Detection of Gaps in Documentation Concerning Remote-piloted Aviation based on Content Analysis

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Abstract. This article dwells upon the procedures of computer-linguistic formation of documentation concerning remote-piloted vehicles that are necessary for the implementation of software components for the collection, processing and preservation of information received from open web-resources. It is highlighted that processing of large volumes of information located on open web-resources requires development of certain approaches to its automated consolidation, classification, structuring, processing and use that is very useful for further certification of remote-piloted vehicles. It is emphasized that linguistic support as a set of linguistic means of information processing is important during development of relevant information systems for aviation support. The procedures for detecting gaps in documentation concerning remote-piloted aviation by analyzing the structure of documentation, its content, frequency analysis of markers and indicative features that allow to improve functional quality indicators are very similar to the same procedures concerning tourism documentation. It has been made based on documentation structure and content analysis and is important for automatic system development of documentation creation in the sphere of remote-piloted aviation.

Keywords: Remote-piloted vehicles, Documentation, Information gap, Indicative characteristics, Linguistic markers, Remote-piloted vehicles certification

8 Introduction

At the present stage of market economy development remote-piloted aviation is one of the promising areas both in the internal and external economic activity of the country and its regions. Intensive development of remote-piloted vehicles use in terms of present days causes growth of the knowledge base and the number of remote-piloted activities subjects. It is therefore necessary to provide the product consumer with the necessary, accurate and truthful information through the formation of a complete information resource in the form of so-called quality documentation.

The need of product consumer to obtain full information about remote-piloted aviation, as well as the increased tendency in the number of consumers that

independently search for information using the Internet by increased discussion of services on the forums cause the necessity the take into consideration needs of product consumer.

This can be achieved through continuous interaction between the producer and the consumer of the remote-piloted vehicle through the data collection about service and the formation of quality documentation. The need continuously to improve the quality of aviation service cause the necessity to analyze in details the documentation and use an appropriate method of evaluation of its quality based on the needs of the product consumer.

The formation of remote-piloted vehicle documentation (RPD) is a complex process that requires time consuming, highly qualified specialists, using of information technology for information processing, its grouping, identification of information sources, logical analysis of materials, choice of methods of data extraction, data aggregation to single accessible to the consumer product format by consolidating the processed information. Effective formation of such a documentation is practically impossible without the development of appropriate components of software and algorithmic complex of remote-piloted aviation support [3, 4].

In the conditions of intensive globalization and significant development of information society, there is a rapid increase in the number of services and the rapid development of the remote-piloted vehicle industry. At the same time, the quantity of information resources with open access, which contains information on remote-piloted vehicles, is significantly increasing.

It is necessary to create appropriate conditions for the prompt processing of all available information in order to bring it to a single standard view, in order to be able to process and use information in the future depending on the needs of services. It is needed to take into account both the processes of data collection and the processes of their verification, cleaning and transformation for further integration with the use of different methods and tools.

9 Development of procedures for detecting gaps in documentation concerning remote-piloted aviation

The legal status of remote-piloted vehicles is currently quite uncertain in Ukraine. Although the Air Code of Ukraine defines the concept of an "unmanned aerial vehicle", the basic regulatory documents regulating the use of Ukraine airspace do not mention the remote-piloted vehicles.

The use of unmanned aerial vehicles, as well as any kind of activity that may be potentially dangerous, should obviously have some legal basis. However, a change in legislation is a rather inertial, slow process that does not keep up with the rapid development of technologies. So today, not only in Ukraine, but also in other countries, the legislative regulation of activities related to the use of remote-piloted vehicles is at the stage of becoming topical. Some changes in legislation are constantly taking place, and rules and norms are being adopted and amended.

COLINS'2018, Volume II: Workshop. Lviv, Ukraine, June 25-27, 2018, ISSN 2523-4013
http://colins.in.ua, online

There are currently no specific regulatory documents on the performance of unmanned aerial vehicles in Ukraine. There is no complete legal basis for certifying remote-piloted vehicles, licensing crews that control them, and concerning with the safety of remote-piloted vehicles, even in temporarily reserved airspace. The national regulatory framework does not contain provisions on the integration of unmanned aerial vehicles into the air traffic management. Ukraine is ready to cooperate with other European institutions and all interested departments to develop joint efforts of the appropriate level of regulatory acts that will regulate the use of unmanned aircraft in Ukraine[7, 8].

