VIRTUAL METHODS IN PROGRAMMING AND SIMULATION OF PROGRAMMABLE LOGIC CONTROLLED MANUFACTURING SYSTEMS

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Problems of a sequential process chain for planning of PLC software

- Difficulties in communication due to organisational and spatial separation
- Different qualifications, ways of thinking and understanding
- Insufficient description of functions (large number of enquiries and misunderstanding)
- Time pressure due to numerous subsidiary tasks (e.g. offers, starting up and service)
- Insufficient inclusion of electrical construction into concept phase (insufficient real team work)
- Insufficient co-ordination of work in time and sequential working
- Uncontrolled storage and passing on of information
- Large number of changes and insufficient personnel to cope

Customer
Marketing
Mechanical construction
Controlling technology
Work preparation
Production and assembly
Initial operation
Documentation
After-Sales Service
Problems at Initial Operation

- About 15% of time electrics/ control engineering
- Up to about 90% of time electrics/ control engineering
- Of this, up to about 70% of time software errors

Typical errors:
- Defective or missing latches
- Incorrect procedures
- Wrong S/R of steps, defective skips
- Wrong S/R of markers/signals
- Multiple usage of variables
- Error in running time (exceeding the cycle time)
- Miscellaneous errors (typing errors, oversight)

Late evaluation of system design leads to great time losses
Virtual Reality as the Integrating Medium

3-Dimensional presentation of complex systems with the possibility of

- interaction with the model
- immersion
- cooperation
- communication

Simulation

Online Numeric Simulation

Interaction

Virtual Reality

Visualization

Walkthrough

Animation
Advantages of VR interface

- Increasingly complex tasks during process and product planning
- Spatial distribution of planning competence
- Cessation of 3D-2D abstraction for visualisation, navigation and interaction
- Insufficiently realized man/machine interfaces
- Direct application of heuristic problem solving behaviour
- Necessity of simulation before realization
- Experiencing model utilizing sensoric feedback
- Observation of critical procedures from the point of view of time
- Possibility of excluding real restrictions

See
Experience
Understand
Decide
Conventional programming versus VR interface and visual programming

Intuitive connection of inputs and outputs in VR

Textual PLC programming
Three applications of VR based simulation

1. PLC Codes can be generated and validated with the virtual model.

2. PLC CODE built in a common PLC Programming environment can be simulated ONLINE.

3. Existing PLC Codes can be simulated by connecting the real PLC and the virtual model.

VR-based simulation environment
Structure of the system

Facility Components Library

- Modelling in VR
- Modelling in CAD

Parameterisation of functions
- Logical connection S/A level

Sequential connecting procedures

Overall facility

Configure

Simulation?

- yes
- no

Simulation

AWL computer
- VR-PLC
- PLC-VR

OEC 1131 programs

Sequential connecting procedures

Control

Online coupling via OPC (DCOM)

Legend

- Docs
- Actions

Procedure script

Symbol file

FBS script

No. I/Os

Layout

Parameterisation of functions

Logical connection S/A level

Simulation?

- yes
- no

Simulation

AWL computer
- VR-PLC
- PLC-VR

Online coupling via OPC (DCOM)

Step identifier

Correction

Correction

Output

Input
Aggregation of a technical system in the VR system

Facility structure (geometry)

- Facility level: production system
- Procedural level: drilling station, milling station, sorting facility
- Functional level: Conveyor belt, drilling machine, milling machine
- Actor/sensor level: CB-forward, CB-stop, Terminal switch, light barrier
- Geometry/Module level: conveyor belt (components), profiles, Switching cabinet, work place
Creating and validate a virtual model and ist PLC Code in four steps

Step 1: Configuration of the facility layout

Step 2: Virtual Wiring
(only needed if the PLC CODE already exists)

Step 3: Dialogue supported programming of PLC functionalities

Step 4: Validate the PLC-Code via OnLine-Connection
Step 1: Configuration of the facility layout

1. Select Actors or Sensors

2. Select geometry

3. Arrange components
Step 2: Virtual Wiring

(only needed if the PLC CODE already exists)

Connect I/O with virtual components
Step 3: Dialogue supported programming of PLC functionalities

Selected Actor

Define the logic

Selected Function
Step 4: Validate the PLC-Code via OnLine-Connection

Control of the real model

SOFT-SPS

Comunication-processor

Industrial Fieldbus

Distributed I/O s

Previous way of testing the PLC Code

Test the PLC-Code via OnLine Conection SPS ↔ VR

OLE for Process Control

LoLi (LogicLink) (VC++ PRG)

VR Enviroment

This Program provides the connection between the PLC and the VR enviroment

Reality

Virtual Reality
Next Steps

- Further exchange of components geometry with CAD Systems
- Create an simulate a PLC-Code for a CNC (Sinumeric 840D)
- Evaluate the concept with a big production System of ROBERT BOSCH GmbH, Homburg, Saar
- Establishing a data structure according to DIN IEC 1131