g$ from the set

$$\mathbf{z}_1, \ldots, \mathbf{z}_\mu$$

satisfies the condition

$$\prod_{k=1}^{n} W(\mathbf{x}_k, \mathbf{z}_g) = \max_{j=1,\ldots,\mu} \prod_{k=1}^{n} W(\mathbf{x}_k, \mathbf{z}_j), \quad (5)$$

then from works [8-9] it is following that a estimation $W(\mathbf{u}, z_g)$ for a probability P(**U**=**u**) of a distribution (3) is the unbiased estimation with good asymptotic properties.

*C. Description of practical application*

Suppose that we need to determine an unbiased estimate of the probabilities of distortions of Agrosmart App by statistical data that are given for values as of August 21 and August 30, 2018 in Akkol district of the Almola region of Kazakhstan.

Thus, we have the realization of sample

$$\mathbf{x}_1 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_2 = \begin{pmatrix} 1 & 0 \\ 2 & 0 \end{pmatrix},$$

$$\mathbf{x}_3 = \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix},$$

$$\mathbf{x}_4 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_5 = \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix},$$

$$\mathbf{x}_6 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_7 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_8 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_9 = \begin{pmatrix} 0 & 2 \\ 2 & 0 \end{pmatrix},$$

$$\mathbf{x}_{10} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

from which are following that a GPS errors, a Earth atmosphere errors, a user error receiver can be values 0 or 1. Hence, in this case $d$=7 and

$$\mathbf{l}_1 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{l}_2 = \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix},$$

$$\mathbf{l}_3 = \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix},$$

$$\mathbf{l}_4 = \begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{l}_5 = \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{l}_6 = \begin{pmatrix} 1 & 0 \\ 1 & 0 \end{pmatrix},$$

$$\mathbf{l}_7 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}.$$

Note that the elements of a realization of a sample $\mathbf{x}_1$, $\mathbf{x}_4$, $\mathbf{x}_6$, $\mathbf{x}_7$ , $\mathbf{x}_8$ and $\mathbf{x}_{10}$ denote that the data obtained by Agrosmart didn't have any distortion in 21 August, 24 August, 26 August, 27 August, 28 August and 30 August 2018.

That is any element from the realization of the sample

$$\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_{10}$$

is a sum of possible matrices from the set

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

In other works it's following that:

- the matrices $\mathbf{x}_1$, $\mathbf{x}_4$, $\mathbf{x}_6$, $\mathbf{x}_7$, $\mathbf{x}_8$ and $\mathbf{x}_{10}$ can be formed by a sum of thrice of $\mathbf{l}_1$;
- the matrix $\mathbf{x}_2$ can be formed by a sum of $\mathbf{l}_1$ , $\mathbf{l}_3$ and $\mathbf{l}_6$ or by a sum of doubled of $\mathbf{l}_3$ and $\mathbf{l}_5$ ;
- the matrix $\mathbf{x}_3$ can be formed by a sum of doubled of $\mathbf{l}_1$ and $\mathbf{l}_2$ ;
- the matrix $\mathbf{x}_5$ can be formed by a sum of doubled of $\mathbf{l}_1$ and $\mathbf{l}_3$ ;
- the matrix $\mathbf{x}_9$ can be formed by a sum of $\mathbf{l}_1$ and doubled of $\mathbf{l}_7$ or by a sum of $\mathbf{l}_3$ , $\mathbf{l}_4$ and $\mathbf{l}_7$ .

I.e. the each elements of the realizations of the sample can presented by next sums

$$\mathbf{x}_1 = 3\mathbf{l}_1,$$

$$\mathbf{x}_2 = \begin{cases} \mathbf{l}_1 + \mathbf{l}_3 + \mathbf{l}_6, \\ 2\mathbf{l}_3 + \mathbf{l}_5, \end{cases}$$

