

Development and Implement of a Model-Based Design Controller for PEPS System

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ABSTRACT

PEPS (Passive Entry and Passive Start) system is gradually becoming a main stream option in automotive keyless entry application, which improves the convenience and vehicle anti-theft performance. Based on the complex functions and safety technical requirements of the PEPS controller, and due to the development method of the model-based system design widely used in the automotive electronics industry, this paper presents a model-based on the development of PEPS controller method, which introduces the process of modeling and automatic code generation for the PEPS controller. Through Simulink/Stateflow of PEPS controller using logic system modeling, the PEPS controller complex system functions are divided into different function layers with each functional layer modeling respectively, and implement logic function design by the graphical language. Based on the model, it describes the process of model debugging and validation, the coverage analysis of the model, MIL (Model In the Loop) testing and SIL (Software In the Loop) testing. Based on the automatic code generation tool called TargetLink software supplied by dSPACE Company and called Simulink/Embedded Coder supplied by MathWorks Company, automatic generated production code of the PEPS controller is achieved. This paper also describes the comparison of the process of generating C-code by Embedded Coder and TargetLink. In the case of ensuring the quality of the code generation, the model-based design method also contributes a lot to improve work efficiency, shorten the development cycle, reduce development costs, and enhance the quality and security of product.

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INTRODUCTION

PEPS System is also called keyless start system, which allows the user to lock/unlock vehicle doors and trunk, or start the engine without the user operating the intelligent key directly. PEPS system applies radio frequency identification technology to querying the intelligent key the user carrying, so as to determine if the key has been authorized and the location of the key, in order to achieve automatic vehicle solutions, atresia and keyless start functions [1].

The application of PEPS system in the car has become a major highlight of automotive electronic and intelligent areas [2]. The traditional RKE (Remote Keyless Entry) system requires the driver to press the button on the key to achieve unlocking/locking vehicle doors functions, bringing the user a certain amount of inconvenience, while RKE system has some security risks, which may be the same frequency interference. Therefore, the PEPS system has been developed. At present, PEPS system is installed in more and more cars. The system is a relatively perfect car security entry solution, which makes body control and security, and anti-theft function of the engine being integrated together.

This paper describes the model-based design method for the development of a PEPS controller. As more and more automotive manufactures start to develop the electronic control units, they are all thinking about designing high quality and efficient automotive electronic products, but the code by written manually extends the

development cycle and increases the likelihood of error code. To meet these challenges, engineers have proposed a design method based on the model. Currently, this method has become an important practical application development mode [3].

The model-based design method can realize the automatic code generation [4]. This paper describes the method of code generation which is divided into two categories: First, after building the simulation model, some debugging and verification, use Simulink/Embedded Coder to generate the embedded code; second, use the TargetLink software to achieve automatic code generation.

This paper describes system modeling and an automatic code generation process with PEPS system functional requirements, and finally the comparison process of the generated code by them.

MODEL-BASED DESIGN PROCESS

The model-based design method has been widely used, which can be applied in most of the traditional process of development. The process and method will be described in detail in the following sub-sections.

Establishment of Requirements Documents

The PEPS controller is the core component of the system, which integrates corresponding sub-function modules, and controls the appropriate operating instructions through these modules.

Before the design of the PEPS controller, it is necessary to establish a number of electronic requirements documents, which is an important part of the development process. In the requirements documents, they describe the structure, principle and function of the PEPS system, providing the theoretical basis for the later development.

Modeling

According to requirements documents, about PEPS system design and implementation, this paper describes that the PEPS controller functions are divided into different sub-function modules with every sub-function specific, as shown in Figure 1. After the flow diagram expresses sub-function logic in detail, each sub-function module is modeled respectively with Simulink/Stateflow. And implement graphical language design in the model logic, resulting in completing most of the work design.

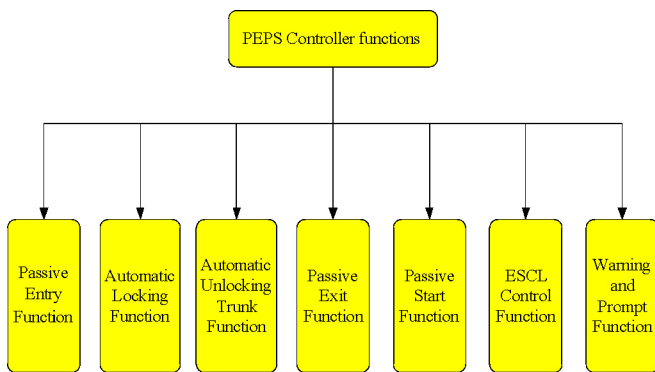


Figure 1. PEPS controller functions are decomposed into many sub-function modules, modeling respectively.

