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Direct Control Flow Testing on Function Block Diagrams
(Direct Function Block Diagram based Programmable Logic Controller Testing)

Junbeom Yoo
CS Dept.
KAIST, Korea
PLC-based Software Development

General I&C System (KINCS)

- FRS - Nat. Lang.
- SRS - Nat. Lang.
  - SCR
  - NuSCR
- SDS - Nat. Lang.
  - SCR
  - FBD
  - LD
  - etc.

Code-based Testing

- C
- Ada
- etc.

CASE Tool

PLC

*.exe
Proposed Testing Approach

Direct FBD Testing

- FRS - Nat. Lang.
- SRS - Nat. Lang.
  - SCR
  - NuSCR
- SDS
  - Nat. Lang.
  - FBD
  - LD
  - etc.

Assumption: Case Tools are fully proved.

Code-based Testing

- FBD

CASE Tool

Assumption: Case Tools are fully proved.

PLC

*.exe

CASE Tool
Direct Testing on FBD

Overview

FBD Unit

FBD → CFG Transformation

CFG (Control Flow Graph)

CFG based Testing Coverage Criteria
- All-Nodes, All-Edges, Paths
- Definition-Use
- FBD-unique ones
- Etc.

Test Cases
1. FBD → CFG Transformation

- **Procedure**
- **Formal Validation**
  (Proof of Soundness)
Transformation Procedure

- Use intermediate variables
- Preserve execution order of FBD
- Need proof of soundness
2. CFG based Testing Coverage Criteria

Can Apply **Existing Coverage Criteria** for CFG
- **Control Flow Testing Coverage**
  - All-Nodes
  - All-Edges
  - Paths
- **Data Flow Testing Coverage**
  - Definition-Use
  - All-Definitions
  - All-Uses

**FBD-Unique** Testing Coverage Criteria
- Something for Timer (TOF function block)
- Execution Order of FBD
- Etc.
Conclusions and Future Work

Direct FBD Testing without Intermediate Code Generation
- Assumption on CASE Tools
- Can Reduce PLC Software Testing Cost

Further Work
- Formal Proof of Transformation Procedure
- Data Flow Testing Coverage Criteria
- FBD-Unique Coverage Criteria