http://communications.science.ankara.edu.tr

Commun.Fac.Sci.Univ.Ank.Series A2-A3
Volume 65, Number 1, Pages 38-51 (2023)
DOI: 10.33769/aupse.1122848
ISSN 1303-6009 E-ISSN 2618-6462

Research Article; Received: June 06, 2022; Accepted: August 10, 2022

ONTOLOGY DEVELOPMENT FOR WEB SERVICES TO BE USED WITHIN THE SCOPE OF REMOTE MONITORING PROJECT

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Abstract. In today's society, as the digital transformation has become widespread rapidly; information technologies also started to develop themselves quickly along with this prevalence. This rapid development and transformation bring about new and different requirements. Situations like reuse of the information, the ability to integrate the obtained information and sharing it, among others, have pushed Semantic Web to the forefront, especially scientifically. Semantic Web, which provides the communication of a machine with other machines, gets a great attention especially in today's digital age. Probably because of this, significant works have been done on ontology development method and ontology based systems started to be advanced over the last decade. Ontology development methods or ontology based systems play a key role in the integrity, being shared and management of the data. Ontology development method, which is of vital importance in reusability and expandability of real time monitoring systems, is in a position to be accommodable to many architectural systems like Deep Learning architecture at the same time.

1. Introduction

Ontology development studies, which have a serious importance in semantic web-

Keywords. Deep learning, semantic web, ontology development method, image processing module.
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based systems, ensure that the applications used to intersect with different fields. Ontology development study aims to manage data in a wise way. In addition to that, Ontology development study is a solution tool in data integration studies. Since applications contain different systems within itself, it is very difficult to contact with different applications. At this point, ontology development studies are needed. Ontology development emerges in accordance with certain requirements and is designed in accordance with the next new requirements. It is a system that starts to be used frequently especially in the data subtitles due to this feature.

The main point of the ontology development method, which provides the key task in data by providing data integrity, consists of a reflection of software engineering and is also used in almost every field. The basic function of the semantic Web actually allows the communication of machines with other machines by using formal semantic science to share and reuse information [1]. Therefore, another purpose of ontology development work is to provide inter-machine communication. In an ontology infrastructure design, the main tasks are distributed among the functions and the information from the user interface based on the distribution of tasks is transferred to the servers by the ontology regulator. Optionally, ontology can make all operations on the server. And so that ontology can only act like an interface that conveys the resulting results to the user [2].

The rapid development of information technologies has revealed the new infrastructure requirements of semantic we -based infrastructure. One of the areas that needs this infrastructure requirement is image processing modules in remote monitoring systems. In these modules, deep learning architecture is of great importance. On the other hand, ontology -based system studies prepared for use in deep learning architecture have just begun to become widespread.

In this study, an ontology-based image monitoring system design will be introduced. In the first part, information about the image processing module and deep learning will be given. In the second part, the concept of ontology development and ontology definition languages will be mentioned. In the third part, under the title of ontology development methodology, the necessary details will be conveyed and finally a general evaluation will be made in the conclusion section. In the third part, the necessary details about how the process should work under the title of ontology development methodology will be given and finally a general evaluation will be made in the conclusion part.

2. Image Processing Module and Deep Learning

In the modern era, there were practices for monitoring industrial parameters such as temperature reading, hardware supply, pressure level, inventory monitoring and management of the relevant machines. The change in the data collected with these applications can lead to serious consequences. Not only these parameters are important, but also for monitoring the position of placed objects. The monitoring of these parameters has changed every passing day since the last few years. In here, various researches are conducted on the use of software technologies such as image processing and machine learning to monitor some industrial parameters.

