dynamically, that’s why it’s unique for each case. And according to that second frame is marked as shot boundary.

We tested the suggested approach with different media types. All results are in the table 1.

Table.1 Accuracy of the technique with different media types

<table>
<thead>
<tr>
<th>Type</th>
<th>Accuracy, %</th>
<th>False cuts, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movie</td>
<td>88,42</td>
<td>5,39</td>
</tr>
<tr>
<td>Sport</td>
<td>79,97</td>
<td>8,21</td>
</tr>
<tr>
<td>News</td>
<td>89,04</td>
<td>4,68</td>
</tr>
<tr>
<td>Hand-made video</td>
<td>91,14</td>
<td>4,26</td>
</tr>
<tr>
<td>HD video</td>
<td>87,33</td>
<td>5,17</td>
</tr>
</tbody>
</table>

So it’s possible to say that the developed technique has a good prospective.

Here we can see that deference between histograms of this frame is tiny. And that’s the reason why algorithm didn’t mark it as shot boundary. **Conclusion**

In this research adaptive threshold method and attention system were realized. Strong and weak qualities of this method were discovered. Advantages of adaptive thresholds are great reaction on hard cut and minor need of calculation resources. Disadvantage is low reaction on fade transition. This research is a huge step to achieving our main goal to investigate different methods of shot boundary detection and find optimal methods for specific problem class.

**References**


**USAGE OF NEURO-FUZZY TECHNIQUES FOR ENERGY EFFECTIVITY ANALYSIS OF TERRITIRIES**

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**Abstract**

The article presents an approach that compares different municipalities by their energy efficiency level. We propose a clustering of the municipalities by neuro-fuzzy methods to estimate how social, economic and climatic features affect the energy use. The energy use indicators analyze allows to create a set of membership functions in each cluster to get fuzzy measures of energy efficiency.

**Key Words**

Energy efficiency; fuzzy clustering; climatic factors analysis

**Introduction**

The problem of effective energy consumption is very actual in all countries the world. Many companies and state institutions try to eliminate surplus resources use and losses. The problem is complex and it deals with many aspects of human activities from the initial stages of energy productions and distribution to creation of new energy saving materials and the formation of specific energy consumption human behavior. Development of complex energy effective technologies is one from the main research directions stated by president of Russia every year for the last ten years. In Russia each regional government creates its own (in addition to state politics) strategy to transform the current low-effective situation in the energy consumption into more effective. The development of local programs should be based on detailed analysis of factors that described nowadays situation of energy use in municipalities of analyzed region. There are many various factors and conditions define the energy consumption level and it’s difficult to understand the dependencies between factors and interpretation of their values. Classes’ situation borders are fuzzy and statements about estimation level can be veritable just with a level confidence. Therefore, the reasonable estimation needs fuzzy values. Municipalities have various natural-climatic and social-economic features (it’s the main difficulty) that have an influence on the view of membership functions. To take into account territorial features we suggest to implement municipalities clustering with Gustafson-Kessel [1] algorithm and based on data membership functions building method [2].
Technique

First of all to estimate the energy situation in municipalities it is necessary to select factors that describe production efficiency and consumption for various energy recourses (electricity, heat energy, hot water, gaz, etc.) in various sectors (households, state institutions, infrastructure, transport complex). These factors are energy efficiency indicators. The interpretation of indicators values allows to create conclusions about energy-saving situation in the natural language with fuzzyfication procedures.

Various municipalities features are defined by choosing “territorial factors”. They are natural-climatic, geographic, social-economic and ecological factors that define unbiased necessity in energy resources and energy-saving potential. Some of them are duration and severity of cold period, income per capita, infrastructure development, industry development level, demography. Experts define territorial factors and for each indicator a set of factors that effect on its values is formed.

Each factor is defined with measurable indicators that are municipalities clustering features by selected factor. Some factors can clone each other. Before clustering we need to find correlation of selected factors. It allows to eliminate correlated data and get independent factors.

The municipalities clustering is implemented by Gustafson-Kessel algorithm that divide the space with hyperspheres generated known methods and it discovers fuzzy clusters to following neuro-fuzzy model building for energy efficiency factors inference. The statistics source of Tomsk region in the work was used to cluster [3]. The number of clusters is not fixed in the algorithm and it is computed so that the distance from each center of cluster is less fixed, expert defined value.

Fuzzy energy efficiency level measure based on indicator values is defined according to municipality type detected in the clustering process. Each indicator described specific energy type in the specific sphere gets a linguistic variable that reflects the energy efficiency level (e.g. low, normal or high). Membership functions for term are specified on the indicator values set. Each cluster has its own set of membership functions. To initialize the set of membership functions it is better to use uniform cover and algorithm based on extreme values of dataset.

The next important direction of research is a heat energy share to municipal product estimation. Here we also clustered districts based on current consumption, municipal product, losses and energy market prices. This analysis shows the connection between energy losses, climatic factors and economics.

Losses Clustering

To archive more adequate outcomes we solved to perform longitude analysis. It’s known the clustering procedure works much better if there are more points to cluster then otherwise. From [3] datasets we got info about the heat energy price, municipal product, energy consumption and losses in 2007, 2008, 2009, 2010. There are some empty cells in the datasets. We also split all municipalities according their economics base. There are: northern oil districts, central forest economics municipalities and southern agricultural, forest districts. The last one includes two cities: Tomsk and Seversk. The number of fuzzy regions wasn’t specified and here the algorithm for automatic search the number of clusters [4] was used.