$$\mathbf{x}_3 = 2\mathbf{l}_1 + \mathbf{l}_3,$$

$$\mathbf{x}_4 = 3\mathbf{l}_1,$$

$$\mathbf{x}_5 = 2\mathbf{l}_1 + \mathbf{l}_5,$$

$$\mathbf{x}_6 = 3\mathbf{l}_1,$$

$$\mathbf{x}_7 = 3\mathbf{l}_1,$$

$$\mathbf{x}_8 = 3\mathbf{l}_1,$$

$$\mathbf{x}_9 = \begin{cases} \mathbf{l}_1 + 2\mathbf{l}_7, \\ \mathbf{l}_3 + \mathbf{l}_4 + \mathbf{l}_7, \end{cases}$$

$$\mathbf{x}_{10} = 3\mathbf{l}_1.$$

Since the partition of matrix $\mathbf{x}_1$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

only once has the form

$$\mathbf{x}_1 = 3\mathbf{l}_1,$$

then a number of ways in the partition is

$$V_1=1$$

and a numbers of matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

from which consist the partition are

3, 0, 0, 0, 0, 0, 0

correspondently. That is the vector of the partition of the matrix $\mathbf{x}_1$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$$

has the form

$$\mathbf{r}_{1_1} = (3, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0).$$

The partition of matrix $\mathbf{x}_2$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$$

has the two forms

$$\mathbf{x}_2 = \mathbf{l}_1 + \mathbf{l}_3 + \mathbf{l}_6$$

and

$$\mathbf{x}_2 = 2\mathbf{l}_3 + \mathbf{l}_5$$

then a number of ways in the partition is

$$V_2=2$$

and a numbers of matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

from which consist the partition are

1, 0, 1, 0, 0, 1, 0

and

0, 0, 2, 0, 1, 0, 0

correspondently. That is the vectors of the partition of the matrix $\mathbf{x}_1$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$$

have the forms

$$\mathbf{r}_{1_2} = (1, \quad 0, \quad 1, \quad 0, \quad 0, \quad 1, \quad 0)$$

and

$$\mathbf{r}_{2_2} = (0, \quad 0, \quad 2, \quad 0, \quad 1, \quad 0, \quad 0).$$

The partition of matrix $\mathbf{x}_3$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$$

has the form

$$\mathbf{x}_3 = 2\mathbf{l}_1 + \mathbf{l}_3,$$

then a number of ways in the partition is

$$V_3=1$$

and a numbers of matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

from which consist the partition are

2, 0, 1, 0, 0, 1, 0.

. That is the vector of the partition of the matrix $\mathbf{x}_4$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$$

has the form

$$\mathbf{r}_{1_3} = (1, \quad 2, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0).$$

The partition of matrix $\mathbf{x}_5$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

only once has the form

$$\mathbf{x}_5 = 2\mathbf{l}_1 + \mathbf{l}_5,$$

then a number of ways in the partition is

$$V_5=1$$

and a numbers of matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

from which consist the partition are

2, 0, 0, 0, 1, 0, 0

correspondently. That is the vector of the partition of the matrix $\mathbf{x}_5$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$$

has the form

$$\mathbf{r}_{1_5} = (2, \quad 0, \quad 1, \quad 0, \quad 0, \quad 0, \quad 0),$$

The partition of matrix $\mathbf{x}_5$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

only once has the form

$$\mathbf{x}_4 = 3\mathbf{l}_1,$$

then a number of ways in the partition is

$$V_4=1$$

and a numbers of matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

from which consist the partition are

3, 0, 0, 0, 0, 0, 0

correspondently. That is the vector of the partition of the matrix $\mathbf{x}_1$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$$

has the form

$$\mathbf{r}_{1_4} = (3, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0).$$

The partition of matrix $\mathbf{x}_6$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

only once has the form

$$\mathbf{x}_6 = 3\mathbf{l}_1,$$

then a number of ways in the partition is

$$V_6=1$$

and a numbers of matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

from which consist the partition are

3, 0, 0, 0, 0, 0, 0

correspondently. That is the vector of the partition of the matrix $\mathbf{x}_6$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$$

has the form

$$\mathbf{r}_{1_6} = (3, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0).$$

The partition of matrix $\mathbf{x}_7$ on matrices

$$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7.$$

only once has the form

$$\mathbf{x}_7 = 3\mathbf{l}_1,$$

then a number of ways in the partition is

$$V_7=1$$

and a numbers of matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$.

