

APPROACH FOR SOFTWARE DEVELOPMENT FOR GENERATION OF CONTROL PROGRAMS BASED ON IEC 61499 STANDARD

ПОДХОД ЗА РАЗРАБОТВАНЕ НА СОФТУЕР ЗА ГЕНЕРИРАНЕ НА УПРАВЛЯВАЩИ ПРОГРАМИ
БАЗИРАНИ НА СТАНДАРТА IEC 61499

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Abstract: This paper presents an approach for software development that generates control programs in the field of reconfigurable manufacturing systems. The proposed approach proposes the use of developed domain ontologies merged in a meta ontology which is based on the standard for integrated production systems and management IEC / ISO 62264. The article addresses the main graphic elements of the software that are being developed as well the principle of generating control programs.

Keywords: IT, ontologies, interoperability, RMS, IEC / ISO 62264, IEC 61499.

1. Introduction

In the field of the reconfigurable manufacturing systems there are too many problems – both hardware and software – that prevent the mass deployment of these systems on the world market. One of the main software problems is the interoperability issue. According to [1], interoperability is the ability of two or more systems to exchange information and to use it. The interoperability allows drastically reducing the number of necessary interfaces for communication among different devices, machines and systems and furthermore reduces the time and cost of implementing new production systems and consequently the price of the final product should be reduced. There are some research areas for the development of interoperability and according to [2] one of them is the ontology area. Through the use of a shared ontology some standards such as IEC/ISO 62264, ISO 10303 (STEP) and IEC 61499 [3, 4, 5] may give a solution to the interoperability issue in the reconfigurable manufacturing systems. Though the ISO 10303 standard is aimed for future work and is not part of the current research the developed software uses developed domain ontologies merged in a meta ontology which is based on the standard for integrated production systems and management IEC / ISO 62264. The ontologies are used by the software as a knowledge base for the generation of control programs based on the standard IEC 61499. The main purpose for the development of this software is to create transition between the developed ontologies which are used as a manufacturing knowledge base and the creation of control programs thus proposing approach for solving the software interoperability issue in the reconfigurable manufacturing systems. On figure 1 is presented the flowchart of the developed software. As you can see it is divided into eight sections but only sections from one to five and some part of section six are topics of the presented article. Sections seven and eight are objects of future work.

2. Graphical User Interface

As you can see on Fig.1 there are some colored elements. The green element marks the beginning of the program while the red ones mark a possible exit of the program. The blue elements mark the transition between the main graphical user interface components and the yellow ones mark areas where the user is allowed to enter data. The program starts from section one which is shown in more details on Fig.2. At the launch of the software, the program begins with an informative window that contains brief information about the software and the programmer as well the university and the faculty, and the license agreement. If the user agrees to the terms of use, he may continue by loading the *Login screen* or to terminate the program. When the *Login screen* is visualized the user may enter his username and password in the appropriate fields and then the system will check if there are any

errors. If there are any, an error message will be displayed, otherwise the system will display a message for the successful connection to the database and will visualize the *Main screen* (fig. 2).