The use of drones in Ukraine must be managed and controlled. All these requirements are not a new fiction of the State Aviation Service, it is its perception and transmitting into Ukrainian realities of the experience of the leading countries of the world, primarily the United States and Great Britain. But there are a lot of incorrect information concerning the remote-piloted vehicle aviation. It is necessary to detect and illuminate such gaps in content.

The procedures for detecting gaps in documentation concerning remote-piloted aviation by analyzing the structure of documentation, its content, frequency analysis of markers and indicative features that allow to improve functional quality indicators is very similar to the same procedures concerning tourism documentation.

Developed algorithms for comparing atomic situations of web-page posts with elements of documentation allow to fill it with consolidated information from the open web-resources. However, these algorithms do not indicate the possible inaccuracy and incoherence of both the structure of the tourism documentation, and its content in the form of facts and events. One of the methods, which allows to find and eliminate the shortcomings of documentation, is a method of detecting and filling gaps[7, 8, 10, 11].

The notion of "gap" is used in many fields, in particular, in the legislation the gap is the lack of the required norm in legislative acts. In this article, under the gaps in the tourism documentation has been understood certain part of the tourism documentation that is has not full of information about the facts or events [1,2].

The general tourism documentation model allows to distinguish two types of gaps [6, 16, 21-51]:

1. structural gaps in the tourism documentation;
2. gaps in the content of tourism documentation.

Such types of gaps also are used in the remote-piloted vehicle documentation

2.1. Peculiarities of identifying structural gaps in documentation

So, structural gaps in RPD may arise when the structure of the RPD does not correspond to the predicted requirements, which are formulated both by the supplier and the consumer of the product.

COLINS'2018, Volume II: Workshop. Lviv, Ukraine, June 25-27, 2018, ISSN 2523-4013
http://colins.in.ua, online

In general, the presence of structural gap can be formulated as follows: the set of the same type elements of RPD contains fewer elements than the corresponding set of these elements in the requirements of the RPD. That is, if $Element^{(RPD)}$ and $Element^{(Requirement)}$ respectively, the set of elements in the RPD and in the requirements of the RPD, then in the general case there is a structural gap, if:

$$Element^{(Gap)} = Element^{(Requirement)} \setminus Element^{(RPD)} \neq \varnothing \quad (1)$$

The elements of RPD, which can cause structural gaps, are remote-piloted aviation objects (O), remote-piloted aviation objects actions (OA), the classifiers and the terms of the classifiers. To eliminate these gaps it is necessary to supplement the corresponding sets with new elements.

The supplement of the O and OA sets of new elements takes place according to algorithm with the following steps[1, 7, 8, 13]:

1) add a new element to the *Object* set according to the requirements of the RPD, specifying the attributes of the fact of the definition of this object including classifiers;

2) determine the indicative feature of the object ;

3) include the object $Object_i^{(Gap)}$ in services and consumer reviews in accordance with the requirements of the RPD;

4) add a new element to the set of actions $Action\left(Object_i^{(Gap)}\right)$ in accordance with the requirements of the RPD, specifying the attributes of the determination of this action for , including classifiers;

5) determine the indicative trait of the OA $ActionIndicator\left(Action\left(Object_i^{(Gap)}\right)_j\right)$;

6) include OA $Action\left(Object_i^{(Gap)}\right)_j$ in services and consumer responses in accordance with the requirements of the RPD;

Note that the procedure for adding a new action to an existing object in the RPD should begin with item 4 [14, 15].

The addition of sets of classifiers and terms of classifiers of RPD with new elements takes place by the algorithm in the following way:

1) add a new element $Classifier_i^{(Gap)}$ to the *Classifier* set in accordance with the requirements of the RPD;

2) add a new element $Term_{ij}^{(Gap)}$ to the set of terms $Term_i^{(Gap)}$ of the classifier $Classifier_i^{(Gap)}$ in accordance with the requirements of the RPD ;

3) to the plurality of links between terms $TermRels_i^{(Gap)}$ add links of the new element $Term_{ij}^{(Gap)}$ with other terms of the classifier $Classifier_i^{(Gap)}$;

4) determine the indicative sign of the term $TermIndicator\left(Term_{ij}^{(Gap)}\right)$.

Note that the procedure for adding a new term for the existing RPD classifier should begin with item 2.

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2.2. Peculiarities of detecting content gaps in documentation

Gaps in content in the RPD arise because of the lack of information on the facts and events associated with certain structural elements of the RPD - O, OA and the terms of the classifiers.

