

The Design and Implementation of Refueling Machine Simulator Control System Based on FPGA

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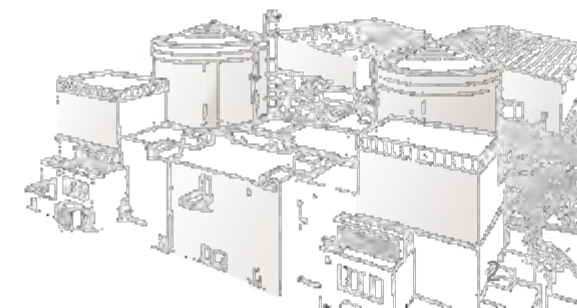
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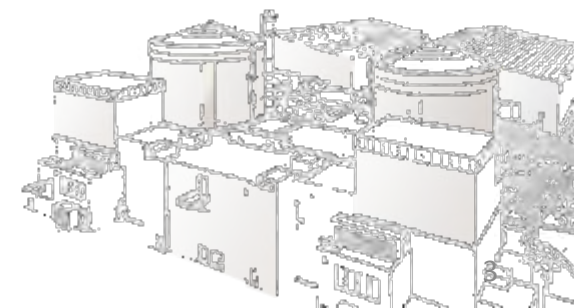
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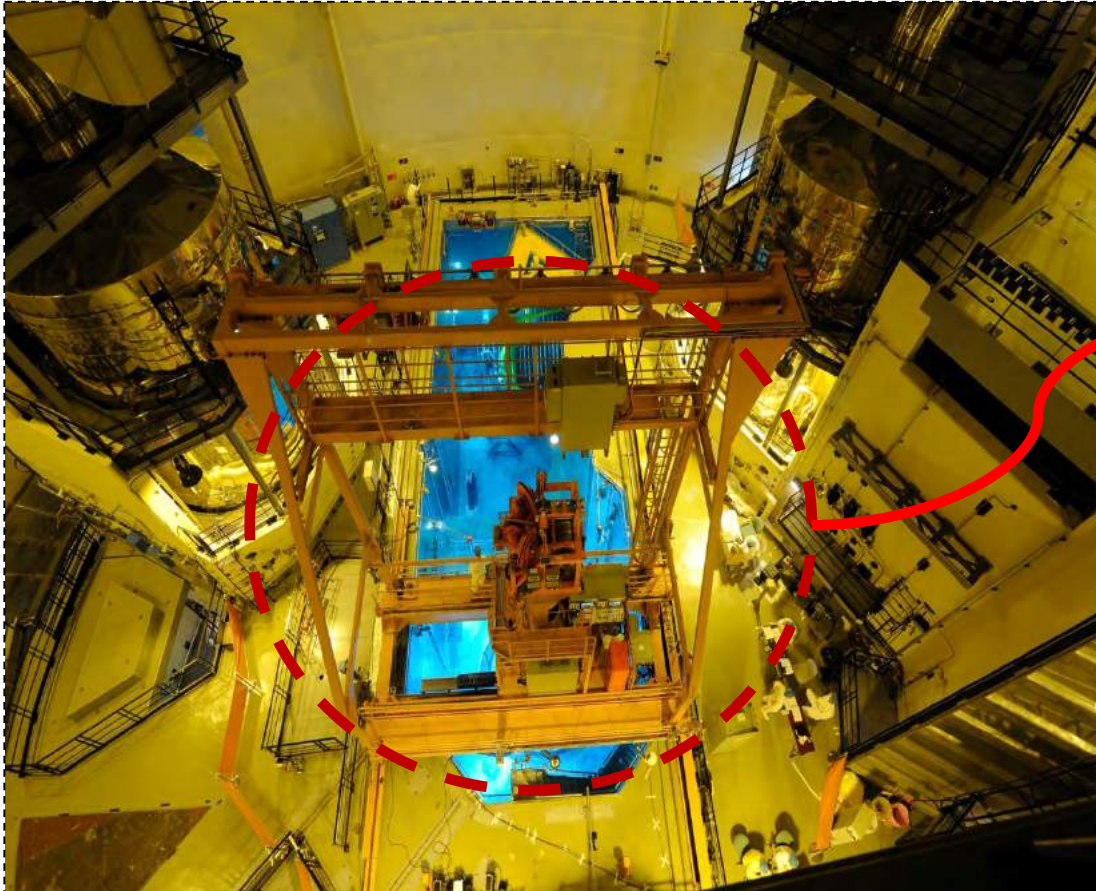
PART 01

