Development Process for Distributed Automation Systems based on Elementary Mechatronic Functions

Entwicklungsprozess für verteilte Automatisierungssysteme basierend auf mechatronischen Grundfunktionen

Proses Pengembangan Sistem Otomatisasi Terdistribusi Berbasis Fungsi-fungsi Mekatronis Dasar

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Seno Darmawan Panjaitan

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Abstract

In this dissertation, two requirements on Distributed Automation Systems (DASs) are investigated: (1) flexibility and re-configurability of the control strategy and (2) a comprehensible development process. Three basic approaches are proposed regarding the first requirement. First, an *Operation Modes (OMs)* guideline is proposed to define different control scenarios for distinctive operations. Second, the concept of *Functionality based Control (FBC)* is proposed to improve reusability of the functional software components (i.e. model and source code). Third, the *Scheduler-Selector-Synchronizer (S³)* architecture is proposed to combine OMs and FBC based on scheduling management. For the second requirement, a development process model for DAS is provided integrating the three proposed approaches in different development phases. An unambiguous mapping from user requirements into system requirements using relation theory is proposed. UML is used for high-level modeling and IEC 61499 is applied in low-level design and for the implementation in the automation plant.

Im Rahmen dieser Arbeit werden zwei Anforderungen an verteilte Automatisierungssysteme (DAS) betrachtet: (1) Flexibilität und Rekonfigurierbarkeit der Steuerung sowie (2) ein nachvollziehbarer Entwurfsprozess. Drei grundlegende Vorgehensweisen werden zum Thema Flexibilität und Rekonfigurierbarkeit vorgeschlagen. Zunächst wird eine Richtlinie zur Spezifikation von Betriebsarten (OM) eingeführt. Anschließend wird das Konzept der Funktionsbasierten Steuerung (FBC) eingeführt um die Wiederverwendbarkeit von Software-Komponenten (Modelle und Quelltext) zu vereinfachen. Zuletzt wird die Scheduler-Selektor-Synchronisator (S³) Architektur zur Vereinigung vorgeschlagen. S³ erlaubt die Integration der beiden ersten Konzepte auf Basis von Planungsalgorithmen (Scheduling). Der angegebene Entwurfsprozess für verteilte Automatisierungssysteme integriert die vorgeschlagenen Konzepte in verschiedenen Entwurfsphasen. Anhand der Relationen-Theorie werden die Nutzer-Anforderung eindeutig auf System-Anforderungen abgebildet. Für den Grobentwurf wird UML eingesetzt wohingegen für die Feinentwurf und die Implementierung auf der realen Anlage auf die Entwurfsmittel der IEC 61499 zurückgegriffen wird.

Dalam disertasi ini, dua isu terbuka pada sistem otomatisasi terdistribusi (Distributed Automation Systems, DAS) diinvestigasi yaitu (1) fleksibilitas dan rekonfigurabilitas dari strategy kendali dan (2) sebuah proses pengembangan yang mudah dipahami. Untuk isu yang pertama, tiga pendekatan dasar diajukan. Pertama, panduan untuk mendefinikan skenario kendali berbasis mode-mode operasi (OMs) diajukan. Kedua, konsep kendali berbasis fungsionalitas (FBC) diajukan untuk meningkatkan tingkat pengunaan kembali komponen perangkat lunak (model dan kode sumber). Ketiga, Skedulasi-Selektor-Sinkronisator (S³) diajukan untuk mengkombinasikan skenario berbasis OMs dan komponen berbasis FBC berdasarkan manajemen skedul. Selanjutnya, untuk isu kedua sebuah model proses pengembangan DAS disediakan untuk menuntun penggunaan beberapa pendekatan dasar yang diajukan. Pemetaan yang akurat dari kebutuhan pemakai ke kebutuhan sistem diajukan dengan mengadopsi teori relasi. UML digunakan untuk pemodelan level atas dan standar IEC 61499 untuk desain level bawah dan implementasinya pada sistem yang konkrit.

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