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Research Article

Software Engineering Perspective on Object Detection Studies: Current Status and Challenges

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Abstract – Software is a popular field of study where studies in this field increase as its use increases. Software engineering is a branch of engineering that covers the development and maintenance processes of software products of different sizes and types. Software engineering is a field where studies are carried out in many different fields. In recent years, it has also shown a great change with its current work areas. With the development of artificial intelligence and deep learning studies, the work areas of software engineers are also updated and developed. Object detection and recognition applications are software that are intensively studied and are the basic parts of many software products. Performing object detection and recognition in a video sequence or image is considered a difficult process. However, in recent years, software engineers have achieved quite successful results in object detection applications. While studies in this field continue, this study was presented in order to reveal the current situation. A study was conducted to reveal the difficulties, new trends and expectations of software engineers who will consider working in the field of object detection.

Keywords – Software Engineering, Object Detection, Deep Learning, Software, Artificial Intelligence.

I. INTRODUCTION

Software engineering is a sociotechnical discipline that covers different phases from the creation of a software product to the maintenance process [1]. The steps to be followed while developing a software product are called the software life cycle. In recent years, with the development of artificial intelligence and deep learning algorithms, software engineers have turned to different research areas.

Among all the developing software engineering sub-fields, one of the most prominent challenges in recent years is object detection applications. The main task of object detection applications is to detect and categorize different types of objects of interest in an image. Online and online object detection studies continue unabated. The idea of performing recognition faster and with less error rate has led to competitions in this field [2, 3].

Object detection has become a multidisciplinary field rather than a field studied only by software engineers. However, within the scope of this study, studies evaluating object detection applications from the education process of software engineers to their roles in the business sector were analyzed [4, 5]. The development of deep learning algorithms with the increasing amount of data has led to the use of new algorithms in the field of object detection. The most widely used algorithms in this field are Region Based

Convolutional Network (R-CNN), Fast R-CNN, Faster R-CNN, SSD, Mask R-NN and You Only Look Once (YOLO) versions.

Within the scope of the study, the first section provides information about the purpose of the study. In the second section, the limitations of the study are given. In addition, the analyzes conducted in the field are presented. In the last section, the results obtained are presented. Suggestions are made for future studies.

II. METHOD

In this section, the areas investigated and the research methods used are presented. Within the scope of the study, studies involving the concepts of "software engineering" and "object detection" were searched and the most cited studies were examined through the R Studio program.

The challenges and trends encountered in the studies are presented both verbally and visually.

A. Challenges

Object detection is a challenging and important topic in software engineering. Various challenges and limitations are encountered in software engineering processes and throughout the software lifecycle. These challenges arise from various factors such as data quality, algorithm selection, computational resources and real-time applications.

Data Quality and Labeling: Object detection applications based on deep learning models require large data sets. The data obtained from online or offline images are labeled using different applications. However, collecting and accurately labeling these data sets is a time-consuming and challenging process. Incorrect or incomplete labeling can negatively affect the model's operational performance. In particular, there may not be enough data for rare objects or special applications. Similar objects may even be confused during labeling [6].

Algorithm Selection and Performance: The selection of algorithms used for object detection is another important problem. Algorithms are selected depending on the requirements of the application. For example, single-stage detectors such as YOLO (You Only Look Once) are fast, but their accuracy rates decrease in cases such as recognizing small objects. Especially in traffic applications, they can sometimes be inadequate in detecting vehicles that are moving away. On the other hand, two-stage detectors such as R-CNN (Region-Based Convolutional Neural Networks) offer higher accuracy but are slower. Therefore, there is a trade-off between speed and accuracy [7].

Computational Resources and Real-Time Processing: Deep learning-based object detection models usually require computers with high computational power and powerful graphical interface cards. Especially in real-time applications, it is important that these models run with low latency. However, it is difficult to run these models on platforms with limited resources, such as mobile devices or embedded systems. Therefore, lighter and optimized models need to be developed [8, 9].