Manual power is needed to monitor parameters of voltage, different gases, etc. in industry. If these parameters are not correctly monitored, abnormal conditions may occur as a result. This is one of the important issues in the industrial sector. Using manual force to control these abnormal conditions in harmful situations is quite risky. Therefore, manual power alone cannot always be relied upon. There is a need for methods that can automate processes. In recent years, monitoring systems have been far from solutions based on manual power. Instead, the system can be automated using up to date technologies such as image processing that allows monitoring on a per second basis during the day. Thanks to the images uploaded to the system, this data can be seen on the computer system and can be viewed from any remote locations that can be accessed to the website. The biggest advantage of the development of such a system is that it minimizes the risks of abnormal states.

Even though the first studies on deep learning are based on the past, one of the main reasons for successful use in recent years is that there is enough data. The algorithms that train deep learning models used in complex tasks are almost the same as the learning algorithms used to solve toy problems in the 1980s. However, the models we have prepared with these algorithms have made changes that simplify the education of very deep architecture. In addition, another important new development is to provide the resources they need to succeed in these algorithms today. The first data that constitutes the first of these sources is achieved by increasing the digitalization of society. With the increase in the activities carried out on computers, the transactions are more recorded. Since computers are connected to more networks, it has become easier to centralize these records and make them a suitable data set for machine learning applications. This increasing data structure has created a new field called "Big Data" in recent years. With big data, machine learning has become much easier. Another reason why deep learning is popular is because computational resources are available today to run larger models. With the introduction of hidden layers in artificial neural networks, the processor capacity has increased for the memory and computational memory used. The network, which is deepened by increasing the number of hidden layers, creates a faster computer need with larger memory. With the development of big data and GPUs, it has been possible to design different Deep Learning models. These designed models make the learning process itself without user-specified features from the input data. This learning process is obtained by discovering different features of data in different layers. The basic model of these architectures is considered Convolutional Neural Networks (CNN). CNNs are successfully applied in image classification, object recognition, image segmentation, etc. problems. CNNs are the improved state of artificial neural networks. The network that deepens as a result of further increasing the number of hidden layers in artificial neural networks can be called CNN. This depth in CNN was performed by using 2-dimensional filters. In addition to this difference in depth, CNNs perform learning in a hierarchical structure. Finally, the main difference that distinguishes CNNs from my artificial neural networks is the Dropout method used by CNNs to prevent memorization during the training of the deepening network structure. This method aims to prevent memorization randomly by removing some nodes of the network in each iteration during the training phase. Today, deep learning method is used in most of the image processing applications. Deep Learning, which provides very successful results in both industrial and academic studies, will also be implemented in this project. As a basic approach, object detection will be tried to be made and CNN will be used for the solution of this problem.

Objectnet (https://objectnet.dev/) data set will be used for the training and verification of the network to be used. Objectnet is a real large data test set for object recognition by control that object backgrounds, rotations and imaging perspectives are random. Similar to the Imagenet, there are 50,000 test data in the 313 object class. One of the important challenges encountered in automatic classification is the emergence of a new class after the education stage. In recent years, researchers have proposed ZSL approaches to overcome this problem. ZSL is a simple but effective algorithm that proposes linear code solution in these approaches. The performance of the relevant algorithm is basically dependent on the selection of parameters. Meta intuitive algorithms are considered as approaches that allow to approach optimization problems with high success. In this context, a problem -specific model and parameter training approaches will be recommended. Developments will be performed with Python language. The problem of estimation of human movements is an area studied in the literature. However, there is a need for a new model unique to the related problem. In this context, the aim is to develop a CNN-based model. If the adaptation of pretrained models to the relevant problem does not produce t he desired results, a hybrid method is intended to be used to combine the respective models. The literature states that hybrid methods achieve better results in comparison data sets than single models. Video summarization will be handled in two methods for online and offline approaches.

The first method is based on adding the locations of the video that were found to be unnecessary during video production to the main recorder before it was saved, and simply saving the desired locations to the main recorder. The second method is to analyze the data generated during the specific periods of the day and week after the end of the video recording and to discard the unnecessary bits.

3. Ontology Development Concept

The rapid development and advance of the information age, and the combination of Information and Communication Technologies in innovative gains, have resulted in the exploitation and development of many others areas, including the private sectorand public institutions and enterpris. Information technologies refer to the entirerange of technologies available for the monitoring, management, sharing an development of existing information. Information technology assets indicate how and how different technologies can be used for different purposes.