In general, the presence of content gap can be formulated as follows: for structure element of RPD not all necessary facts and events are associated with it. There are the following types of content gaps [5, 12]:

1. facts and facts of the definition of O and OA are not associated with the terms of the classifiers;
2. facts are not associated with O and OA;
3. events are not associated with O and OA;

If $Term_{ij}$ - the term of the classifier, $ElementDefiniton^{(TD)}(Term_{ij})$ - the set of all the facts of the definition of O and OA associated with this term in the RPD, $ElementDefiniton^{(Expected)}(Term_{ij})$ - the set of all facts of the definition of O and OA, which should be related to this term, then there is content gap by classification of the facts of determination, if:

$$ElementDefiniton^{(Gap)}(Term_{ij}) = ElementDefiniton^{(Expected)}(Term_{ij}) \setminus ElementDefiniton^{(RPD)}(Term_{ij}) \neq \varnothing \quad (2)$$

If $ElementFact^{(RPD)}(Term_{ij})$ - the set of all O and OA facts related to the term in the RPD, $ElementFact^{(Expected)}(Term_{ij})$ - the set of all O and OA facts that would be expected to be related to this term, then there is a gap in the content of the classification of the facts if:

$$ElementFact^{(Gap)}(Term_{ij}) = ElementFact^{(Expected)}(Term_{ij}) \setminus ElementFact^{(RPD)}(Term_{ij}) \neq \varnothing \quad (3)$$

If $ElementEvent^{(RPD)}(Term_{ij})$ – set of all events of O and OA, related to term $Term_{ij}$ in RPD, $ElementEvent^{(Expected)}(Term_{ij})$ – set of all events of O and OA, that may be related to the term $Term_{ij}$ in RPD, then there is content gap by event classification, if:

$$ElementEvent^{(Gap)}(Term_{ij}) = ElementEvent^{(Expected)}(Term_{ij}) \setminus ElementEvent^{(RPD)}(Term_{ij}) \neq \varnothing \quad (4)$$

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http://colins.in.ua, online

If $Element_i$ – O or OA, $ElementFact^{(RPD)}(Element_i)$ – set of all facts of O or OA in RPD, $ElementFact^{(Expected)}(Element_i)$ – expected set of all facts of O or OA, then there is fact content gap, if:

$$ElementFact^{(Gap)}(Element_i) = ElementFact^{(Expected)}(Element_i) \setminus ElementFact^{(RPD)}(Element_i) \neq \varnothing \quad (5)$$

If $ElementEvent^{(RPD)}(Element_i)$ – set of all O or OA $Element_i$ in RPD, $ElementEvent^{(Expected)}(Element_i)$ – espected set of all events in O or OA, then there is the event content gap, if:

$$ElementEvent^{(Gap)}(Element_i) = ElementEvent^{(Expected)}(Element_i) \setminus ElementEvent^{(RPD)}(Element_i) \neq \varnothing \quad (6)$$

Gaps in the content according to classification of the facts of definition (2) is eliminated by the expert, which should determine the plurality of terms that are associated with O or OA.

Gaps in the content according to classification of facts and events (3), (4), and the gaps in the content of facts and events (5), (6) are eliminated in the following ways:

1) use of new open web-resources that are relevant to the available indicative characteristics;

2) specification of the indicative characteristics of the O, experience, time component, OA and the classifier term by the frequency analysis method.

To identify new open web-resources that are better suited to the existing indicative traits, it is necessary to apply the algorithm for forming a set of web-resources according to keywords that are specified in markers of indicative signs, and check the usefulness of web-pages of these open web-resources by criterion [7-11, 22-23].

2.3. Frequency analysis of markers and indicative characteristics to eliminate gaps in content

Frequency analysis is widely used in cryptography and is based on the explicit of statistical distribution of individual characters and their sequences in the text of the message. That is, frequency analysis suggests that the frequency of occurrence of a given character in rather long texts is one and the same for separate texts of messages.

If *Element* is a certain element of the RPD, which reflects either a certain O, OA or the term of the classifier, or a certain sign of experience or time component, then, accordingly, on the basis of the indicative characteristics of the O, OA, the classifier term, experience, time component, generalize the concept of the indicative characteristic for *Element*:

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$$ElementInd\,icator = \left\{ \left\langle \begin{matrix} Marker\,(ElementInd\,icator\,)_i, \\ \mu(ElementInd\,icator\,)_i \end{matrix} \right\rangle \right\}_{i=1}^{N^{(ElementInd\,icator\,)}} \quad (7)$$

where $Marker(ElementIndicator)_i \in Marker$ - the i-th marker to display the RPD element, $\mu(ElementIndicator)_i \in [0,1]$ - the measure of correspondence of the i-th marker to the RPD element, $N^{(ElementIndicator)}$ - the number of markers that reflect the element of the RPD.