Other Challenges Affecting Performance: Object detection models can be affected by environmental factors such as different lighting and weather conditions, image angle changes, partial overlaps and background complexity. These conditions can degrade the overall performance of the model and prevent the expected results in the field [10,11].

These limitations in software engineering and object detection have led software engineers to develop more efficient, accurate and resource-friendly solutions. In this context, studies on improving data quality, optimizing algorithms and efficient use of computational resources are ongoing.

B. *Featured Topics in the Field*

The discipline of software engineering supports work in many different fields of study. Object detection has also attracted attention due to its developing aspects and the fact that it is still of great interest to engineers. For the most prominent work topics in this area, see the all-time word frequency anazlin from R Studio.

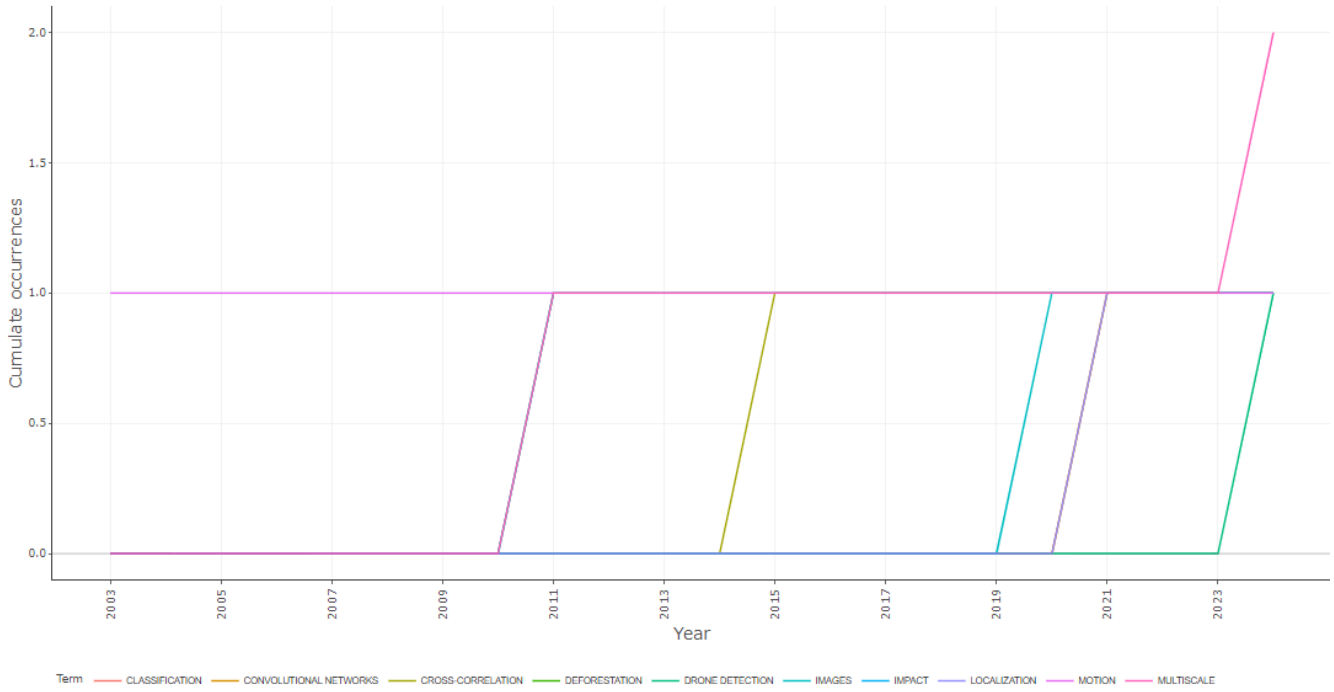

Fig. 1 Words' Frequency over Time

As can be seen in the figure, the frequency and usage rate of the words used have changed over the years. New studies have been produced with the addition of concepts such as drone detection and localization. This can be interpreted as a change in the orientation of the fields of study.