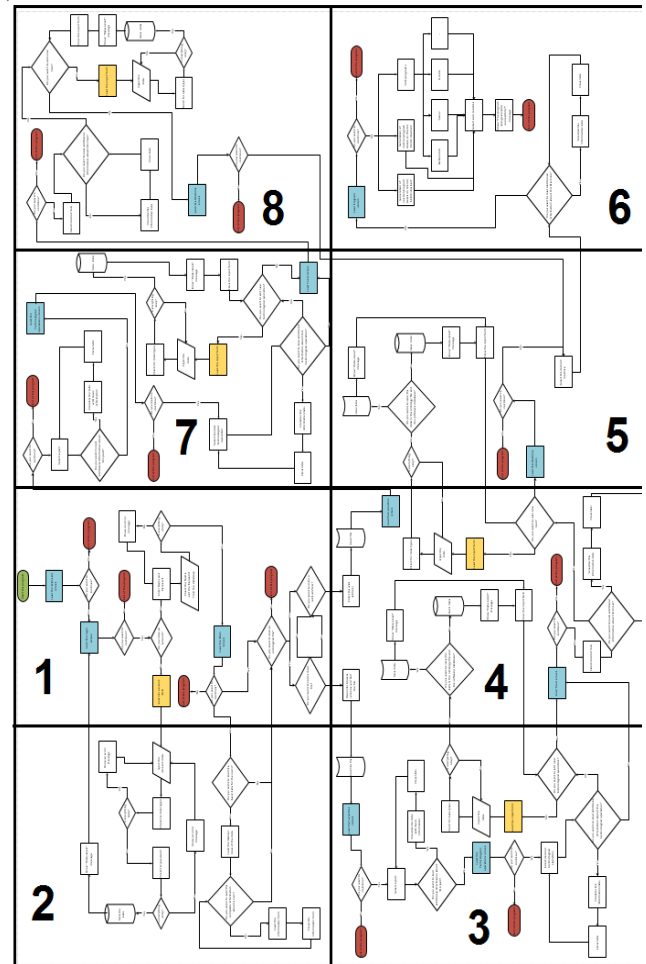


Fig. 1: Flowchart of the developed software

If the user does not have an existing account, there are two other options. The first one is to terminate the execution of the program and the second one is to create an account. The second option transfers the user to the *Account form* that needs to be filled correctly in order to create the account. The algorithm of the *Account form* is presented in Fig. 3 (section two of Fig.1). The system makes a check for the compliance of the entered data types and if there is any mistake the system displays the appropriate error

message. Finally, if everything is entered correctly the system makes one final check for the compliance of the password. If there are any differences the system displays an error message, and if there aren't the system saves the data in the database and displays message for the successful save of the data and returns the user to the *Login screen*.

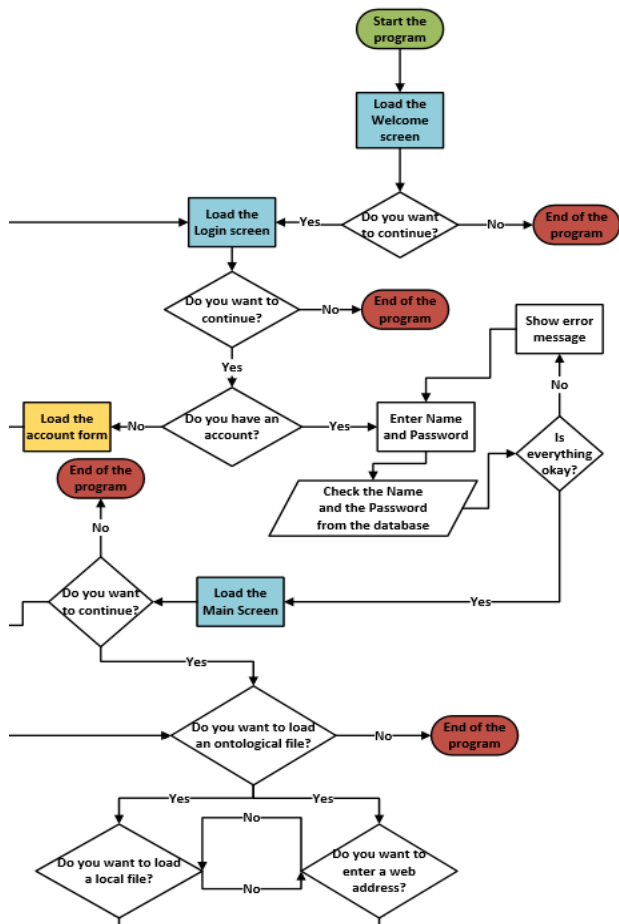


Fig. 2: Initialization algorithm for the developed software

When the *Main screen* is loaded it displays the server date and time and the user has a few options. The first one is to terminate the program. The second is to visualize a tabular presentation of the basic information about the different accounts. If the user wants he may visualize a *Business card* with detailed information for the appropriate user (Fig. 3). The third option leads the user to two different pathways of the program. The first one is to enter a web address that leads to an ontological file but that leads to section seven and eight (Fig. 1) which are not part of this paper and won't be discussed any further. The second option for the user is to open an ontological file locally. When the file is located and loaded, the system extracts all the data that the file contains and from this point on the user may continue with the generation of the control programs for reconfigurable manufacturing systems where all of the proposed decisions such as different parts, technological operations, tools, machine tools are based on the relations between classes and individuals in the opened ontology.

