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AN APPROACH TO DSS METHODS USAGE AT VEHICLES RECOGNITION AND IDENTIFICATION

Abstract: The current review contributes with an overview of decision support systems in road safety systems detection and identification components. Decision support systems are researched since the middle of the past century, however approaches and methods it proposes are still actual and actively used when building information systems. DSS methods provide structural and constructional tools to build systems that can effectively solve problems in conditions of uncertainty. This article focuses on approach to registration plates detection problem solving in recognition components of road safety systems. Results obtained are demonstrated with applied task solving and proposed approach effectiveness confirmed.

Keywords: decision-making, image recognition, image annotation, machine learning, artificial intelligence, decision support system.

Introduction

Computing power constant growth and field of computer engineering development provokes scientific interest in decision support systems (DSS) methods research and application. Given methods confirmed its effectiveness in various fields of human activity, demonstrates high effectiveness rates in conditions of uncertainty, and loosely structured tasks, including ones that have many criteria.

Vehicle recognition and identification problem is actual in modern road safety systems. This is because of inhomogeneity of the environment, which serves as a source of data for analysis and decision making. For the system, mentioned above this environment is an outdoor transport infrastructure. This environment is volatile due to time of the day change, time of year, weather conditions, etc. Therefore, recognition and identification problems cannot be completely solved with static algorithms usage only, like classical implementation of optical character recognition (OCR).

Artificial intelligence capabilities provides tools for detection process accuracy increase performed into DSS knowledge machine, in accordance with the architecture proposed by Marakas.[4]

Artificial intelligence usage in DSS is actively researched and discussed in scientific society at conferences and scientific articles.

An approach for DSS methods with artificial intelligence abilities usage on vehicle plate recognition tasks as an example will be discussed in this article.

Problem statement

Approaches demonstration for vehicle plate recognition problem solution in road safety systems with DSS methods usage.

Vehicle plate recognition and vehicle identification problem definition.

Definition for DSS methods for machine learning, their features, advantages and disadvantages.

Justification of the vehicle plate recognition problem solution results obtained, proof of the effectiveness of the chosen approaches.

Vehicle plate recognition and vehicle identification problem from DSS point of view

In accordance with [13] decision support systems by taxonomy can be divided into:

- communication-driven DSS;
- data-driven DSS (data-oriented DSS);
- document-driven DSS;
- knowledge-driven DSS;
- model-driven DSS.

With a classification provided a road safety system component responsible for vehicle recognition and identification could be regarded as knowledge-driven DSS. This can be argued in accordance with the tasks performed by this component.

Classification defines that knowledge-driven DSS operates with specialized knowledge for task solving. This knowledge is stored as facts, rules, procedures or similar structures as interactive trees or diagrams.

In the same time component, that provides training for the detection system is data-driven DSS and fully depends on input datasets.

In accordance with classification, data-driven DSS operates with knowledge-specific internal data and sometimes with external, or knowledge-tangented data.

Existing road safety systems being used by the law enforcement agencies of Ukraine corresponds to the State standard of Ukraine[1]. In most cases, such systems operate with OCR technology for plate recognition tasks solving.

By its nature, classical OCR is a linear algorithm and poorly inclined/not inclined to retrain on erroneous detections. This significantly limits its abilities for efficiency increase in conditions of uncertainty, which include road conditions, where images for recognition brought from.

Machine learning models pattern recognition direction development provides an opportunity for efficiency increase and recognition mechanism of DSS knowledge base retrain, thereby increasing the accuracy of its work.

To demonstrate a problem model-driven OCR-based DSS vehicle plate recognition task execution has been analyzed. For uncertainty conditions modeling Gaussian blur was used, which can be treated as a capturing system focusing issue.

Blur levels gradation from lowest to highest are illustrated on Fig. 1.

*Figure 1.*Gaussian blur levels (1-10) applied
to vehicle plate image illustration

2000 images dataset OCR-based processing (recognition) results by blur level distribution are shown on chart at Fig. 2.