Introduction



1

Introduction



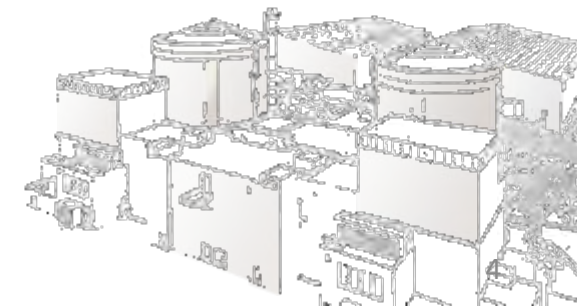
Refueling machine

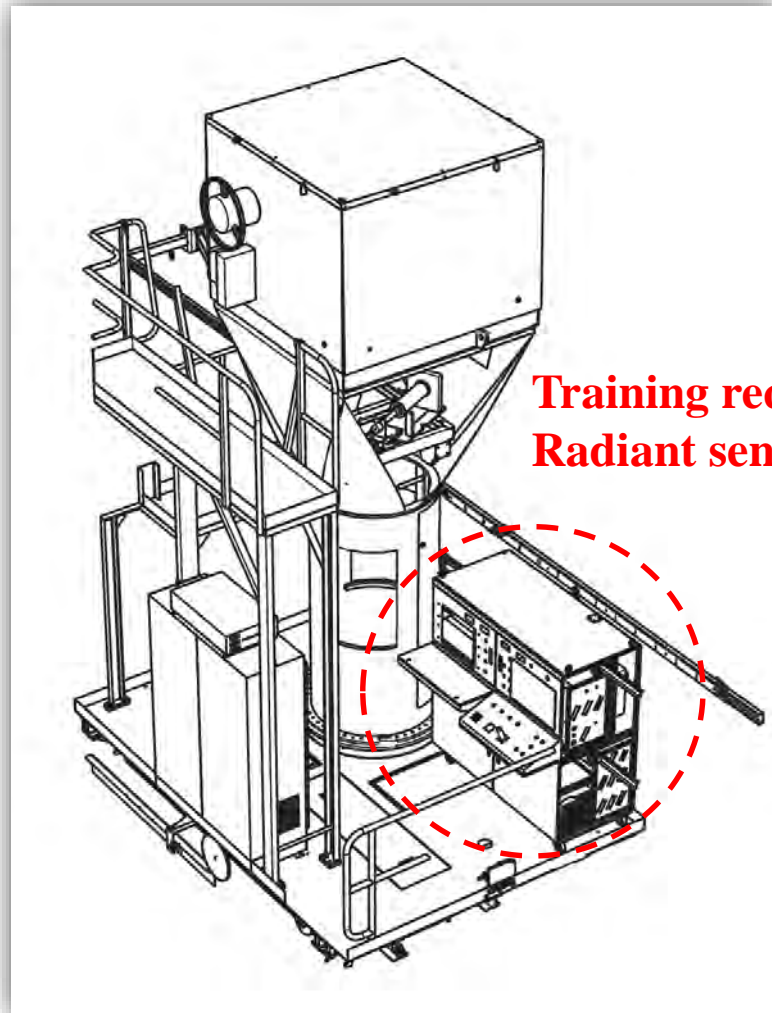
Transferring fuel assembly (FA) during reactor overhaul outage.

The **refueling cycle** of units has been extended to **18 months.**

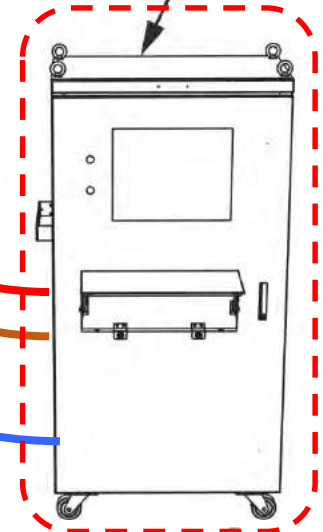


The optimal period for **training operators.**





Dismantle

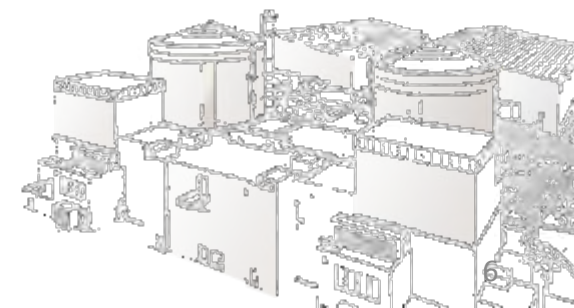
Control Console of
Refueling MachineRefueling Machine
Simulator

Virtual simulation technology
instead of physical instruments and electrical components