Climatic factor analysis

We would like to show an example of suggested method implementation for heat energy consumption efficiency estimation task in households of Tomsk municipalities.

The “heat energy specific consumption per 1 sq. m. of total household square”, Giga-calorie/m² factor. The main “territorial” factor that affects the indicator value is duration and severity of cold period. The factor can be described with the following indicators:

- \( x_1 \) – The heating period duration, days;
- \( x_2 \) – Average year temperature, Celsius degree;
- \( x_3 \) – Degree day of the heating period, Celsius degree·days;
- \( x_4 \) – Average total sun radiation for the heating period, MJoule/m²;
- \( x_5 \) – Average temperature in the cold period, Celsius degree;
- \( x_6 \) – Average temperature for the heating period, Celsius degree;
- \( x_7 \) – Average wind power, Watt/m².

To estimate the correlation between given indicators we use the statistic of Tomsk region municipalities for 2007 – 2010 years. In table 1 the matrix of correlation coefficient for each pair of indicators is presented.

<table>
<thead>
<tr>
<th>( x_1 )</th>
<th>( x_2 )</th>
<th>( x_3 )</th>
<th>( x_4 )</th>
<th>( x_5 )</th>
<th>( x_6 )</th>
<th>( x_7 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x_1 )</td>
<td>1</td>
<td>0.98</td>
<td>0.87</td>
<td>0.71</td>
<td>0.92</td>
<td>0.82</td>
</tr>
<tr>
<td>( x_2 )</td>
<td>0.98</td>
<td>1</td>
<td>0.83</td>
<td>0.69</td>
<td>0.88</td>
<td>0.86</td>
</tr>
<tr>
<td>( x_3 )</td>
<td>0.87</td>
<td>0.83</td>
<td>1</td>
<td>0.55</td>
<td>0.91</td>
<td>0.9</td>
</tr>
<tr>
<td>( x_4 )</td>
<td>0.71</td>
<td>0.69</td>
<td>0.55</td>
<td>1</td>
<td>0.71</td>
<td>0.65</td>
</tr>
<tr>
<td>( x_5 )</td>
<td>0.92</td>
<td>0.88</td>
<td>0.91</td>
<td>0.71</td>
<td>1</td>
<td>0.98</td>
</tr>
<tr>
<td>( x_6 )</td>
<td>0.82</td>
<td>0.86</td>
<td>0.9</td>
<td>0.65</td>
<td>0.98</td>
<td>1</td>
</tr>
<tr>
<td>( x_7 )</td>
<td>0.51</td>
<td>0.6</td>
<td>0.59</td>
<td>0.72</td>
<td>0.53</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Then, we perform the cluster analysis of municipalities by the “duration and severity of cold period” for three indicators: \( x_3, x_4, x_7 \). Consequently three clusters were detected: 1 – «severe climatic conditions», 2 – «unfavorable climatic conditions », 3 –
«relatively favorable climatic conditions ». According to the fuzzy clustering each municipality belongs to some clusters with defined confidence level.

**Membership Function Building**

Membership functions for fuzzy estimation of heat energy in households are built for each detected cluster. We select three terms: low, normal and high consumption in municipality households. To create these functions we take indicators values for all municipalities in the cluster with level confidence > 0.75. The interval of values can be equally split by the number of terms or use the algorithm of membership function building based on data density. Extreme points of base set are selected so that the minimum and maximum indicators value in the cluster lies at the level of confidence = 0.5 for appropriate terms.

Figure 1 illustrates the outcome of analysis. In the Tomsk region map all municipalities are painted with three colors. The first cluster regions are light grey. «Unfavorable climatic conditions» municipalities are covered with grey and the last cluster regions with the best conditions are dark. Letters at the center of municipalities mean the level of energy consumption according to the membership functions.

Fig. 1. Tomsk region municipalities and their energy consumption levels. H, N, L are high, normal and low levels of consumption respectively

**Conclusion**

Suggested method that analyzes energy efficiency situation in municipalities allows to infer estimation reflected in natural language based on energy data interpretation and influence of natural-climatic, geographic, social-economic and other territorial features. Neuro-fuzzy approaches usage for municipalities clustering by territorial factors gives unbiased outcome that doesn’t depend on expert opinion. Clustering results and fuzzy estimation reflection on the cartogram allows to represent the energy efficiency situation and helps to make a decision in the energy sphere.

**References**


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**МОДИФИЦИРОВАННЫЙ АЛГОРИТМ ХЕББА И ЕГО ПРИМЕНЕНИЕ В ЗАДАЧАХ КЛАССИФИКАЦИИ**

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**Введение**

Задача снижения размерности данных является весьма актуальной. Действительно, исходные данные нередко являются избыточными при решении ряда задач классификации. Обработка таких многомерных данных требует значительных компьютерных ресурсов и временных затрат. Снижение размерности пространства признаков при классификации положительно сказывается на итоговых результатах [1].

Одним из часто используемых при снижении размерности данных методов является метод главных компонент. Классическая реализация этого метода достаточно сложна, однако, есть возможность аппроксимировать используемый для этого алгоритм при помощи искусственной...