from which consist the partition are

3, 0, 0, 0, 0, 0, 0

correspondently. That is the vector of the partition of the matrix $\mathbf{x}_7$ on matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$

has the form

$$\mathbf{r}_{1_7} = (3, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0).$$

The partition of matrix $\mathbf{x}_8$ on matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$.

only once has the form

$$\mathbf{x}_8 = 3\mathbf{l}_1,$$

then a number of ways in the partition is

$V_8$=1

and a numbers of matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$.

from which consist the partition are

3, 0, 0, 0, 0, 0, 0

correspondently. That is the vector of the partition of the matrix $\mathbf{x}_8$ on matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$

has the form

$$\mathbf{r}_8 = (3, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0).$$

The partition of matrix $\mathbf{x}_9$ on matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$

has the two forms

$$\mathbf{x}_9 = \mathbf{l}_1 + 2\mathbf{l}_7$$

and

$$\mathbf{x}_9 = \mathbf{l}_3 + \mathbf{l}_4 + \mathbf{l}_7$$

then a number of ways in the partition is

$V_9$=2

and a numbers of matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$.

from which consist the partition are

1, 0, 0, 0, 0, 0, 2

and

0, 0, 1, 1, 0, 0, 1

correspondently. That is the vectors of the partition of the matrix $\mathbf{x}_1$ on matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$

have the forms

$$\mathbf{r}_{1_9} = (1, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0, \quad 2),$$

and

$$\mathbf{r}_{2_9} = (0, \quad 0, \quad 1, \quad 1, \quad 0, \quad 0, \quad 1).$$

The partition of matrix $\mathbf{x}_{10}$ on matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$.

only once has the form

$$\mathbf{x}_{10} = 3\mathbf{l}_1,$$

then a number of ways in the partition is

$V_{10}$=1

and a numbers of matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$.

from which consist the partition are

3, 0, 0, 0, 0, 0, 0

correspondently. That is the vector of the partition of the matrix $\mathbf{x}_{10}$ on matrices

$\mathbf{l}_1, \mathbf{l}_2, \mathbf{l}_3, \mathbf{l}_4, \mathbf{l}_5, \mathbf{l}_6, \mathbf{l}_7$

has the form

$$\mathbf{r}_{1_{10}} = (3, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0, \quad 0).$$

Since

$$\mu = \prod_{k=1}^{10} V_k = 4$$

and the vectors of realizations of statistics which obtained as

$$\mathbf{z}_1 = \sum_{k=1}^{10} \mathbf{r}_{1_k},$$

$$\mathbf{z}_2 = \sum_{\substack{k=1,\\ k\neq 9}}^{10} \mathbf{r}_{1_k} + \mathbf{r}_{2_9},$$

$$\mathbf{z}_3 = \sum_{\substack{k=1,\\ k\neq 2}}^{10} \mathbf{r}_{1_k} + \mathbf{r}_{2_2},$$

$$\mathbf{z}_4 = \sum_{\substack{k=1,\\ k\neq 2,\\ k\neq 9}}^{10} \mathbf{r}_{1_k} + \mathbf{r}_{2_2} + \mathbf{r}_{2_9},$$

are

$$\mathbf{z}_1 = (23, \quad 2, \quad 2, \quad 0, \quad 0, \quad 1, \quad 2),$$

$$\mathbf{z}_2 = (22, \quad 2, \quad 3, \quad 0, \quad 1, \quad 0, \quad 2),$$

$$\mathbf{z}_3 = (22, \quad 2, \quad 3, \quad 1, \quad 0, \quad 1, \quad 1),$$

$$\mathbf{z}_4 = (21, \quad 2, \quad 4, \quad 1, \quad 1, \quad 0, \quad 1).$$

By using of the method of a construction of a unbiased estimations that was presented in formula (5) for probability:

1) of the $\mathbf{x}_1$ are

$W(\mathbf{x}_1, \mathbf{z}_1) = 0.436$,

$W(\mathbf{x}_1, \mathbf{z}_2) = 0.379$,

$W(\mathbf{x}_1, \mathbf{z}_3) = 0.379$,

$W(\mathbf{x}_1, \mathbf{z}_4) = 0.328$;