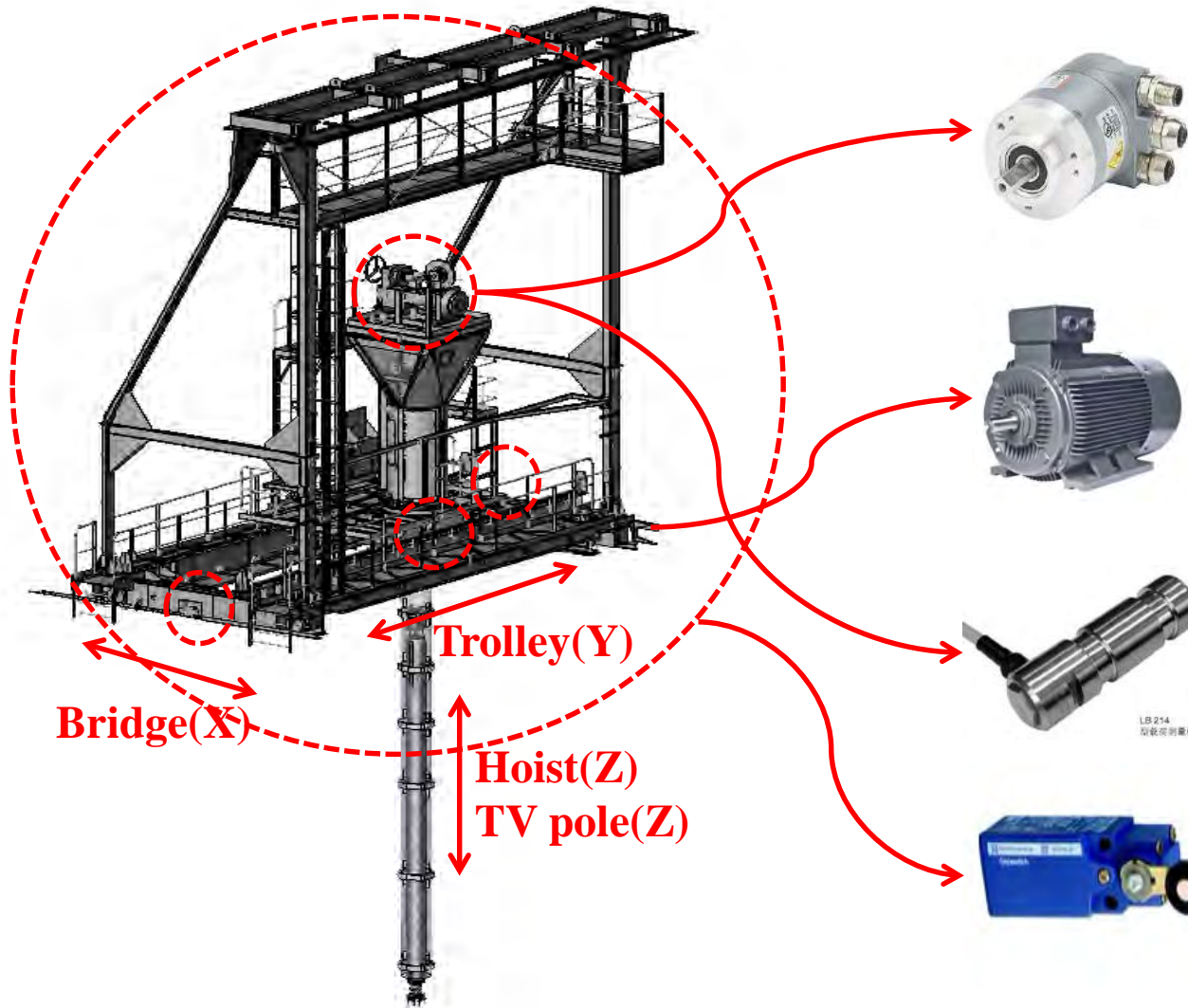
PART 02

Requirements Analysis



1

Requirements Analysis



7 encoders: Bridge(2), Trolley(2), Hoist(2) and TV pole(1).

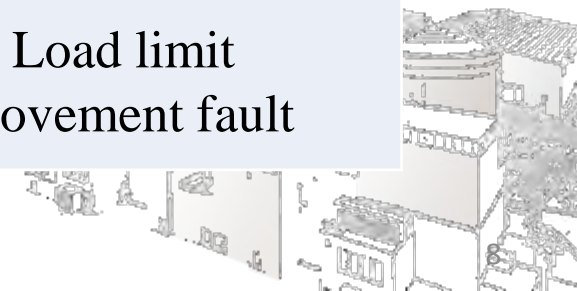
5 motors: Bridge(2), Trolley(1), Hoist(1) and TV pole(1).

4 load sensors: Hoist(2) and TV pole(2).

Switches: Limit switches & proximity switches.

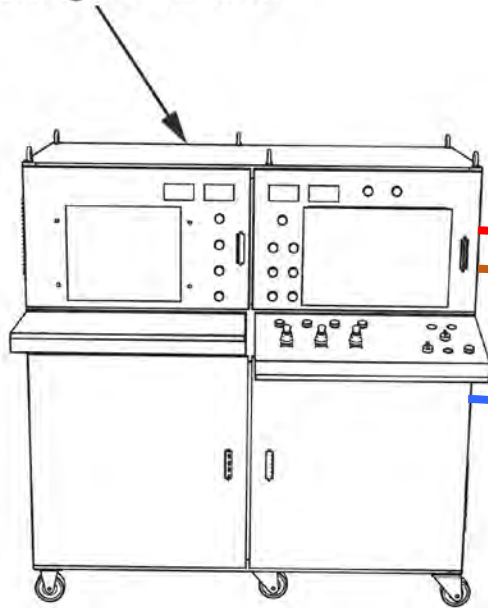
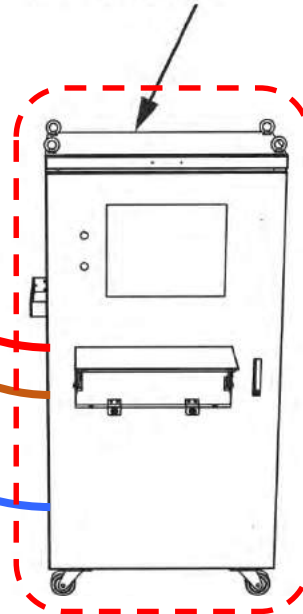
Control Principle of Refueling Machine