The information technologies used for this reason must be structured and developed in accordance with the philosophy of data integration. At this point, Information Technologies Asset Ontolog (BTVO) arises. According to some sources, the first use of ontology in computer science was in William J. Rapaport's "Philosophy of Computer Science". It was developed later and continues to be developed today. This situation, which we define as ontology development, is very new, as well as in the studies carried out in this field generally covers the after math of 2010 [3].

The ontology development method, which has come across different studies, is especially widely used in engineering studies involving the sciences. This model is used in many fields, such as providing systematic improvement over software processes, as well as providing access control, such as creating databases, integrating data, creating hierarchical classifications of systems, access control, decision support and more.

In the most common and simple definition of computer science, ontology is refe rred to as "theformal and clear specification of a shared conceptualization". In a more meaningful way, ontology should be revealed in a clear and understandable way and shared information should be clearly expressed by expressing semantically expressed [4].

Ontology is the most important feature that can develop when underlying the semantic web. In other words, ontology, called a smart data model, database aims to build a developable that fits the philosophy of data integration, and to build an infrastructure that is suitable for modeling. Therefore, it is expected that the ontology offered in addition to the fact that different technologies appear with different types of application is expected to serve these differences. The ontology development method also incorporates several foundations, including openness, connectivity, and conformity. An ontology developed in this perspective will gain meaningfully value through the relationship of activities and activities that arise in development processes. From a broad perspective of ontology development methods, the reflections of the software development process are clearly seen.

Many methods covering software engineering, such as analysis, design, planning and testing, have been redefined, taking into account the characteristics of ontology identification languages.

Another important point in the way of developing ontology is that the process is progressing according to a particular flow diagram, comprehensively handled, acted according to a particular order and planning. In the study to be put forward, certain researches are made and deficiencies are determined and scope, analysis and planning are determined accordingly. In accordance with the determination of these deficiencies and then the analysis and planning, the databased is modeled according to the deficiencies, the data integration is provided and the hierarchical classification is designed by looking at these studies.

The method of developing ontology is based on the conceptual framework, which is primarily developed by Gomez-Prez and later by Simpler [5]. This system, which was developed in three basic categories as the use of ontology, ontology development and support ontology, has been determined within a certain framework. The purpose of the ontology to be developed here is how the use of the RDF language to OWL language in line with the use of the target, adequacy, suitability and compliance with its purpose. In the ontology method developed, feasibility study, field analysis, conceptualization, realization, maintenance and use are determined as different situations. The main scenarios are also produced according to these situations. The conceptualization of the scenarios produced and the basic solutions through this conceptualization should be created and then these solutions should be transformed and realized to be represented. The ontology development work produced through these scenarios must be adaptable to new requirements. In other words, it is mentioned that the new information obtained after the study should be included in the process. Therefore, the systematic foundations of the study should be established by concentrating on the concept of "extensibility" and the reuse of ontology should be ensured. In this way, the new information obtained will be actively included in the system and the work will appear as a dynamic structure in terms of efficiency [5,6].

4. Ontology Definition Languages

Ontology, which is a basic concept for the semantic web, contains some of its unique definition languages. On the other hand, the basis of semantic web ontology lies in facilitating the integration of internal and external information. This integration is also provided by ontology languages. Ontology studies are developed in different fields using languages, and ontogy studies developed here can be reused in other ontology studies. In addition, that it can also be connected to resources in different ontologies integrating distributed ontology studies developed here can be reused in other ontology studies. In addition, that it can also be connected to resources in different ontologies, integrating distributed information with this connectivity.

