UDC 528.8:528.7:528.4:528.06

A NEW DATA COMBINATION APPROACH IN UAV-BASED REMOTE SENSING PROBLEMS IN CASE OF CONFLICTING SOURCES OF INFORMATION

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Keywords: remote sensing, evidence theory, combination rules, conflicting data, Dempster's rule.

Nowadays UAV (unmanned aerial vehicles) give new opportunites for solution different remote sensing problems, such as: ecological monitoring, surveying mines, forest classification and others [1]. Information fusion is a one of most difficult procedures in land-cover classification, using UAV-based Remote Sensing. But a lot of known combination approaches yield illogical results, when sources of information highly conflict with each other [1-2]. The object of this work is description of a new data combination approach, when sources of data (spectral bands) highly conflict with each other. This approach is based on application of Dempster's rule of combination, that can efficiently handle highly conflicting data. This approach is summarized in next steps:

1) At first, we define the Distance measure between pairs of spectral bands:

$$d_{BPA}(m_i, m_j) = \sqrt{\frac{1}{2}(\|m_i\|^2 + \|m_j\|^2 - 2\langle m_i, m_j \rangle)}, \qquad d_{BPA} \in [0,1]. \tag{1}$$

$$\langle m_i, m_j \rangle = \sum_{k=1}^{2^n}\sum_{l=1}^{2^n} m_i(A_k) m_j(A_l) \frac{|A_k \cap A_l|}{|A_k \cup A_l|}, \quad k,l = 1,...,2^n; \tag{2}$$

where $|A_k \cap A_l|$ – cardinality of the intersection of sample sets A_k and A_l;

$|A_k \cup A_l|$ – cardinality of the union of sample sets A_k and A_l;

$m(A) \in [0,1]$ is a basic probability assignment, that represents the degree of belief allocated to the hypothesis *A* by experts and satisfies the next conditions:

$$\sum_{A \subseteq \Omega} m(A) = 1; \quad m(\varnothing) = 0. \tag{3}$$

2) The Similarity measure between two bodies of evidence m_i and m_j is defined as:

$$sim(m_i, m_j) = 1 - d(m_i, m_j). \tag{4}$$

3) Then we should build Measure Matrix:

$$SMM = \begin{bmatrix} 1 & s_{12} & \dots & s_{1n} \\ s_{21} & 1 & \dots & s_{2n} \\ \dots & \dots & \dots & \dots \\ s_{n1} & s_{n2} & \dots & 1 \end{bmatrix}. \tag{5}$$

4) The Support degree of each piece of evidence m_i is defined as:

$$Sup(m_i) = \sum_{j=1}^{n} s_{ij},\ i = 1,2,...,n. \quad (6)$$

5) The Credibility degree of each piece of evidence m_i is calculated as:

$$Crd(m_i) = \frac{\sup(m_i)}{\sum_{i=1}^{n} \sup(m_i)}. \quad (7)$$

6) The weight average mass m_M of the evidence for the hypothesis a is defined as:

$$m_M(a) = \sum_{i=1}^{n} Crd_i(m_i) \times m_i(a). \quad (8)$$

7) At the last step we use Dempser's rule to combine the weighted average of the masses $n - 1$ times, if we have n pieces of evidence (n spectral bands).

The Dempster's combination rule is defined by the next following formula:

$$m(A_k) = \frac{\sum_{A_{1i} \cap A_{2j} = A_k} m_1(A_{1i}) m_2(A_{2j})}{1 - C}, \quad C = \sum_{A_{1i} \cap A_{2j} = \varnothing} m_1(A_{1i}) m_2(A_{2j}), \quad (9)$$

where m_1 is a basic probability assignment of the hypothesis appointed by the first source of information and m_2 is a basic probability assignment of this hypothesis appointed by the second source of information. The $C \in [0, 1]$ is called the conflict coefficient and shows the degree of conflict among the sources (spectral bands) [2-3]. Nowadays processing of conflicting data is a very difficult problem in UAV-based Remote Sensing tasks, because known approaches of combination can't deal with significant conflict in the sources of information (spectral bands). A new data combination approach based on application of Dempster's rule of combination was considered in this work. It is noted, that this described combination approach based on application of Dempster's rule of combination can be applied in numerous UAV-based Remote Sensing tasks, such as: ecological monitoring, mining, exploring for oil and gas, agricultural tasks and forestry [3].

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