Operating mechanism	Control method	Position measurement	Motor driver	Interlock protection
Bridge(X)	Joystick Input coordinate	Mechanical ruler Dual encoders	Dual servo drivers	Synchronous operation Movement fault
Trolley(Y)	Joystick Input coordinate	Mechanical ruler Dual encoders	Single servo driver	Synchronous operation Movement fault
Hoist(Z)	Joystick Buttons	Dual encoders	Single servo driver	Gearing chain break Load limit Movement fault
TV pole(Z)	Buttons	Single encoder	AC motor	Load limit Movement fault



3

Requirements Analysis

Control Console of
Refueling MachineRefueling Machine
Simulator

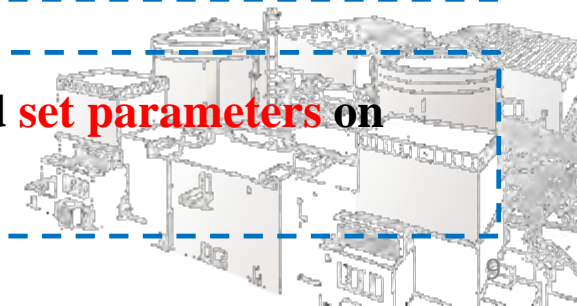
Provide **power supply** to control console.

Quickly interconnect with control console by prefabricated cables.

Complete the simulation of **absolute encoders, motors, load sensors and switches**.

Complete the simulation of **faults alarm and other operation steps**.

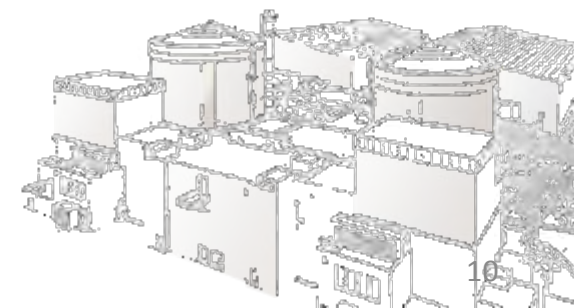
Display running states and set parameters on HMI.



PART 03

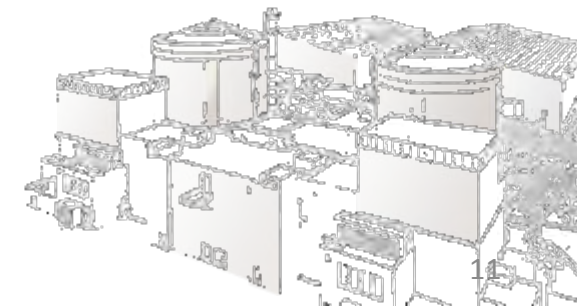
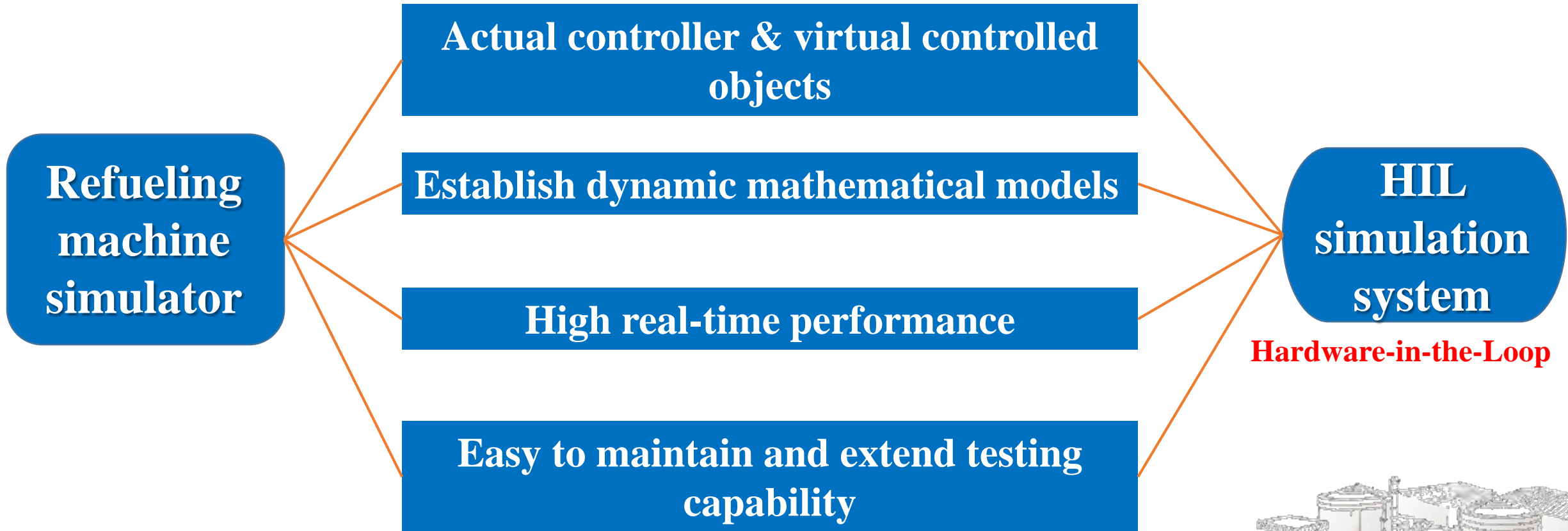
Hardware Design