However, ontology definition languages aim to build acknowledge model in a particular field. Two main structures play a major role in defining and developing all the standards in the Semantic Web infrastructure. The first of these is the WWW (World Wide Web) Consortium. The second is the ontology developers spread around the world. The WWW consortium constitutes the structures that form the core of the Semantic Web and that are expressed as the ontology language within these structures. There are two basic ontology language standardized; RDFS (Schema for Resource Definition Frame work) and OWL (Ontology Web Language). These two ontologies are language standardized and highly self developed languages, as we look back at the present. The following languages are following SWRL, SPARQL, RDF. RDF (Resource Definition Framework) is the most concise ontology language. Over time, RDF-S and OWL languages have risen above the RDF standards and have been defined for displaying information in a semantic web environment. The RDF language was inspired by the structure of natural language and identified three main elements to represent knowledge. These main elements are subject, object and predicate. These three elements make up the smallest pieces of information in the RDF document. These smallest pieces of information are defined by the HTTP URI standard and thus can be accessed on the web. Thanks to this method, the source RDF triplet on any server can be defined as an object and an interconnected concept network can be created on the web. Unlike RDF, RDF-S is the lightest ontology language of the consortium. The basic structure in the RDF-S ontology language is class and property definitions. With this basic structure, it is possible to define which class and which properties a concept has. In addition, new model definitions are created on top of OWL and RDF-S definitions. Another feature of RDF-S and OWL languages is that rich inferences can be made through identification logics. In other words, to put it more broadly, new information can be extracted using structures from a pre-existing knowledge model. SWRL and SPARQL languages are the other two languages defined by the consortium. SWRL (Semantic Web Rule Language) is a rule definition language. Using this rule definition language, new rule languages can be added to an existing ontology study. This definition language is mostly used in field ontology studies. SPARQL, on the other hand, is a query standard developed to query the knowledge bases of the created ontologies.

The definitions of ontology languages are given in the Ontology Development Standards Report as follows;

RDF: It is the standard that aims to define semantic information on the web and constitutes the essence of the semantic Web.

RDF-S: It is a lightweight ontology definition language. It is suitable for creating performance-efficient knowledge bases.
OWL: It is an ontology definition language with high modeling and therefore inference capabilities. It is suitable for modeling areas with semantically rich modeling requirements.
SWRL: It is the standard rule definition language. It aims to support applications that require external rule definition on the developed ontology.
SPARQL: It is the standard ontology query language in the Semantic Web environment. It aims to make all knowledge bases distributed on the semantic web questionable in a single language.

Ontology definition languages make it possible to use all the semantic information scattered over the existing website and the wealth of information revealed by the semantic web in ontology development work. When using these languages, an ontology development editor is used. The generally used ontology development editor is the program called Protégé (http://protege.stanford.edu/).

5. Ontology Development Methodology

The working continuity of the devices that play a key role in capacity in the production facilities will be checked. Here, it is aimed to detect anomaly on the device with computer vision technology and to generate an alarm in the form of status change. Images will be collected over the cameras in the environment of the industrial establishment and stored in the computer environment. If necessary, a minimum image quality standard will be defined for capacity monitoring. Object detection will be made with the CNN model on the samples to be collected, if this model is not successful in object detection, the existing model will be trained with new samples and the success rate in object detection will be increased. After these processes at T0 time, this model will be run on new samples with regular video streaming and the difference with the previous samples will be calculated. If this difference is above a certain threshold value, the application will generate an alarm. Deep Learning method will be used to solve the problem. CNN, which is most preferred in object detection, will also be applied in this project. According to the model's success rate, the model will be retrained with new samples if necessary. If the adaptation of the pre-trained models to the relevant problem does not provide the desired success, it is aimed to propose a hybrid method combining different models. Results will be evaluated with different performance analysis metrics (Accuracy, F-Score, Sensitivity etc.). With the zero-shot method, it is aimed to classify objects without the need for labeled training data. Thanks to this approach, it will be possible to identify the machinery and equipment that are not in the training set. Meta-heuristic algorithms are considered as approaches that allow to approach optimization problems with high success. In this context, a problem-specific model and parameter estimation approaches will be proposed.

