A Proposed Conveyor Sorter Model by Using Object-Oriented Petri Nets Approach

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ABSTRACT – This article presents a model of conveyor sorter system by using Object-oriented Petri Nets (OOPN) approach. OOPN is one of the popular modeling techniques to describe a real industrial system specially to model a Cyber Physical system (CPS). This approach also includes the application of Petri Nets method for formal modeling of a system. In this paper, we used conveyor sorter system as the real application and formalizes it using Petri Net software. This paper also discusses some theoretical aspect of the OOPN and how the graphical representation can be realized with the technique.

1. INTRODUCTION

New trends in product manufacturing and services, which is the introduction of Industry 4.0 brings manufacturers to focus on one objective which is to achieve the latest manufacturing process and services with high reliability for their product. With the approach of smart manufacturing concept, Industry 4.0 is the revolution towards Internet of Things (IoTs) and Cyber-Physical System applications. In such complex systems, there are plenty of aspects that should be put into considerations and precaution measures must be in place to avoid any problem occurrences to the systems. For example, in a single material handling system such as conveyor sorter, there are several aspects that need to be considered such as safety and reliability in order to ensure the smoothness of process operations while also avoiding faults and errors. Therefore, prior to actual running of the control programs on the system, the program correctness need to be verified and at the same time the system requirements and specification also need to be validated.

Researchers always use verification and validation (V&V) method to verify a system. Results of the verification need to be analyzed and satisfied the process requirements before apply the system on real application. Process of verification of system is involve with formalism method which is to formalize the programming before applying them on the verification technique. Formal method of formal model is a form of model of the system that represent in formal languages of a real system. In this paper, case study is using conveyor sorter system as a real system.

This paper presents Object-Oriented Petri Nets (OOPN) formalism and considers their application to object-oriented modelling. The objective of OOPN is to accomplish an integration of object-orientation into the Petri Net formalism as previous study [1]. Petri Nets are utilized for the formal specification of real system. They have a characteristic graphical representation, which helps user in the understanding of formal specification. Object-oriented technique, has turned out to be amazingly well known due to its provision of powerful structuring facilities, which stress encapsulation and promote advance programming reuse. This tends to a customary shortcoming of Petri Net formalisms, in particular the deficient help for compositionality [1].
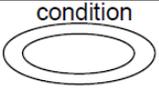
2. OBJECT-ORIENTED PETRI NETS

To covering the approach of object orientation and Petri Nets, Object-Oriented Petri Nets (OOPN) was introduced. This Petri Nets approaches, it gives user to describe properties of the system model in proper formal way and object oriented [2] can be as illustrations of the system's structure as stated in previous study [3].

Objective of OOPN is to achieve a complete integration of object-oriented with Petri Nets formalism tool. Koci [6] stated that the formalisms like OOPN can be straightforwardly interpreted and, consequently, incorporated into target applications. It suggests that there is no requirement for coding and it is conceivable to investigate and to truly create applications using models.

Structure of OOPN have introduced in [2] as next descriptions. Class, Object, encapsulation, inheritance. OOD defines the hierarchy of classes and object cooperation and then Petri Nets are used to represent those classes and object interaction [2]. Petri Nets model will allow us to verify the system before its implementation into its applications. In this model, existed model surely uses in design process. Table 1 shows the existed notations and its functions.

Table 1 Notations and its functions.

Notations	Function
condition	To show the encapsulation specification
(square)	To show the class specification
(circle in square)	To show the object specification
(square in square)	To show the inheritance specification

Class and object: Objects are software bundles of data and the procedures that act on that data. The procedures are also known as methods. The merger of data and methods provides a means of more accurately representing real-world objects in software. Without objects, modeling a real-world problem in software requires a significant logical leap [2].

3. MODEL DESIGN USING PETRI NET

The design process begins with analyzing the conveyor sorter system. From that, classes needed to come out. Every classes are representing the characteristic of activities happen, as depicted in following statements as previous study [5]:

- the object identification and their classification into two sections which is active subjects and passive objects.
- the identification of active subjects in roles.
- the classification of objects and subjects into classes [4]
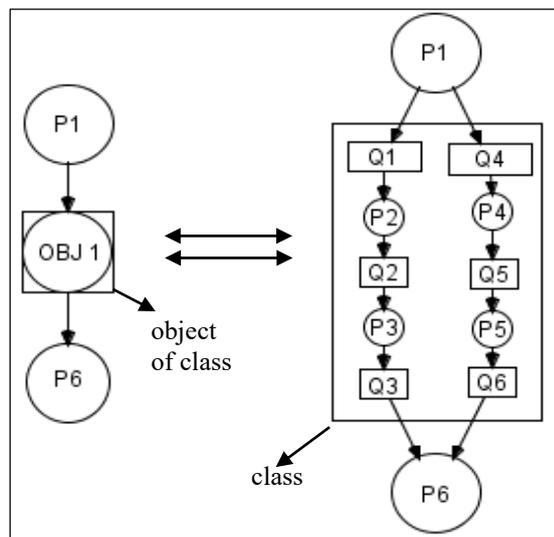- the classification of roles into classes.

Example:

Figure 1 Object-Oriented Structure

4. PRELIMINARY RESULT

For first result, by using Petri Nets software, model of conveyor sorter was developed as in Figure 1. To describe the Object-Oriented in this model, one of element will explain in Table 2.

Table 2 Conveyor Sorter State Condition

P1: (initial) S3=0, S2=0, S1=0, S9=0, C2=0, S8=0, C1=0	*Q1*: S2=1
P2: S8=1, C1=0	*Q2*: S8=1
P3: S8=0, C1=1	*Q3*: S8=0 / C1=1
P4: S9=1, C2=0	*Q4*: S1=1
P5: S9=0, C2=1	*Q5*: S9=1
P6: (end) S3=0, S2=0, S1=0, S9=0, C2=0, S8=0, C1=0	*Q6*: S9=0 / C2=1

5. CONCLUSIONS

This paper is introduced the model of conveyor sorter case study in Object-oriented Petri Nets (OOPN) formalism approach. OOPN development allows user to design systems at up level of abstraction in good improvement and performance.

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