In order to use marker frequency analysis to eliminate content gaps in the RPD, it is necessary to analyze the frequency of occurrence of the corresponding markers when comparing the atomic situation with the components of the documentation.

If in the result of the open web-resources processing, $N^{(PostPart,Processing)}$ atomic situations have been detected, and $N^{(PostPart,Marker(ElementIndicator)_i)}$ of them are in comparison with the indicative characters containing the marker $Marker\,(ElementInd\,icator\,)_i$, then the appearance frequency of marker $Marker\,(ElementInd\,icator\,)_i$ in atomic situations is the following:

$$MarkerFrequency(Marker(ElementIndicator)_i) = \frac{N^{(PostPart,Marker(ElementIndicator)_i)}}{N^{(PostPart,Processing)}} \quad (8)$$

To evaluate the frequency of the marker the following criterion is introduced:

$$MarkerFrequency(Marker(ElementIndicator)_i) \geq \alpha^{(MarkerFrequency)}, \quad (9)$$

where $\alpha^{(MarkerFrequency)} \in (0,1]$ - the minimum allowable value for the frequency of the marker.

The presence of many markers that do not meet criterion (9) may be due to the presence of gaps in content. Gaps on the basis of frequency analysis of markers are eliminated in the following ways [3, 16, 18]:

1) use of new open web-resources that better suit to markers that do not satisfy the criterion (9);

2) reassessment of the marker compliance $\mu(ElementInd\,icator\,)_i$ of marker $Marker(ElementIndicator)_i$ for each indicative characteristic (7) where this marker occurs;

3) remove of the marker $Marker(ElementIndicator)_i$ from a set of all markers *Marker*, and completing of this set with new markers.

The use of the frequency analysis of indicative features to eliminate content gaps in the RPD is based on the analysis of the frequency of comparisons of atomic situations with indicative features.

If in the result of the processing of open web-resources $N^{(PostPart,ElementIndicator)}$ atomic situations are compared with the indicative characteristic (10). Then the frequency of this indicative characteristic in atomic situations is the following:

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$$IndicatorFrequency(ElementIndicator) = \frac{N^{(PostPart,ElementIndicator)}}{N^{(PostPart,Processing)}}, \quad (10)$$

The relevant criterion for the frequency of the indicative characteristic is:

$$IndicatorFrequency(ElementIndicator) \geq \alpha^{(IndicatorFrequency)}, \quad (11)$$

where $\alpha^{(IndicatorFrequency)} \in (0,1]$ - the minimum allowable value for the frequency of appearance of the indicative characteristic.

If the indicative characteristic does not satisfy the criterion (11), it may be due to the presence of gaps in the content of the corresponding RPD element. Gaps on the basis of the frequency analysis of the appearance of indicative features are eliminated by the following methods [3, 19, 20]:

1) use of new open web-resources that are better suited to indicative features that do not meet the criterion (11);

2) reassessment of the conformity measures $\mu(ElementIndicator)_i$ for the indicative characteristic (7);

3) removal of indicative characteristic, if the RPD element is the O, the OA or the classifier term;

4) adding of new markers to marker set $Marker(ElementIndicator)_i$.

The procedures of computer-linguistic formation of documents are developed on the basis of comparing the content of open web-resources with elements by using indicative features, as well as procedures for detecting gaps and incorrect information in documents based on analysis of its structure and content, which allow to improve the quality indicators of documentation and are necessary for the construction of system for the automated formation of documentation [14, 17, 18, 20].

3. Conclusions

Remote-piloted aviation need quality documentation to provide a wide range of services. The development of such documentation will ensure the accelerated development of airspace infrastructure.

The need constantly to improve the quality of remote-piloted aviation documentation explains the importance of developing a method for evaluating its quality based on the needs of the consumer. This is an actual scientific-applied challenge.

Procedures for detecting gaps in documentation have been developed by analyzing the structure of documentation, its content, frequency analysis of markers and indicative features that allow to improve functional quality indicators. This allows to develop procedures for the detection of incorrect information in the RPD, which can improve the quality indices of documentation. Such procedures are very simmilar to the same procedures concerning remote-piloted vehicles.

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