3. Generation of control programs

When the ontology had been loaded, the user may continue and the system loads the *Part screen* (presented on Fig.4) where the user has the following options: the first one is to terminate the program, the second one is to load the basic information in tabular form for all available parts in the ontology, Fig.5.

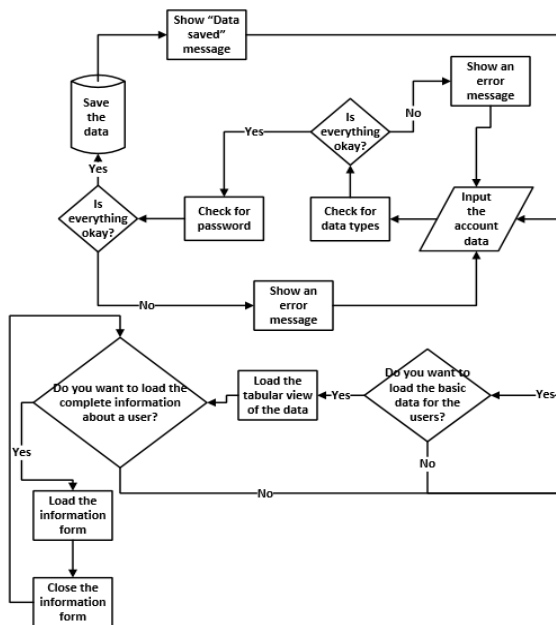


Fig. 3: Account algorithm and information algorithm

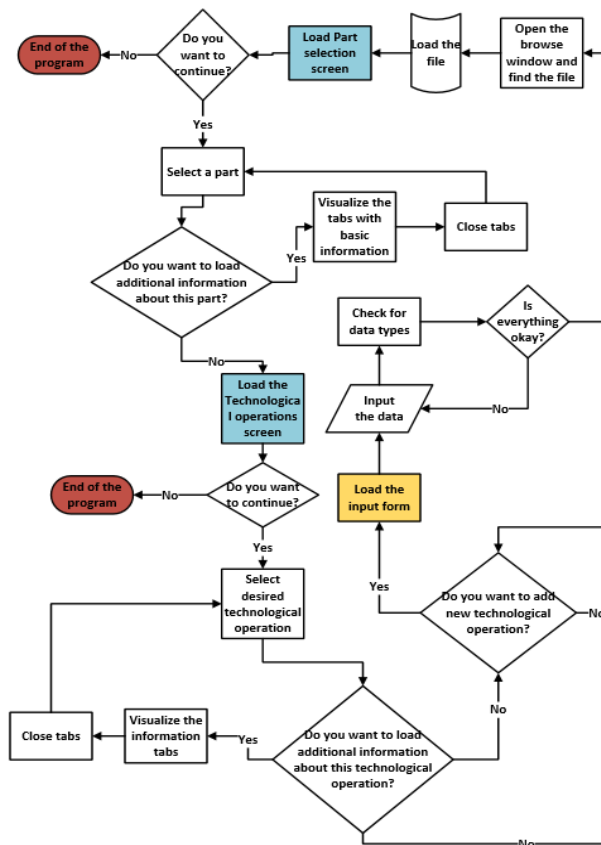


Fig. 4: Algorithm for selection of part and technological operations

The software allows the user to visualize more detailed information about the desired part by loading the *Part form* where the presented information such as drawings, needed technological operation, tools and so on, is properly presented in separate tabs. When the user selects the desired part he may continue with the generation of the control program by loading the *Technological operation screen*. From this point on all of the proposed decisions are based on the selected part.

№	Part	Data	Drawing	Choice
1	Hydraulic Cylinder	<input type="button" value="View Data"/>	<input type="button" value="View Drawing"/>	<input type="checkbox"/>
2	Pneumatic Cylinder	<input type="button" value="View Data"/>	<input type="button" value="View Drawing"/>	<input type="checkbox"/>
3	Plate	<input type="button" value="View Data"/>	<input type="button" value="View Drawing"/>	<input type="checkbox"/>

