Configuring of an Integrated Development Environment for Human Machine Interface

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Abstract—Now a day's automated product design is the prime demand of manufacturing industries. To provide Quality of service in design, Human Machine Interface is the finest option for automation. Human Machine Interface is the part of industrial automation which provides an interface between human and machine through wearable devices and computers. Human-machine interface is the sector in automation which has made the greatest progress in the last few years. This progress is due to increasingly sophisticated and user-friendly HMI applications. The quality of the operating interface design can be measured by the ease with which an operator can detect and understand an event and how efficiently he can respond. With the right choice of interface and its configuration, users can control processes with ever greater exactness and undertake diagnostics and preventive maintenance to increase productivity by reducing downtime. At lower level, basic sequences are coded in elementary software objects, termed as application screens or controlling and monitoring screens, providing their functionalities as Services. The proposed system will be compatible in any Windowsx86 environment. By using the proposed system, user can do alarm, report management, event logging, remote real time monitoring. The configuration software will be divided in three layers. The designers of operator panels and industrial PCs are making their user interfaces more friendly and intuitive by taking inspiration from consumer devices such mobile phones. HMI gives the ability to the operator, and the management to view the plant in real time.

Keywords— Quality of service, Human Machine Interface, wearable devices, computers, user friendly, Windowsx86, configuration software.

I. INTRODUCTION

The complexity of human–machine interaction (HMI) is rapidly growing in modern industrial, medical, and military systems. Human operators are often challenged by control of high-order systems or unstable systems near the limits of controllability. Human Machine Interface is the part of industrial automation which provides an interface between human and machine through wearable devices and computers. Provide a good interface between operator and machine. So there is a natural need for a mechanism through which the operator can configure and monitor the machine. A human machine interface (HMI) typically fulfills this need as in [1].

Mission of system is to meet the defined usability requirements for a specific HMI System. The configuration software will be divided in three layers. The first layer will be User Interface Layer. This layer will contain all User Interfaces required to enter HMI information e.g. user interface to create a new project, to enter alarm, data logger settings. The second layer will be business logic layer. This layer will contain business logic of the software i.e. all classes required to hold the information entered using the UI layer. The third layer will be data access layer. This layer will contain the classes used to retrieves and store data e.g. storing project configuration data in xml database format.

The Human Machine Interface is where people and technology meet. We all use HMIs to monitor and control a wide range of electronic systems, such as our home thermostats, building elevators, bank kiosks, gas pumps, manufacturing operator panels, and data access terminals. All of the new HMI product gives customers the flexibility to configure the various I/O requirements based on different applications. Human Machine Interface (HMI) Systems provide the controls by which a user operates a machine, system, or instrument. The following are the applications listed below:

- Machine monitoring and control
- Supervisory Control and Data Acquisition (SCADA)
- Control Center Monitoring, Tracking, and Control
- Building Automation and Security
- Electrical Substation Monitoring
- Pipeline Monitoring and Control
- Transportation Control Systems
- Batch Process Monitoring and Control[2]

HMI architecture forms part of the HMI range and is designed for use in applications requiring a high degree of client-specific adaptability, large and/or complex applications and projects that impose specific system requirements and functions. Object orientation facilitates efficiency in engineering and flexible system expansions. Scalable up to networked redundant high-end systems with more than10 million tags. HMI software is platform-independent and available for Windows and Linux.

II.   BACKGROUND AND APPLICATIONS

Human Machine Interface (HMI) equipment provides a control and visualization interface between a human and a process, machine, application or appliance. HMIs allow us to control, monitor, diagnose and manage our applications.

A.   *Automated Boiler Plant:* Erwin et al [3] proposed an HMI for an automated boiler plant in 2014. This system aims at providing high quality graphics for realistic representation of machinery and processes, alarms, trending, simulation, messaging, animation of equipment based on operator standards. The Fig-13 of [3] depicts the automatic operation of the automated boiler plant. The screens are available for operator control and monitoring devices as well as standard PCs.

B.   *Energy Automation for Airports:* This article [4] elaborates on energy automation system for airports. It ensures smooth operation at all times by providing an energy automation systems tailored to the individual subsystems. It highlights aspects like user friendly alarm signaling, a reduced volume of information and reliable operator dialogs at central human-machine interfaces contributing to stable and economical operation of the entire power supply system. The basic operational functions comprise operation and monitoring, logging, controlling, tracking, marking and alarm signaling. In addition alarms can be forwarded, for example using paging and/or Intranet/ Internet.

HMI provides you a broad range of operators and panels. HMI's main functionality is to monitor, supervise, and control processes. HMI can be used in many other applications viz marine applications, transportation, food processing, sawmills, oil and gas industries, pharmaceuticals etc.

In context with automated product manufacturing in industries, the configuration software will be developed with following outcomes like 1. Performance 2. Perfection 3. Flexibility 4. Reliability 5. Openness 6. Expandability.

