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Architecture of Embedded Human-Machine Interface for Intelligent Electronic Devices ⋆

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Abstract: Emerging IT technologies, specially high performance micro-controllers enable an intelligent electronic device (IED) for a power-delievery system. Since range of applications can be developed with these intelligent devices, Human-Manchine Interface (HMI) should be very flexible for these diverse applications. This paper introudces our approaches to develop an embedded Human-Machine Interface in our intelligent Electronics Devices.

1. INTRODUCTION

Electric power system including power delivery system grows rapidly and becomes increasingly complex noswadays. For this large and complex power systems, traditional SCADA systems that rely on their own private network are no longer efficient to control overall system. The improvement of computer and network technology enables the control systems to handle massive information in the distributed computing environments by utilizing high speed networks, such as field-buses, Ethernet, and wireless networks. With adopting these information technologies in WAN (Wide Area Network), the geometric range for a distributed control system becomes wider and wider, and in turn, a new software framework is required for this new environment(Lee and Park [2001]). IEC proposed an international stanard, IEC 61850(IEC [2003]), for electric power substation systems. It defines the communication between devices in the substation and the related system requirements. The ideas behind IEC 61850 are also applicable in areas of automation such as control and monitoring of distributed generation(Baigent et al. [2004]). To support IEC 61850 standard, an intelligent control device that can handle network protocol and local control functions is required. Modern high performance microcontrollers make it possible to develop a flexible Intelligent Electronic Device (IED) for electric power system, which are connected over high-speed Internet. IED's usually get data from sensors and power equipment, and control actuators including circuit breakers and/or other control devices.Since an IED needs user interaction like key input, diagram display, vector display, it should provide proper user interface to assist system administrators and users. This paper introduces our efforts to develop a flexible human-Machine interface (HMI) for the next generation of intelligent electronic devices that support IEC 61850 standard.

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2. ARCHITECTURE OF EMBEDDED HMI

3. IMPLEMENTATION AND TEST

To develop such a distributed control system, a middleware that provides various services such as ORB (Object Request Broker) or event services is required. Using a middleware reduces the development cost and provides the compatibility between the heterogeneous control systems [2]. There are some well-known commercial middlewares currently available: CORBA (Common Object Request Broker Architecture) from OMG (Object Management Group), EJB (Enterprise JavaBeans) from Sun Microsystems, and COM (Component Object Model) from Microsoft [8][9]. Even this kind of the ordinary commercial middleware provides various services to developers, it is still difficult to write domain - specific applications such as distributed control and monitoring applications because they are originally designed for the general distributed applications. With these basic middleware services only, it is really hard to maintain the compatibility between the control applications from different vendors. To achieve the openness within the control domain, there are a couple of consortiums in work. OPC (OLE for Process Control) is one of those consortiums to use COM-based middleware for the control domain [3].

Before describing the middleware proposed in this paper, the underlying technologies are introduced in this section. 1. Component-base architecture Although object-oriented methodology makes it possible to design and implement the huge and complex systems, it also has some problems such as code exposure, versioning difficulty, and deploying. Furthermore, its white-box model inherently lacks compatibility and reusability. To overcome these shortcomings of the object-oriented method, the componentbased methodology that uses the black-box model is widely used to isolate interface from implementation. The framework for the middleware also moves from the object-oriented to the component-based methodology [13]. To develop a distributed system in the past, the lower layer APIs such as socket or RPC have been widely used. But these proce-

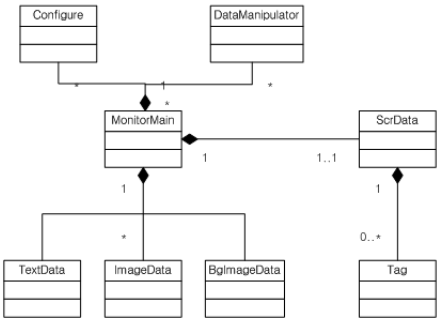

Fig. 1. Class diagram

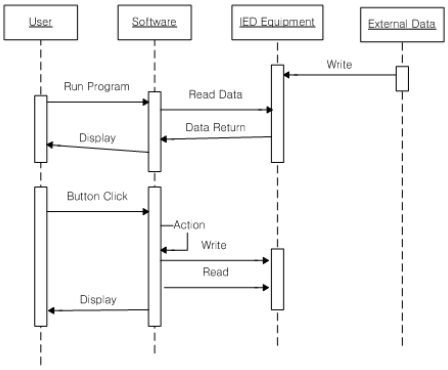

Fig. 2. UML diagram of operation

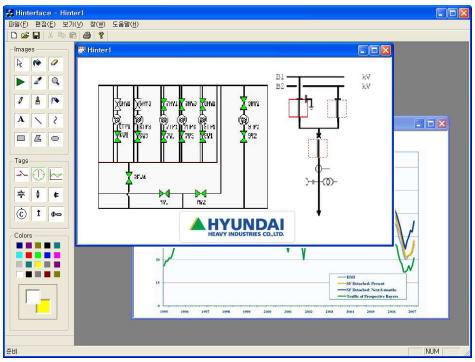

Fig. 3. Illustration of nodes movement

dural methods require more time and cost to develop and maintain than the object-oriented methods. Since most of the component models support RMI (Remote Method Invocation), the component itself can be distributed over the network environment. This means that developers can write distributed control applications more easily using a component-based middleware. Another trend in designing a modern middleware is to support T/P monitor feature, often called as CTM (Co mponent Transaction Manager) that provides load balancing, resource management, message queuing, and event service [12].

4. CONCLUSION

Emerging IT technologies, specially high performance micro-controllers enable an intelligent electronics device (IED) for a power-delievery system. Since range of applications can be developed with these intelligent devices,

Fig. 4. Illustration of nodes movement

Human-Manchine Interface (HMI) should be very flexible for these diverse applications. This paper introudces our approaches to develop an embedded Human-Machine Interface in our intelligent Electronics Devices.

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