2) of the $\mathbf{x}_2$ are

$W(\mathbf{x}_2, \mathbf{z}_1) = 0.012,$

$W(\mathbf{x}_2, \mathbf{z}_2) = 0.017,$

$W(\mathbf{x}_2, \mathbf{z}_3) = 0.017,$

$W(\mathbf{x}_2, \mathbf{z}_4) = 0.022;$

3) of the $\mathbf{x}_3$ are

$W(\mathbf{x}_3, \mathbf{z}_1) = 0.006,$

$W(\mathbf{x}_3, \mathbf{z}_2) = 0.005,$

$W(\mathbf{x}_3, \mathbf{z}_3) = 0.005,$

$W(\mathbf{x}_3, \mathbf{z}_4) = 0.005;$

4) of the $\mathbf{x}_4$ are

$W(\mathbf{x}_4, \mathbf{z}_1) = 0.436,$

$W(\mathbf{x}_4, \mathbf{z}_2) = 0.379,$

$W(\mathbf{x}_4, \mathbf{z}_3) = 0.379,$

$W(\mathbf{x}_4, \mathbf{z}_4) = 0.328;$

5) of the $\mathbf{x}_5$ are

$W(\mathbf{x}_5, \mathbf{z}_1) = 0.125,$

$W(\mathbf{x}_5, \mathbf{z}_2) = 0.171,$

$W(\mathbf{x}_5, \mathbf{z}_3) = 0.171,$

$W(\mathbf{x}_5, \mathbf{z}_4) = 0.031;$

6) of the $\mathbf{x}_6$ are

$W(\mathbf{x}_6, \mathbf{z}_1) = 0.436,$

$W(\mathbf{x}_6, \mathbf{z}_2) = 0.379,$

$W(\mathbf{x}_6, \mathbf{z}_3) = 0.379,$

$W(\mathbf{x}_6, \mathbf{z}_4) = 0.328;$

7) of the $\mathbf{x}_7$ are

$W(\mathbf{x}_7, \mathbf{z}_1) = 0.436,$

$W(\mathbf{x}_7, \mathbf{z}_2) = 0.379,$

$W(\mathbf{x}_7, \mathbf{z}_3) = 0.379,$

$W(\mathbf{x}_7, \mathbf{z}_4) = 0.328;$

8) of the $\mathbf{x}_8$ are

$W(\mathbf{x}_8, \mathbf{z}_1) = 0.436,$

$W(\mathbf{x}_8, \mathbf{z}_2) = 0.379,$

$W(\mathbf{x}_8, \mathbf{z}_3) = 0.379,$

$W(\mathbf{x}_8, \mathbf{z}_4) = 0.328;$

9) of the $\mathbf{x}_9$ are

$W(\mathbf{x}_9, \mathbf{z}_1) = 0.007,$

$W(\mathbf{x}_9, \mathbf{z}_2) = 0.007,$

$W(\mathbf{x}_9, \mathbf{z}_3) = 0.017,$

$W(\mathbf{x}_9, \mathbf{z}_4) = 0.021;$

10) of the $\mathbf{x}_{10}$ are

$W(\mathbf{x}_{10}, \mathbf{z}_1) = 0.436,$

$W(\mathbf{x}_{10}, \mathbf{z}_2) = 0.379,$

$W(\mathbf{x}_{10}, \mathbf{z}_3) = 0.379,$

$W(\mathbf{x}_{10}, \mathbf{z}_4) = 0.328.$

It's following that

$$\prod_{k=1}^{10} W(\mathbf{x}_k, \mathbf{z}_1) = 3.75 \cdot 10^{-10},$$

$$\prod_{k=1}^{10} W(\mathbf{x}_k, \mathbf{z}_2) = 3.23 \cdot 10^{-10},$$

$$\prod_{k=1}^{10} W(\mathbf{x}_k, \mathbf{z}_3) = 7.73 \cdot 10^{-10},$$

$$\prod_{k=1}^{10} W(\mathbf{x}_k, \mathbf{z}_4) = 9.21 \cdot 10^{-10},$$

i.e.

$$\prod_{k=1}^{10} W(\mathbf{x}_k, \mathbf{z}_4) = \max_{m=1,\dots,4} \prod_{k=1}^{10} W(\mathbf{x}_k, \mathbf{z}_m).$$