III.   ARCHITECTURE DESIGN

Fig 1 shows the typical HMI architecture. It shows the relationship between several software components:
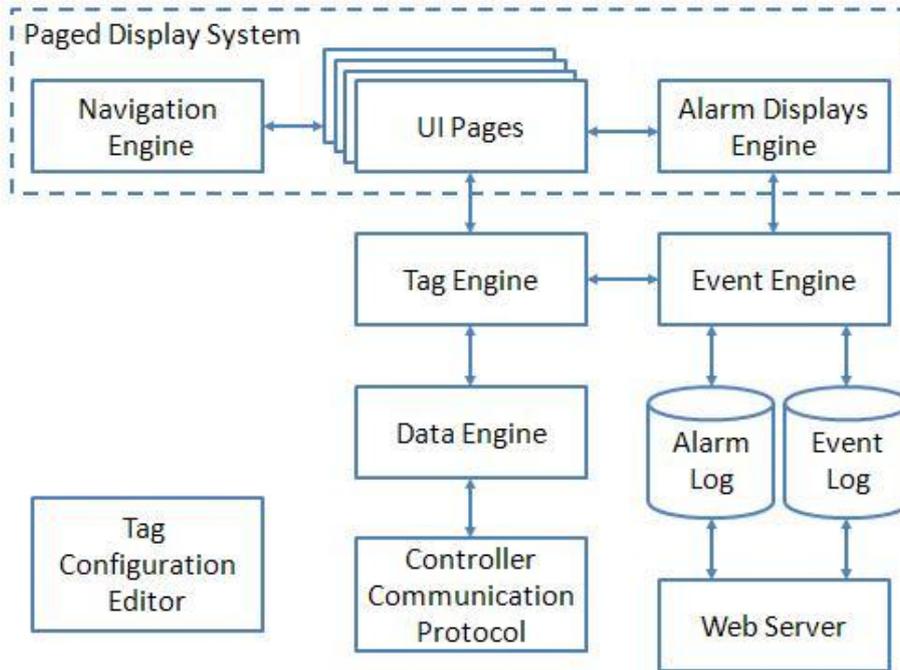

Fig. 1 System Architecture

A.   *Paged display System:* The typical machine control application involves hundreds of data variables or tags. Some of these tags are related to controller I/O and controller status, but the tag list also includes many internal tags for system state management, configuration, calibration, and so on. An HMI application organizes tag values and presents them to the operator by grouping related tags in a display page. In addition to the tag data, each page includes navigation buttons that 9allow the operator to view other pages. Behind the scenes, a Navigation Engine handles transitions between display pages [7].

B.   *Display object:* You can use standard indicators to display analog, string, and digital tag values. Alarm displays, however, have behaviours that require additional software support. Common alarm displays include an alarm summary and an alarm footer. The alarm summary typically is its own page, which an operator can view to see a complete list of alarms. An alarm footer is a one-line display that you can add to the bottom of any page to bring alarms to the operator's immediate attention. The Alarm Displays Engine provides the behaviour for alarm displays.

C. *Data entry objects:* HMI data entry can require more effort than a typical desktop computer, particularly when the HMI is targeted to a touch panel device where the mouse and keyboard are not available. Data entry objects must be oversized and custom keypads must be created for entering most data types (numeric, date, password, enumerated, and so on).

D. *Tag engine:* The Tag Engine is a mechanism for storing and retrieving current tag values. It is the hub that the other components use to exchange data are UI pages to read tag values for display purposes, operators use data entry objects to update tag values that are passed to the rest of the system

E. *Event Engine:* The Event Engine compares a subset of tag values to a set of predefined conditions (value equal to X, value in range or out of range, and so on) and logs an event when a tag value matches one of its event conditions. Some events are simply logged while other events require operator intervention and are configured as alarms. The alarm event data is sent to the Alarm Displays Engine, which manages how the alarm is presented to the operator. When the tag value goes out of the alarm state, the Event Engine sends an alarm canceling the event to the Alarm Displays Engine

F. *Web server:* An HMI may provide Internet access to the alarm and event logs, allowing remote users to read the log files using a Web browser. HMI server allows a Web based server to be added to any Modbus/TCP server (slave) or client (master). HMI sever comes into two versions- server and client. The client version acts as a client (master) and will connect to a single server (slave) field device. The server version acts as a server (slave) and will accept multiple connections from multiple client (master) field devices. There is no limit on the no of incoming connections which the server version will handle.

G. *Data Engine:* The HMI Data Engine exchanges tag values with the machine controller via a communication protocol supported by the controller.

H. *Tag configuration Editor:* The Tag Configuration Editor is a utility that developers use to create, configure, and maintain the application tag list. It exports a configuration file that the HMI can use to initialize the tag engine. It is distributed as an executable application and can be accessed from the tools menu. The tag configuration files created by the TCE describe the list of tags used in a HMI and controller of the machine control reference architecture and are used to initialize a number of other components in the application.

IV.   SOFTWARE DESIGN

A. Modules in the System

1)   Tags: This is the central database for the tags that need to be used in the application. Once the tags are defined and their attributes selected, the tags can be used in the application on screens, tasks, alarms etc. Select the type of tag from the Tag Type field. The Tag Name field is user definable. A tag is not added to the tag list unless a tag name is defined.