The three-field plot, which shows the links between the journals where the studies were published, the most cited authors and the keywords, is important in terms of showing the general structure of the research field. Figure 2 shows the three-field plot.

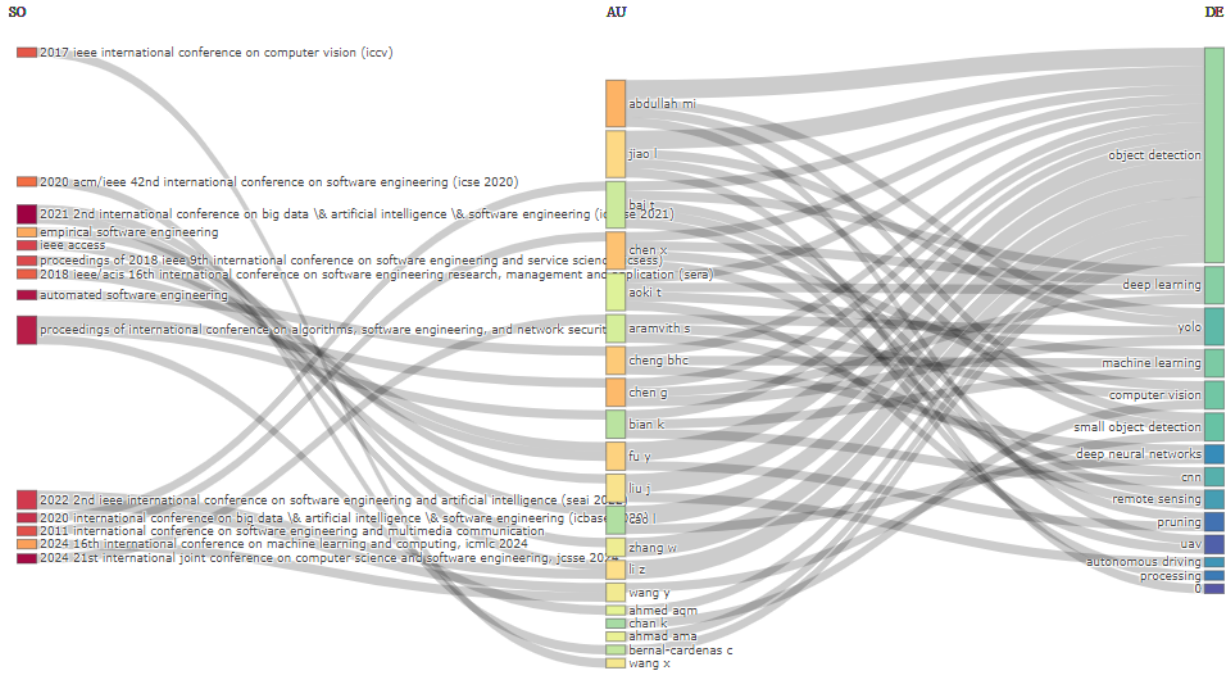

Fig. 2 Sources, authors and most frequently used keywords

As can be seen in the figure, keywords such as object detection, deep learning and yolo are used by all the top 20 authors in the field. The gray links between them show the relationships between each field and their strengths. The most cited source was used by a single author.

III. CONCLUSION

Software engineering is an important discipline with many sub-disciplines. With the development of deep learning algorithms, object detection has been one of the most researched areas by software engineers. With the increase in YOLO versions and the development of Faster R-CNN, very successful results have been achieved in this field.

In this study, an overview of object detection applications in software engineering is presented. Both the challenges in the prominent researches in this field and the trends in the field are visualized with various analyses.

Object detection is a young research area that is still in progress, although its applications have reached a very good point today. It requires large amounts of data on computers with high computing power. The process of labeling the data is costly and challenging. There is no single algorithm to overcome these challenges.

It is thought that the study will provide an overview of the field to researchers who want to work in the field. It is planned to extend the study and conduct a comprehensive study in which the object detection results obtained are compared and the algorithms used are explained.

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