From the Figure 1, each sub-function module is classified detailedly according to the function. Taking AutoLock module as an example, it is also divided into AutoLock_Entry and AutoLock_Exit, as shown in Figure 2.

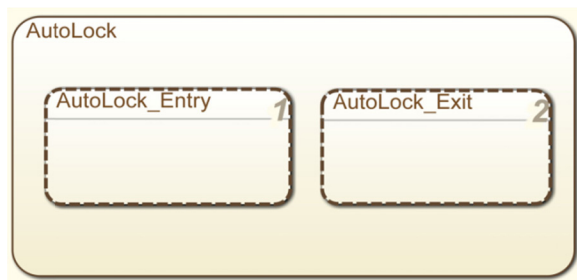


Figure 2. AutoLock module is divided into AutoLock_Entry and AutoLock_Exit by Stateflow.

In the paper, the sub-function module can be used to reflect the logical relationships between each state diagram, and Stateflow depicts the complex logic between objects through clear and concise logic diagram. Using software timers [5], the Page 2 of 6 following is the process of logic system modeling for the PEPS controller with Stateflow, and take AutoLock module as an example.

The following is a description of the AutoLock module function:

AutoLock_Entry

when the driver successfully unlocks the door, and does not open the door, if the intelligent key is valid, then the time is more than 30 seconds, the door is automatically locked; If the key is located outside of the valid range, if the time is more than 2 seconds, the door is automatically locked;

AutoLock_Exit

when the vehicle is stopped, the driver leaves the vehicle. If the intelligent key is valid, then the time is more than 30 seconds, the door is automatically locked; in these 30 seconds, the polling operation is performed. If the key is located outside of the valid range, the door is automatically locked.

The following diagrams are based on the above features, then design the flow chart and perform modeling.

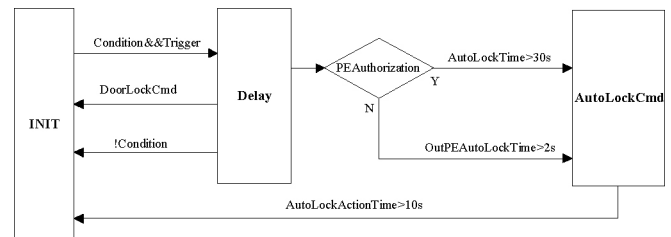


Figure 3. AutoLock_Entry flow chart

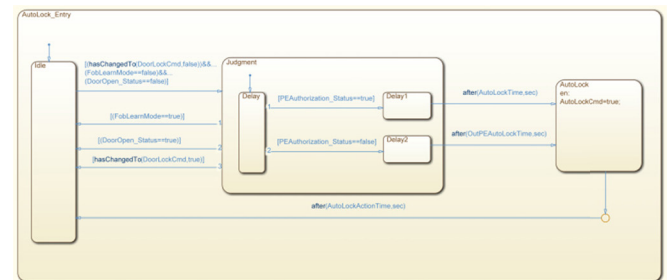


Figure 4. AutoLock_Entry state flow

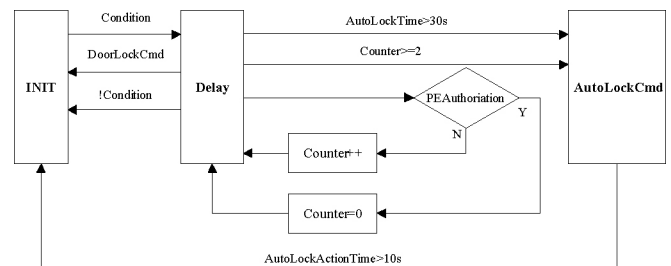


Figure 5. AutoLock_Exit flow chart

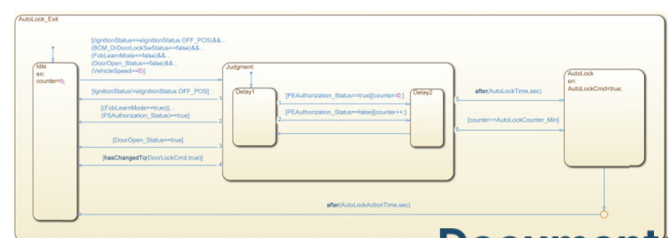


Figure 6. AutoLock_Exit state flow