2)   Screens/Logic blocks: The basic function of displays in HMI applications is to provide an information source – operators interact to obtain information or to prompt for the next screen. The screen contains all the HMI pages for an application. The most common elements on a page front panel are navigation buttons, action buttons, numeric indicators, graphs, images, and Boolean controls and indicators.

3)   Alarm: An alarm display is often just a special type of HMI page that displays the latest active and historical alarms. Alarm limits can be defined for high, high, low, low, rate of change, and digital alarms [6].

4)   Data Logging: Data logging is the measuring and recording of physical or electrical parameters over a period of time. The Data Logger can be used to record the values of tags over time. The data can be viewed using the Historical Trend Object. It can also be uploaded to a computer for analysis.

5)   Communication: Once we have established how HMI will look, feel, and operate, you need to consider how the HMI will connect to and communicate with the core equipment or system under control. Typically, communication can be achieved through several approaches: hard wired connection, serial bus connection, or wireless connection.

6)   Language Configuration: Supporting many alphabets, including English, France which makes it easy to add text in several languages to the labels in each object and change between the languages in runtime.

B. Working of the System

The configuration software will be divided in three layers. The first layer will be User Interface Layer. This layer will contain all User Interfaces required to enter HMI information e.g. user interface to create a new project, to enter alarm, data logger settings. The second layer will be business logic layer. This layer will contain business logic of the software i.e. all classes required to hold the information entered using the UI layer. The third layer will be data access layer. This layer will contain the classes used to retrieves and store data e.g. storing project configuration data in xml database format.

The Fig 2 displays the flowchart for the proposed system. In the first level of configuration software i.e. User Interface admin will provide all information required to view and enter HMI information. In this layer, depending upon user requirements admin will create new project and will select new product. Depending on HMI information admin will decide how much should be the screen size, what will be the variables required. Admin will set variables for alarm configuration and network configuration. Alarm configuration will contain setting of start time, end time, and fix time of plant. Network configuration will contain USB, Ethernet and Serial port variables and respective data. These all information will go to XML database format. After finishing of all these steps admin will save project and closed the project. If he wants to download project then he can download project through USB or Ethernet or Serial port.
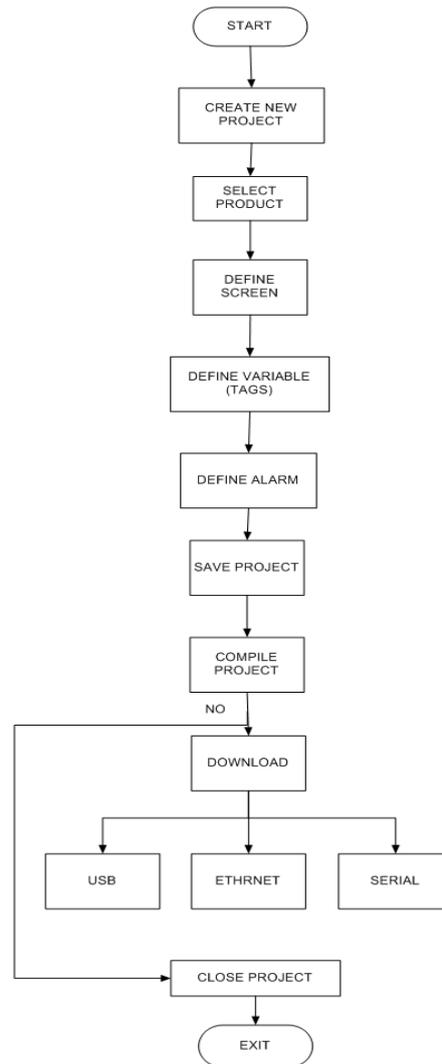
Fig. 2Working of the Proposed System

V. CONCLUSIONS

HMI solutions are in a state of change, with industrial user interfaces taking inspiration from consumer products. The use of advanced 3D-style graphics and icon-based navigation and controls is generating user-friendly and intuitive user interfaces. Trend-setting HMI solutions will support this mindset, with fully embedded state-of-the-art graphics providing well designed intuitive user interfaces, based on flexible widespread modern software technologies and true open platform architectures. Graphic user interfaces do not necessarily have to include the use of advanced graphic solutions. Simplicity and consistency often beats complexity and overly artistic solutions. However, the design process very often benefits from co-operation between graphic designers and application engineers. The designers of operator panels and industrial PCs are making their user interfaces more friendly and intuitive by taking inspiration from consumer devices such mobile phones. Digital technology offers the potential to enhance the human-machine interface and thus overall operator performance. Human factors and human-machine interfaces are well enough understood that they do not represent a major barrier to the use of digital I&C systems in any power plants [7]. There is a wide range in the type and magnitude of the digital upgrades that can be made to safety and safety-related systems. Displays are human-made artifacts should design to support the perception of relevant system variables and to facilitate further processing of that information. It is important for the magnitude of the human factors review and evaluation to be commensurate with the magnitude of the change. Any change, however, that affects what information the operator sees or the system's response to a control input must be empirically evaluated to ensure that the new design does not compromise human-system interaction effectiveness[8].

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