Fig. 5: Tabular presentation of all parts in the ontology

When the *Technological operation screen* is loaded the user may terminate the program or to select the desired technological operations which are presented in a tabular form. If the user is not familiar with the presented information he may load the *Technological operations form* where the desired operation is displayed in detailed view. If the desired operations are not in the presented list, the user may add them manually. To do that he loads the desired form (for drilling operations, for milling operations and so on) enters the desired data. The system makes a check for the compliance of the entered data types and if there is any mistake the system displays the appropriate error message. When all of the data is entered the user may decide how to save the data. The first option is to save the data in the software database. In that case these technological operations will be marked as additional operations and if the ontological file is loaded a second time, they won't be marked by default. The second option is to save the data in the software database and in the ontological file simultaneously. The main benefit in that case is the enrichment of the knowledge base and if the file is loaded a second time, all of the added operations will be related to the appropriate part and will be marked by default. When everything is done the user may continue by loading the *Tool screen* and the *Machine screen* (section four and section five of figure 1). Due to the fact that the work algorithms of these screens are similar to that of the *Technological operation screen* (with the exception that machines cannot be added to the ontological file and the software database) they won't be discussed in details any further. When all conditions are fulfilled (all elements that are needed for the production of the desired part) the software visualize the last of the main graphical user interfaces – the *Program screen* – presented in details on figure 6 (section six of figure 1). In the *Program screen* the user may decide the output format of the generated control program. When the IEC 61499 format is selected the user has to point the location where the XML code of the function blocks will be saved (each one of the blocks correspond to the appropriate technological operation). When the location for saving the blocks is selected, the software displays a message for the successful generation of the control program and terminates the execution of the program.

4. Future work

The development of the software will continue in the future by expanding its capabilities. For instance, the initial design of the software predicts the use of the internet, so one of the task for future development is the ability to open and extract information from ontological files that are uploaded in the internet, in compliance with all security protocols (section seven and section eight of figure 1). Another example may be made with the final output of the generated control programs. The developers wish to expand the interoperability capability of the software by adding different options for the final output – IEC 61131, CL Data files, G code and so on.

6. Conclusions

The presented approach, for software development in this study aims to present a way for solving the software interoperability issue in the reconfigurable manufacturing systems through the use of ontologies. Some of the benefits for using the software are:

- fast generation of control programs based on the standard IEC 61499;
- fast software reconfiguration in RMS;

- the software uses the developed ontologies as a source for information, so the enrichment of the knowledge of the ontologies expands the possible solutions that could be offered by the software;
- opportunity to expand the knowledge base of the ontology through the use of the software;

The software will be tested on a system of FESTO workstations, property of the Technical University of Sofia, Faculty of Industrial Technologies, Department of Mechanical Engineering and Machine Tools.

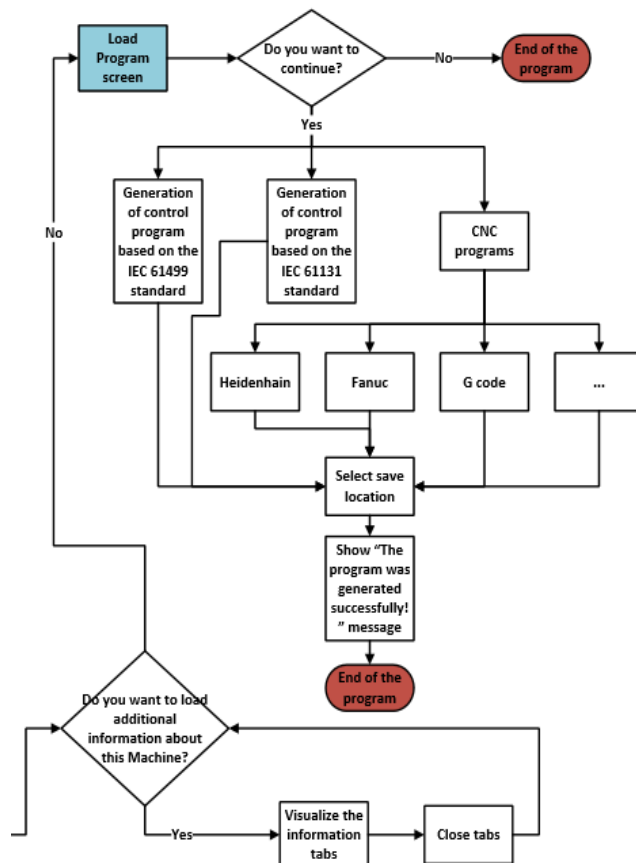


Fig. 6: Generation of control program algorithm

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