Software Design



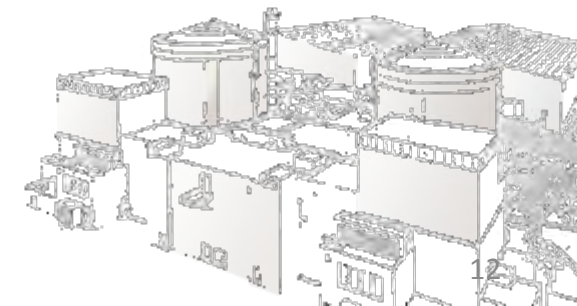
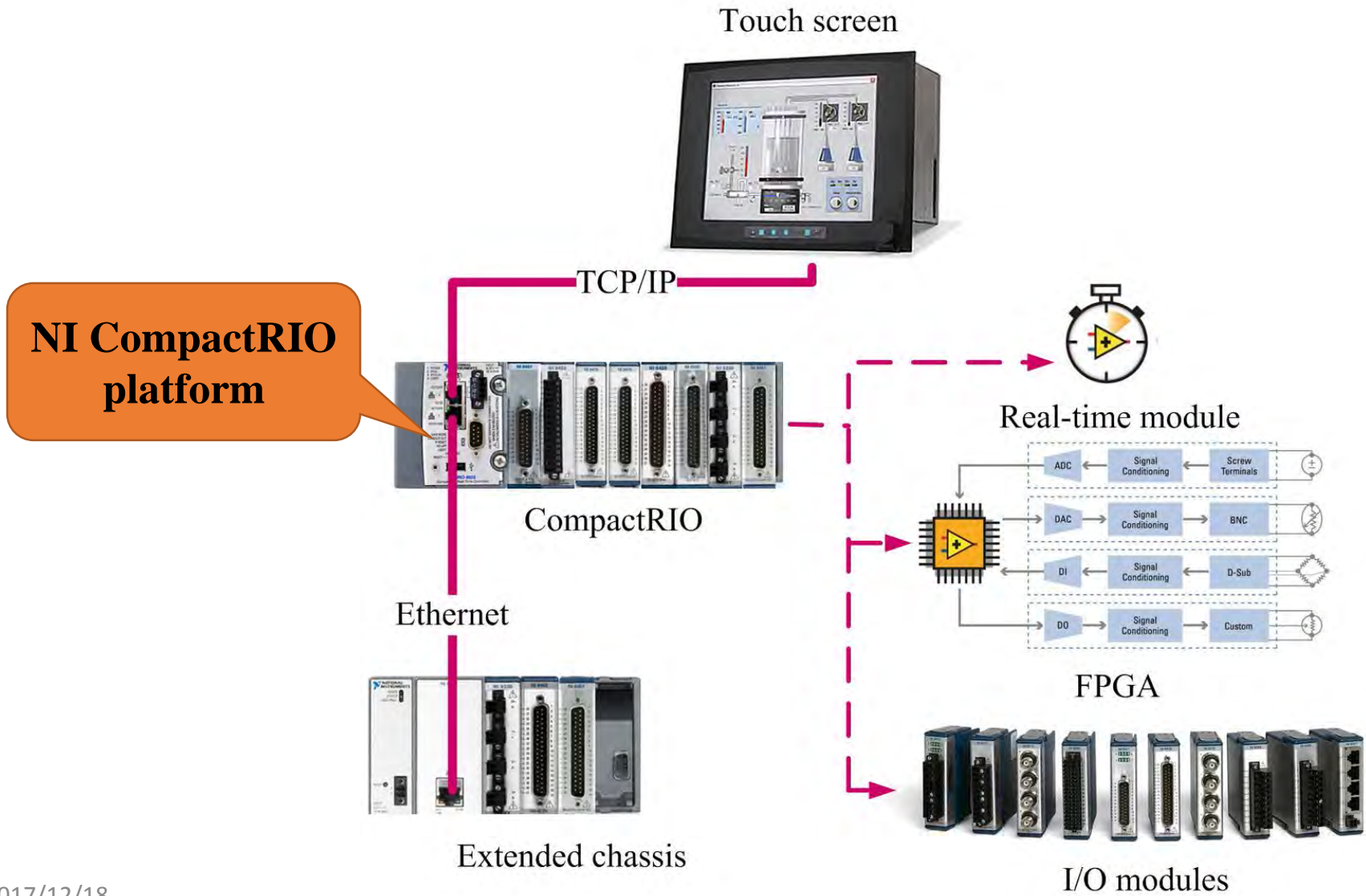
1