The designs related to the tasks targeted by the image processing module are given below.

- Motion Estimation Module Design
- Design of the Identification and Identification Subsystem of Remote Object
- Design of the data summarization subsystem
- Performance analysis module design

There are processes that need to be followed when building an ontology-based subsystem. These processes are crucial to the ontology development process of the study. There are many methodologies in the literature in terms of ontology development. The methodology that we will base our development process on is the work of Noy and McGuiness in 2000. The reason for this is that the development process in the study presented supports there usable notions of ontology. Noy and McGuinness discussed this process seven steps. These steps;

1. Define the ontology scope and domain
2. Enabling ontology reuse
3. Identifying terms and term types in ontology
4. Defining classes and creating class order
5. Defining the attributes of classes
6. Defining properties of attributes
7. Defining class instances is in the form

5.1. **Define the ontology scope and domain.** While developing an ontology, it is the first and most important step to determine the scope and domain of the ontology. After this step is determined, other steps should be taken. In other words, it should be determined what the ontology will serve to whom, how, where and how it will be used by whom and what kind of questions the developed ontology will answer in the process, and these steps should be acted upon. On the other hand, the answers to some questions may change during the development process, so there is no certainty about the answers. Although it may vary, it is important that the scope and impact area have certain limits, since ontology development is acted within certain limits.

5.2. **Enabling ontology reuse.** Developed ontologies should be reusable in the process. In other words, the relations between the object and the object should be in a dynamic structure and the ontology design should be done by looking at them. The main reason for this is that the remote tracking system ontology intended to be developed would refer to another tracking system ontology that would be developed five or 10 years later. Therefore, in the relationship between an object and object, terms must be defined according to these criteria.

5.3. **Identifying terms and term types in ontology.** Some terms are needed to create RDF, RDFS and OWL while developing ontology. Therefore, a wide list of terms should be created. These terms emerge in line with the information obtained from the system and application to be developed. Order, attribute, data type, holistic relationship, etc., are not important when listing terms. A list is created regardless of anything else. This step is the most important step after scope and domain. Because that's where the ontology will be developed.

5.4. **Terms list.** The list of terms is the list that will be used to create classes. As mentioned above, everything about the system is written and the class hierarchy is built according to these kinds of things.

5.5. **Defining classes and creating class order.** In ontology studies, commonly common terms are taken as classes, and in other specific terms they have elements of those classes. Class patterns can also be viewed from top to bottom or bottom to top. In this way it will be easier to see the hierarchical structure of the class layout.

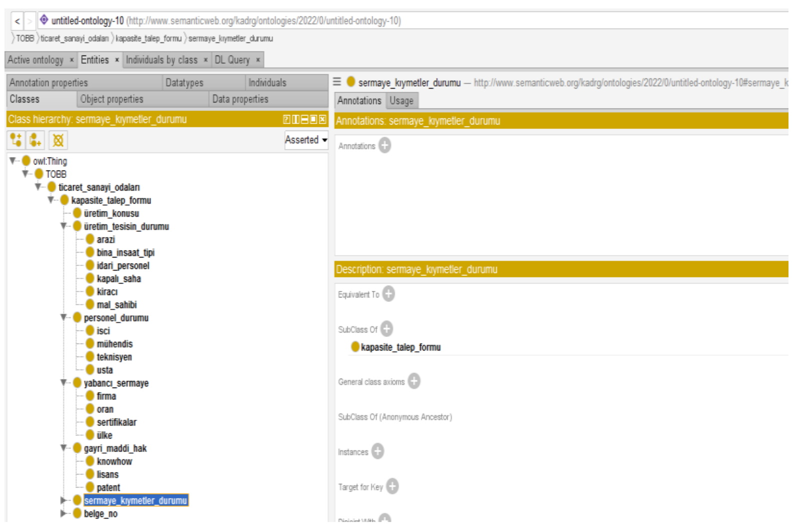

FIGURE 1. Defining classes and creating class layout.