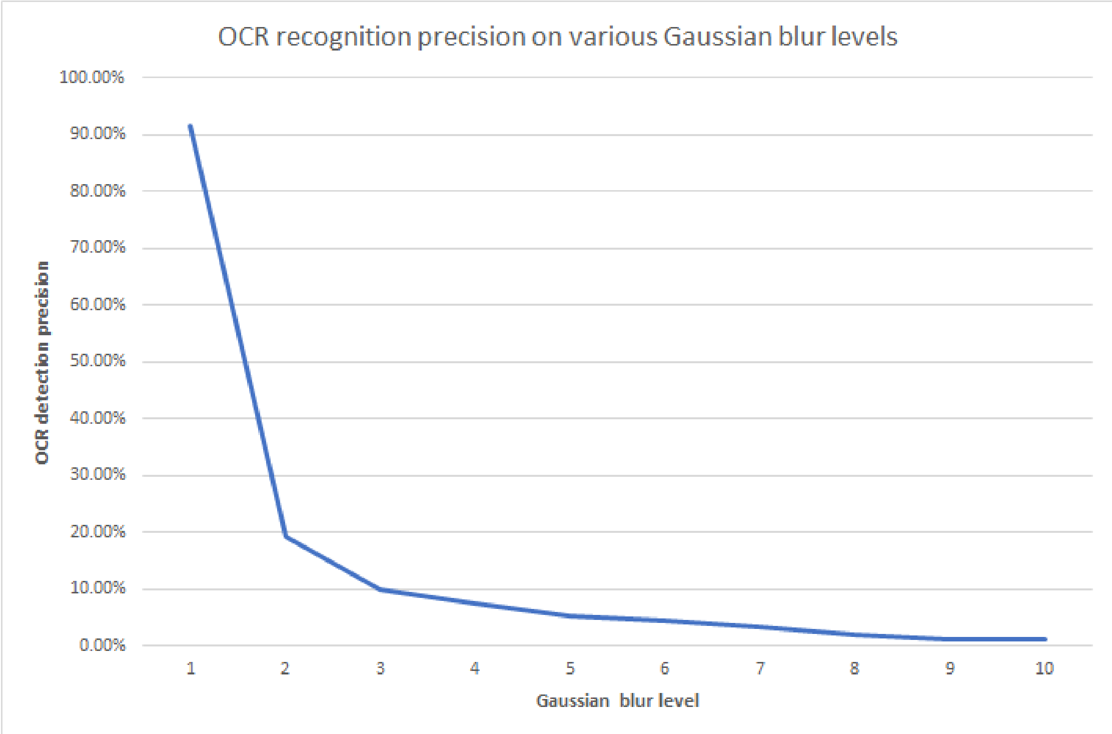

*Figure 2.*Model-driven OCR-based DSS precision level graph
in uncertainty conditions. Precision decrease is a negative trend

As seen on chart even a minimal change in focusing conditions dramatically reduces such systems precision.

Propositions for DSS methods usage for vehicle plate recognition task solution

Data-driven DSS envisage internal (in accordance with the task being solved) data usage and manipulation, sometimes also using external data, obtained while solving similar tasks.

Road safety systems data is intended for governmental institutions internal use only and not publicly available due to legal reasons.

Therefore, it was suggested *a real data-specific driven DSS system with task-specific graphical data generation hardware system creation approach*, which corresponds with standard and is actual for existing systems.

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To build the system, hardware components (cameras and computation systems) were used and installed in accordance with the standard.

Fig. 3 illustrates an example of graphical data generated by the system.

Figure 3. Real data-specific driven DSS system with task-specific hardware system of graphical data generation sample image

Graphical data (images) dataset array has been prepared for machine learning in the detection system. To demonstrate knowledge-driven DSS building, with an approach proposed, Yolo v5 detection system was used.

This approach provides opportunities for continuous system re-train with fresh data, thereby increasing system precision by covering a wider quantity of probable cases in uncertain conditions.

For automated data preparation (classification) for training a YoloAnno application was developed, which is illustrated on Fig. 4.

*Figure 4.*YoloAnno application for Data-oriented DSS internal data preparation

As a result of given system work a training dataset was obtained, used for training and detection with real data usage, which is identical to the one used in existing systems.

Evaluation of the effectiveness of the proposed approaches

Obtained knowledge-driven artificial intelligence-based DSS was used for a dataset of 20000 images recognition. Recognition results were distributed by five categories, demonstrating precision characteristics of work of the system. Fig. 5 chart illustrates results distribution.