Hardware Design



2

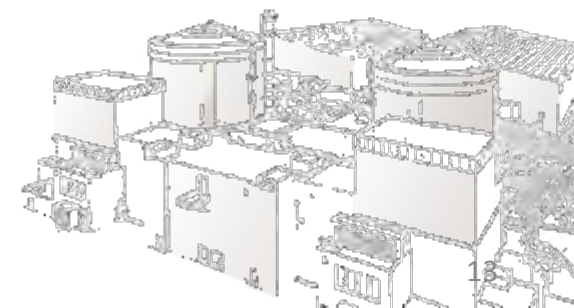
Hardware Design



PART 03

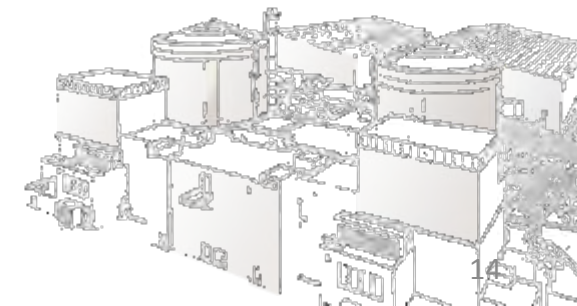
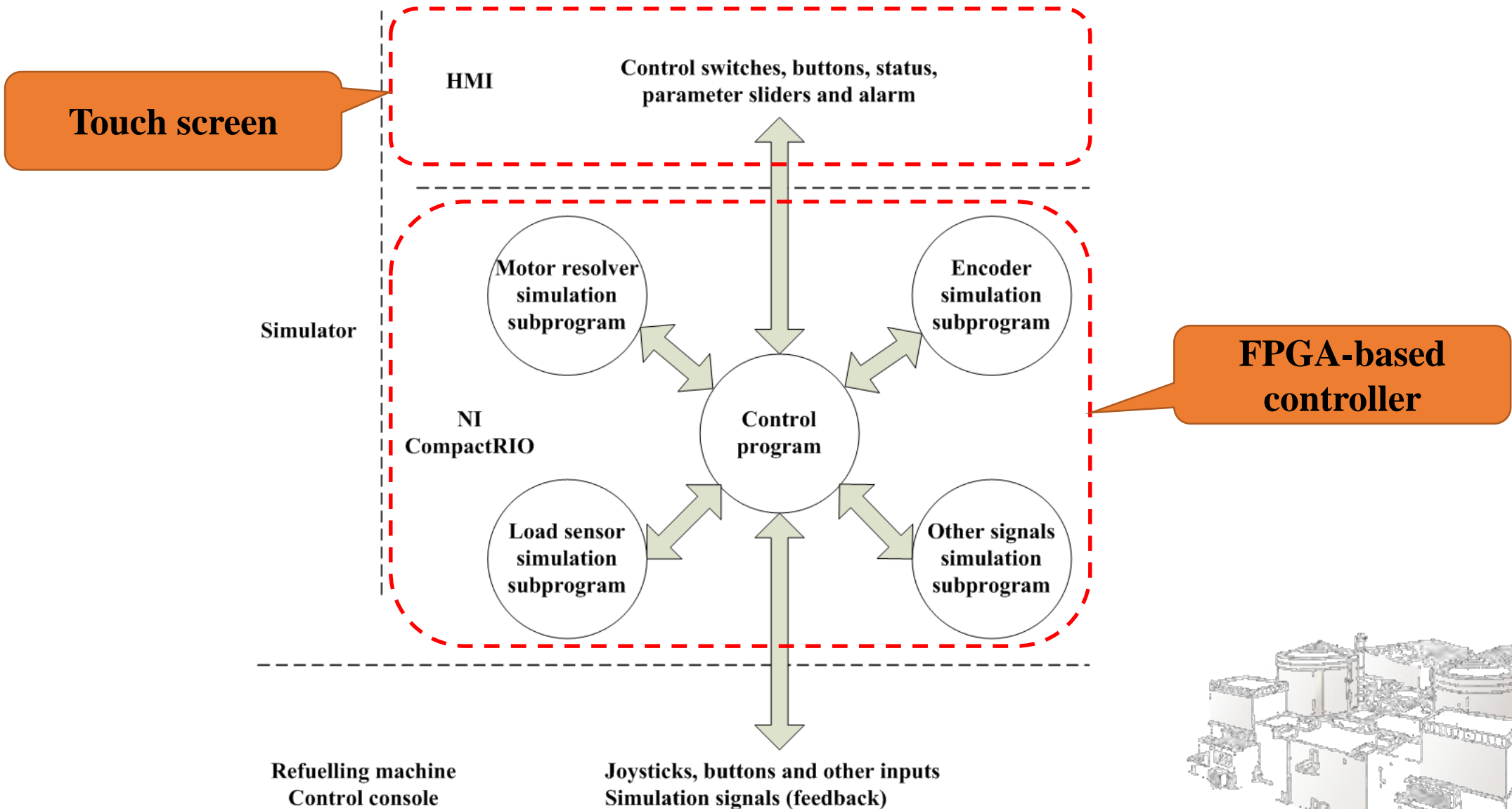
Hardware Design

Software Design



1

Software Design



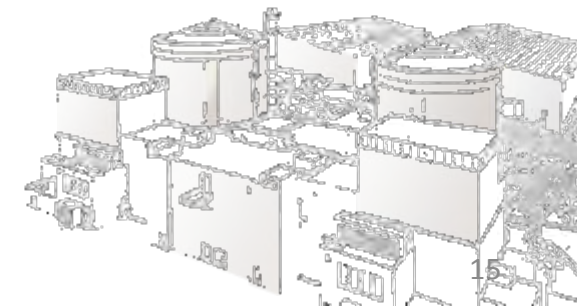
HMI configuration (based on LabVIEW software)