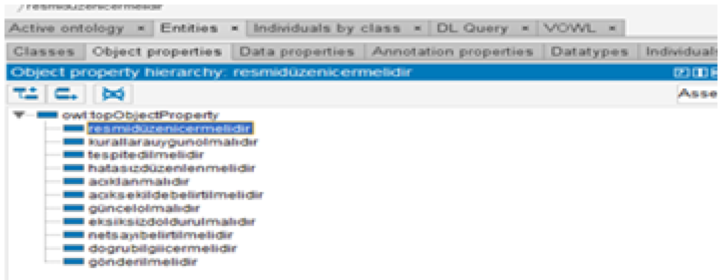

FIGURE 2. Definition of class qualities.

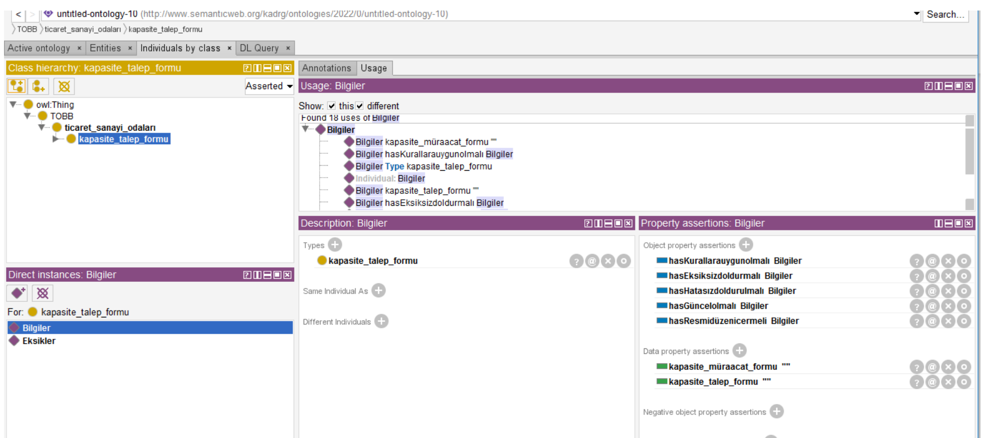

FIGURE 3. Identification of class instances.

5.6. **Definition of class qualities.** This title actually discussed about the internal structure of the classes, how they should be. So this is the stage at which the basic internal structures of the classes are being created Each object attribute creates the semantic relationship in the ontology study.

5.7. **Identification of class instances.** In the developed ontology study, class examples suitable for ontology are tried to be revealed. Both the class and object attribute properties mentioned above are the two main tools for the creation of these instances. First, it is decided which class will be created. Secondly, the instance is named and the previously determined class attribute properties are filled. This is the hardest part of the work. Because this is the part where RDF is completely revealed.

Finally, a scheme is devised using the VOWL plugin of the Protégé OWL editor to better view the organizational structure of the class and understand how the hierarchical structure is transferred to an order. This diagram provides a very clear view of which class has which subclasses, where the center point of all classes is.