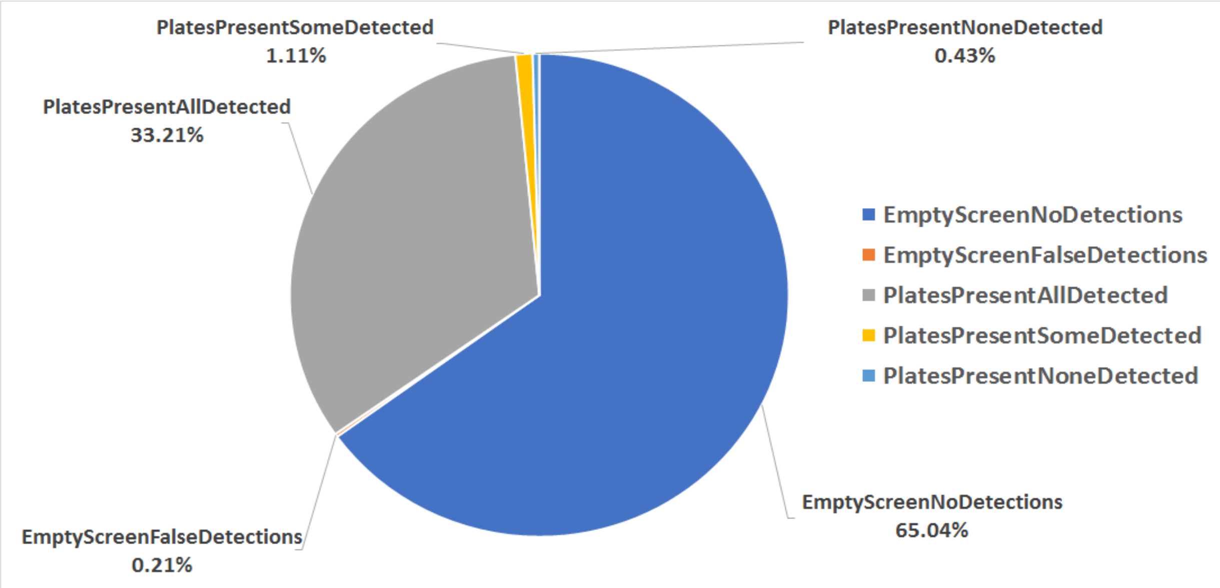

*Figure 5.*Knowledge-driven artificial intelligence-based DSS detection results on 20 000 images dataset

In accordance with results obtained **98,25%** of detections were correct, **1,11%** partially correct, **0,64%** erroneous.

For practical confirmation of the statements made a dataset of 2000 images with real road conditions were collected and processed with corresponding Gaussian blur levels. Dataset was recognized with the system mentioned above. It should be noted that a dataset of images without Gaussian blur was used for detection system training.

Highest Gaussian blur level image example is illustrated on Fig. 6.

*Figure 6.*Gaussian blur level 10 applied to an image generated by the created system

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Pre-trained detection system recognition results are shown on images with various Gaussian blur levels at Fig. 7.

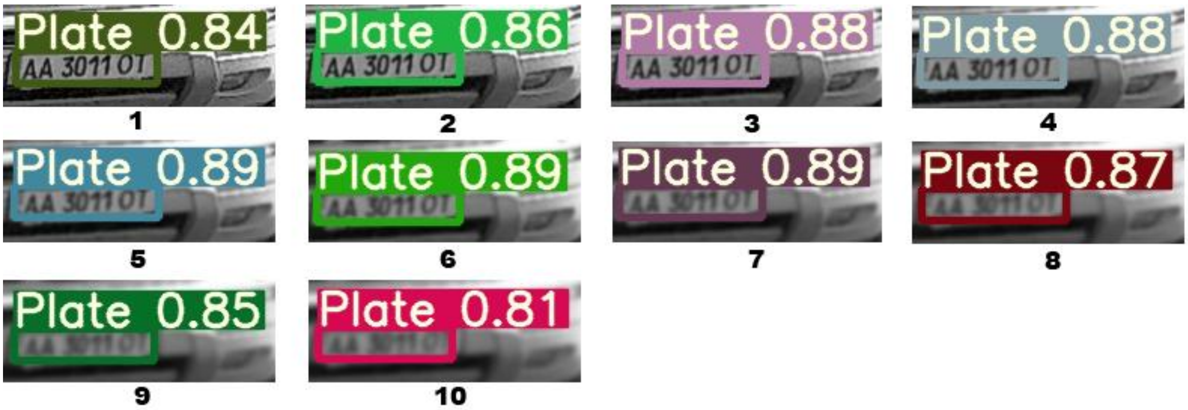

*Figure 7.*Knowledge-driven AI-models-based DSS detection results on various Gaussian blur levels (1-10)

2000 images dataset OCR-based processing (recognition) to AI-based processing (recognition) results by blur level distribution are shown on chart at Fig. 8.