Information Area

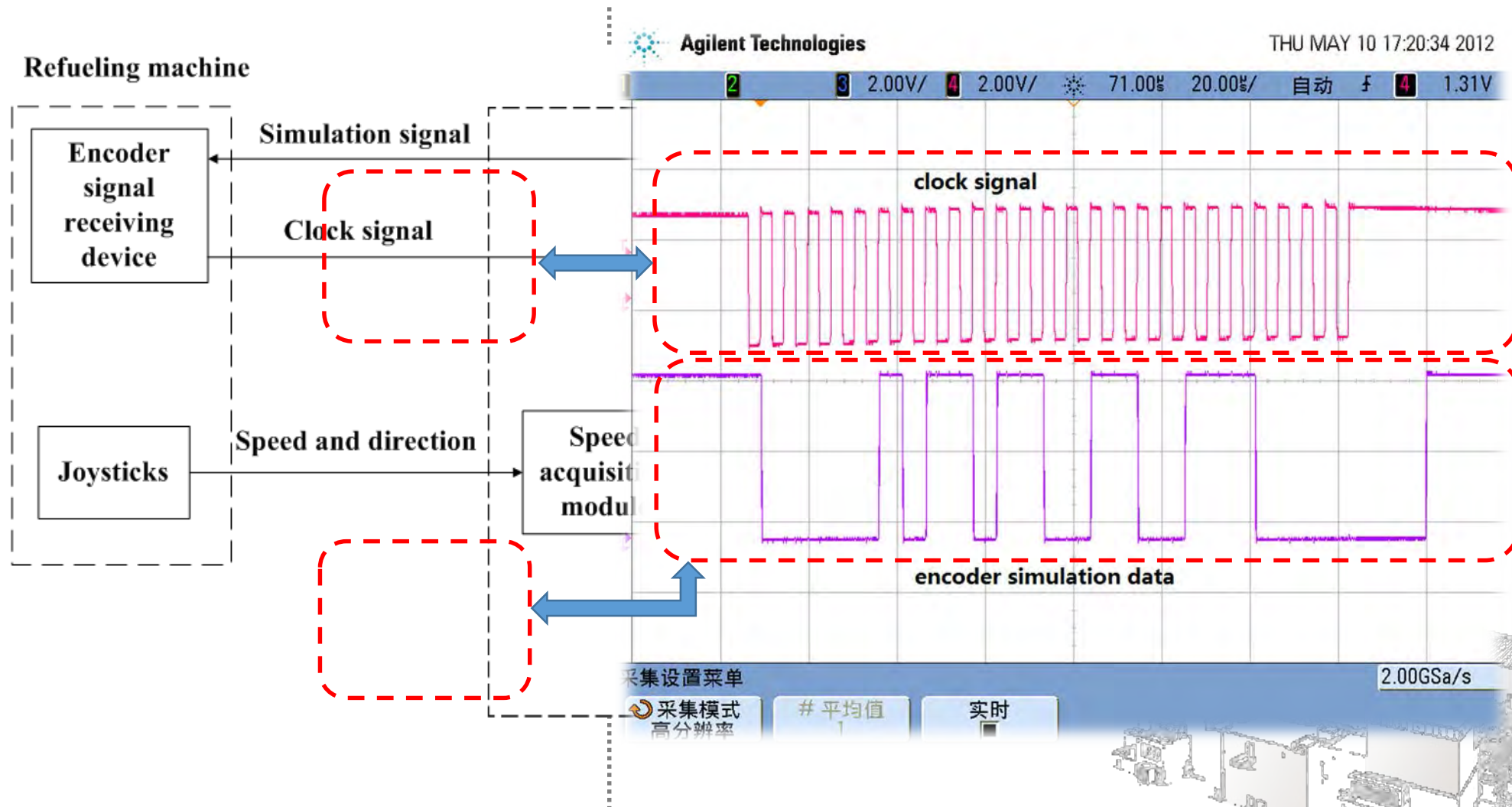


Control Area

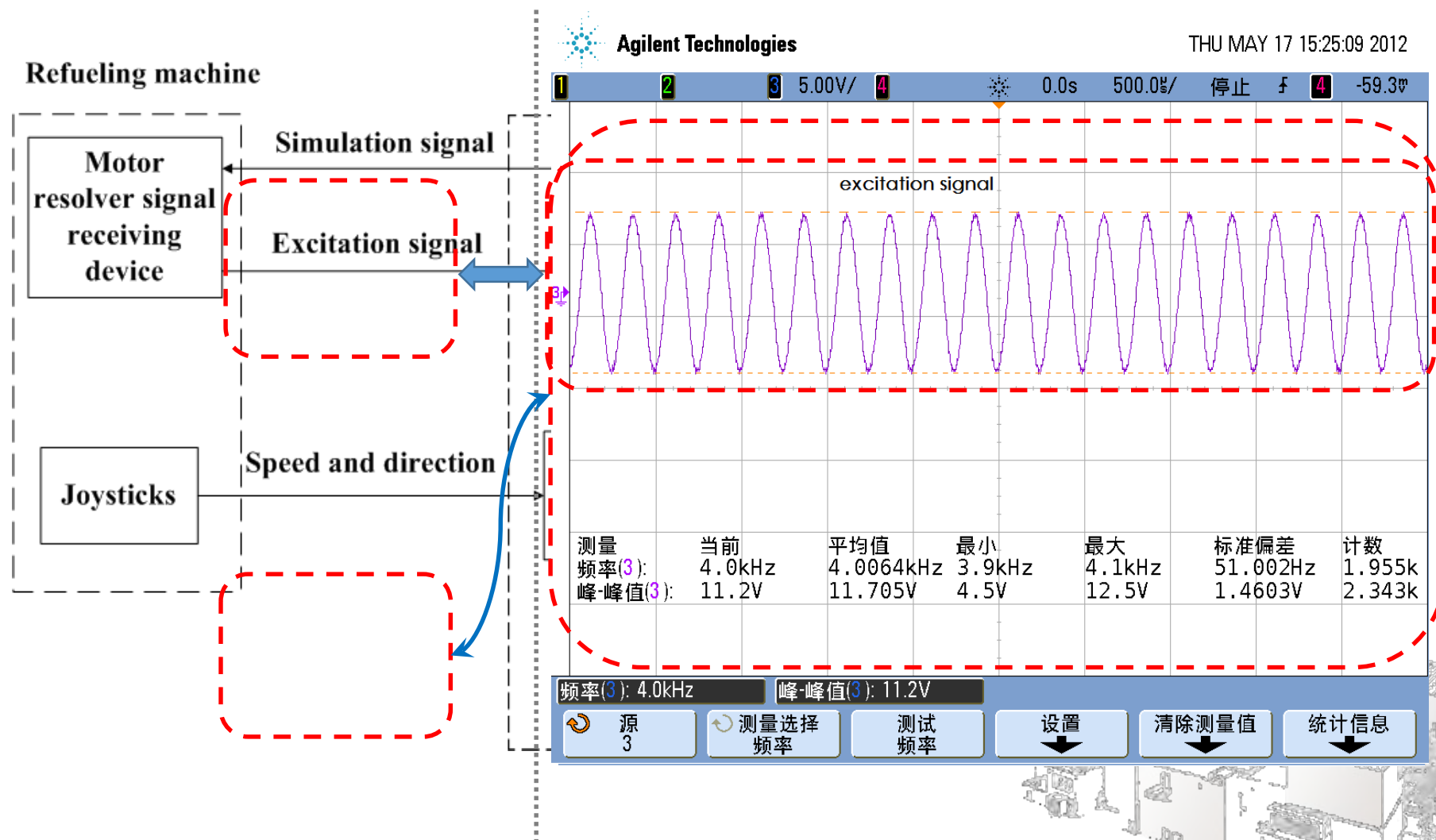
Display area of running states



Encoder simulation

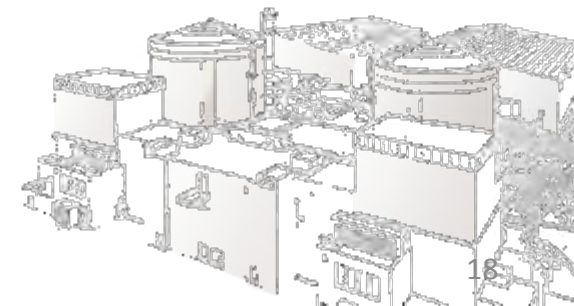


Motor resolver simulation



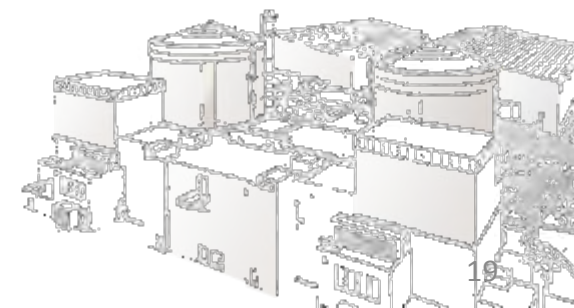
Simulation of other necessary signals

No.	Signal name	I/O type
1	Hoist load	AI
2	Upper limit switch of TV pole	DI
3	Upper limit switch of hoist	DI
4	Gripper latch/unlatch limit switch	DI
5	Brake open (emergency brake and safety brake)	DI
6	Brake wear (emergency brake and safety brake)	DI



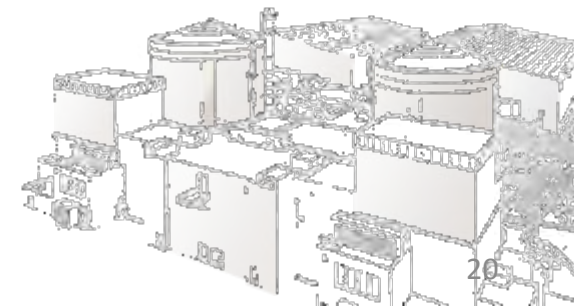
PART 04

Conclusions



Conclusions

- **Analyzes functional requirements of refueling machine simulator.**
- **Proposes a scheme that uses virtual simulation tech instead of physical instruments and electrical components.**
- **Makes full use of high speed performance and synchronization ability of NI CompactRIO platform based on FPGA, and successfully develops the simulator control system.**



THANKS

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