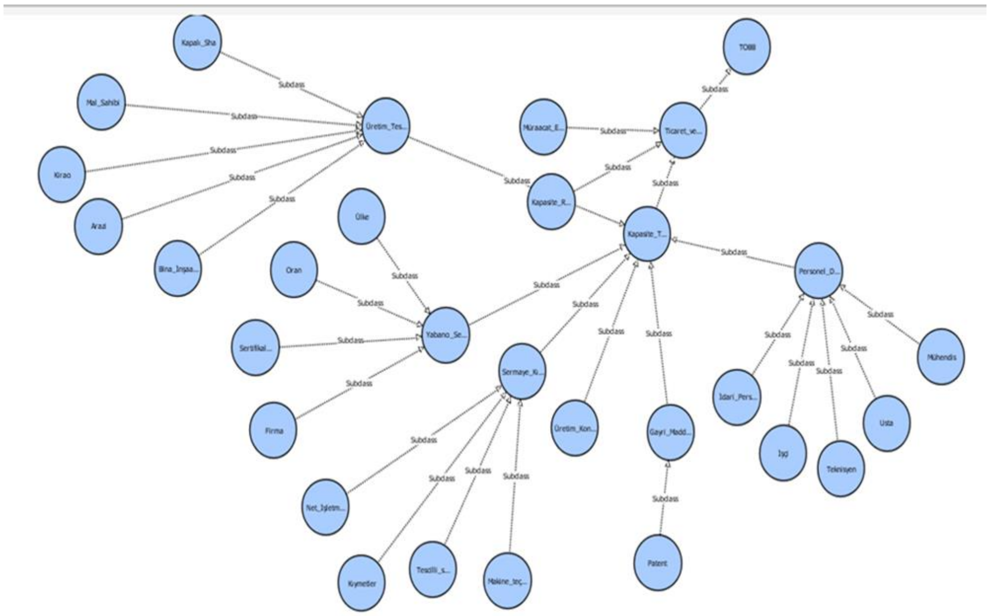

FIGURE 4. Class hierarchy scheme.

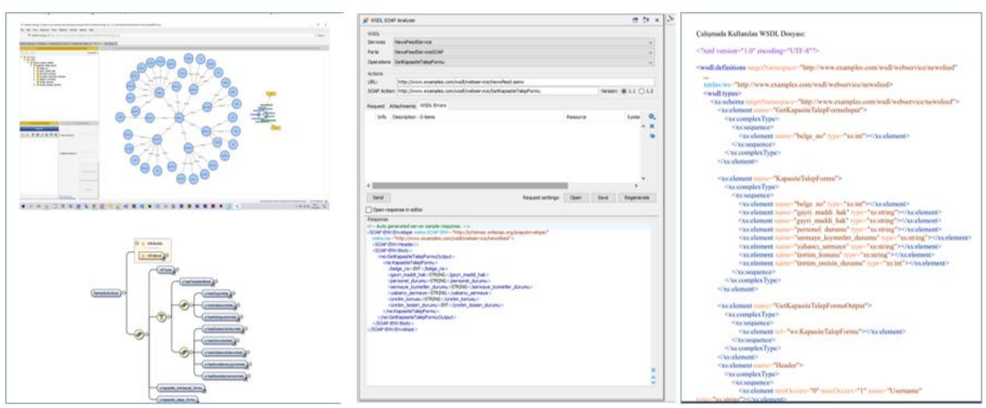

FIGURE 5. WSDL conversion and connection test work-in-progress.

6. Conclusions

When we consider information technologies, it is clearly seen that real-time monitoring is very important. In this real-time monitoring process, introducing an ontology-based system provides a serious benefit both in terms of developability and extensibility and in terms of reuse. In the proposed study, it is aimed to reveal a semantic expressiveness for the image monitoring module in remote monitoring systems.

In addition, this work is being developed by building on the architecture of deep learning. On the other hand, the method of developing ontology for the effectiveness and usability of the work has been applied. When we look at it within the scope of ontology development work, firstly the scope and domain were analyzed, and then a list of terms was created by determining the relations between the objects and objects required for reuse. By looking at the list of generated terms, classes, class properties, and class objects have been created to create the basis for extracting the RDF language that is the essence of the Semantic Web. The next process of study is still in development. While one one side data collection for image-processing continues, the ontology base is also being converted into Web Services Description Language (WSDL) format using Oxygen XML Editor.

Author Contribution Statements Corresponding author Kader Gürcüoğlu wrote about what ontology is and how it is distributed. Mehmet Güzel wrote deep learning and machine learning models of this research. Tunç Medeni and Tolga Medeni checked the research subject, content development, correct use of the ontology sub-resource and research. Halil Arslan took the task of operating the ontological database in the web service.

Declaration of Competing Interests The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement This study is carried out within the scope of the AURIZ projects supported by TEYDEP. Many thanks to TEYDEP which enabled the advancement of this project.

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