Thus, the unbiased estimations with asymptotic properties for probabilities of the elements of the realization of sample

$\mathbf{x}_1, \mathbf{x}_2, \dots, \mathbf{x}_{10},$

which has a distribution (3) are

$W(\mathbf{x}_1, \mathbf{z}_g) = 0.328,$

$W(\mathbf{x}_2, \mathbf{z}_g) = 0.022,$

$W(\mathbf{x}_3, \mathbf{z}_g) = 0.005,$

$W(\mathbf{x}_4, z_g) = 0.328,$

$W(\mathbf{x}_5, \mathbf{z}_g) = 0.031,$

$W(\mathbf{x}_6, \mathbf{z}_g) = 0.328,$

$W(\mathbf{x}_7, \mathbf{z}_g) = 0.328,$

$W(\mathbf{x}_8, \mathbf{z}_g) = 0.328,$

$W(\mathbf{x}_9, \mathbf{z}_g) = 0.021,$

$W(\mathbf{x}_{10}, \mathbf{z}_g) = 0.328.$

Note the matrices

$$\mathbf{x}_1 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_4 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_6 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_7 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_8 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix},$$

$$\mathbf{x}_{10} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$$

show that data don't have any distortions of Agrosmart App, which obtained in 21 August, 24 August, 26 August, 27

August, 28 August and 30 August 2018. Since the unbiased estimations with asymptotic properties for probabilities for elements of realizations of sample

$$\mathbf{x}_1, \mathbf{x}_4, \mathbf{x}_6, \mathbf{x}_7, \mathbf{x}_8, \mathbf{x}_{10}$$

are

$$W(\mathbf{x}_1, \mathbf{z}_g) = 0.328,$$

$$W(\mathbf{x}_4, \mathbf{z}_g) = 0.328,$$

$$W(\mathbf{x}_6, \mathbf{z}_g) = 0.328,$$

$$W(\mathbf{x}_7, \mathbf{z}_g) = 0.328,$$

$$W(\mathbf{x}_8, \mathbf{z}_g) = 0.328,$$

$$W(\mathbf{x}_{10}, \mathbf{z}_g) = 0.328,$$

then we can note that the estimation of probability of distortions will absent by Agrosmart data is 32.8%.

Hence, the proposed model of a multidimensional discrete probability distribution allows one to determine an unbiased estimations of the probability of distortions of Agrosmart App. The obtained results of estimations of probabilities of distortions

$$\mathbf{x}_2 = \begin{pmatrix} 1 & 0 \\ 2 & 0 \end{pmatrix},$$

$$\mathbf{x}_3 = \begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix},$$

$$\mathbf{x}_5 = \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix}$$

and

$$\mathbf{x}_9 = \begin{pmatrix} 0 & 2 \\ 2 & 0 \end{pmatrix}$$

are

$$W(\mathbf{x}_2, \mathbf{z}_g) = 0.022,$$

$$W(\mathbf{x}_3 , \mathbf{z}_g) = 0.005,$$

$$W(\mathbf{x}_5, \mathbf{z}_g) = 0.031,$$

$$W(\mathbf{x}_9, \mathbf{z}_g) = 0.021.$$

It can be seen that estimates of probability of distortions from 0.5 to 3.1% are observed. This suggests that a position of distortions of GPS system isn't rather high. The obtained estimates of a probability point to the well-known fact that highly of data of application. That use GPS system do not lend themselves to 100 percent prediction, which is sometimes required by consumers or other interested parties. It's following that to reduce distortions of Agrosmart App it is necessary to improve the GPS system.

## III. CONCLUSION

The analysis conducted in this paper studies allows us to formulate the following conclusions.

1) Proposed and studied a new probability distribution of distortions of radiation processes of Agrosmart data.
2) Define the generating function for the distribution of the proposed model.
3) The set of unbiased estimates for the probability distribution of the proposed model and the variance of these estimates.
4) Introduced a new concept of the most appropriate evaluation of the set of unbiased estimates, with asymptotic properties.
5) Found that position of distortions of data AgroSmart system isn't rather high.

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