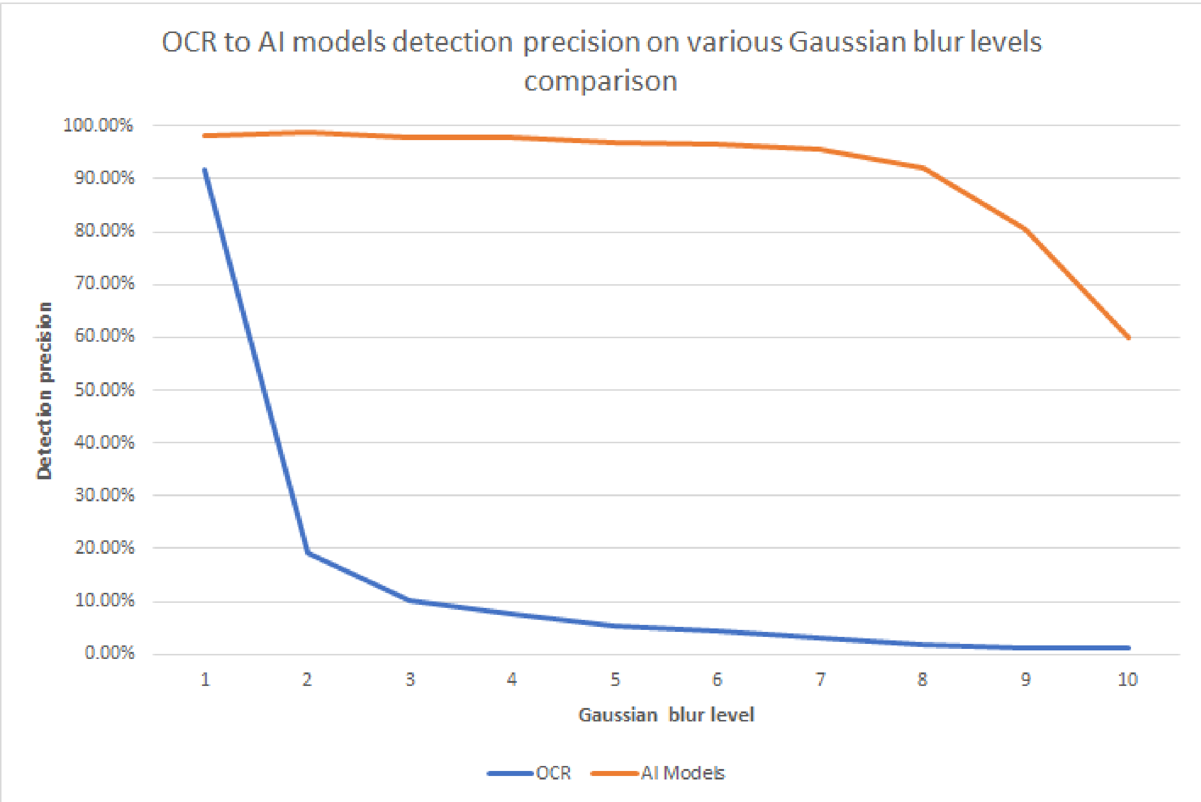

*Figure 8.*Model-driven OCR-based DSS precision to knowledge-driven AI-models-based DSS precision on various blur levels comparison charts. AI-models-based DSS precision growth is a positive trend

In accordance with the data obtained, a knowledge-driven artificial intelligence-based DSS shows high precision level of recognition even in uncertain conditions like input data quality unpredictable variations. Considering artificial intelligence models retrain capabilities with unrecognized (erroneous) data given approach provides a field of opportunities for further research.

Conclusions

Synthesis of DSS methods and artificial intelligence provides a field of opportunities for application research in various directions of human activity. Relevance of research in this direction warmed up by computing power constant growth, software engineering tools development and corresponding reduction of the requirements for the mathematical complexity of calculations.

Artificial intelligence-based DSS methods usage were investigated while building automated DSS in uncertainty conditions.

Real data-oriented driven AI-models-based DSS system was built with a task-specific hardware system of graphical data generation creation to demonstrate proposed approaches application.

With the results obtained, effectiveness of an approach chosen was proven. Proposed approach implies DSS methods usage for vehicle recognition and identification task solving in road safe systems with uncertain road conditions.

Further research in the given field relates to image capturing devices clarity growth, artificial intelligence models complexity growth, computing power growth, expert systems results precision requirements growth, etc.

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