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DESIGNING OF HUMAN-MACHINE INTERFACES

Abstract: The history of human communication with the first computer begins with punch cards inherited from the 19th century. It is unlikely that someone could have imagined how the development of the computer industry would go, and that today everyone would use laser mice, Bluetooth-keyboards, virtual reality helmets and dream of achieving the «full presence effect» soon.

Nowadays, the level of automation of industrial enterprises is constantly increasing. The functioning of a modern automated control system depends on the coordinated work of its parts. High quality of interaction within the hardware and software complex has been provided by high-performance computing facilities that support open data exchange protocols and unified control and management signals. The proper level of communication between this complex and the operating personnel is achieved employing Human Machine Interface. The importance of Human Machine Interface is difficult to overestimate: in automated control system, regardless of the degree of automation, operators play a crucial role. The regular functioning of the entire automated technological complex and the adoption of important decisions depend on them.

In the modern world most enterprises are automated, which means that there is a constant interaction – «operator-equipment». In order for production to go without fail, it is important to «communicate» with the machine comfortably. Therefore, this paper studies the existing technical means of control and management, considers their possible modernization, as well as gives the answer to the question: «Is it possible to create a universal human-machine interface?».

Keywords: computer industry, automated control system (ACS), human-machine interface (HMI), hardware complex, software complex, control and management signals, technological complex, designing.

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ПРОЕКТИРОВАНИЕ ЧЕЛОВЕКО-МАШИННЫХ ИНТЕРФЕЙСОВ

Аннотация: История общения человека с первым компьютером начинается с перфокарт, унаследованных из 19-го века. Вряд ли тогда кто-то мог предположить, как пойдет развитие компьютерной индустрии, и что сегодня все будут пользоваться лазерными мышами, bluetooth-клавиатурами, шлемами виртуальной реальности и мечтать о скором достижении «эффекта полного присутствия».

В наше время уровень автоматизации промышленных предприятий постоянно возрастает. Функционирование современной автоматизированной системы управления (АСУ) зависит от согласованной работы ее частей. Высокое качество взаимодействия внутри программно-аппаратного комплекса обеспечивают высокопроизводительные вычислительные средства, поддерживающие открытые протоколы обмена данными, и унифицированные сигналы контроля и управления. А должный уровень связи между таким комплексом и оперативным персоналом достигается с помощью средств человеко-машинного интерфейса (Human Machine Interface, HMI). Степень важности HMI переоценить сложно: в АСУ, независимо от степени автоматизации, именно операторы играют ключевую роль. От них зависит штатное функционирование всего автоматизированного технологического комплекса и принятие важных решений. [1]

В современном мире большинство предприятий являются автоматизированными, а это значит, что происходит постоянное взаимодействие – «оператор-оборудование». Для того чтобы производство шло без сбоев, важно, чтобы человеку было комфортно «общаться» с машиной. Поэтому в этой статье мы займемся изучением существующих технических средств контроля и управления, рассмотрим их возможные модернизации, а также дадим

свой ответ на вопрос: «Возможно ли создать универсальный человеко-машинный интерфейс?»

Ключевые слова: компьютерная индустрия, автоматизированная система управления (АСУ), человеко-машинный интерфейс (ЧМИ), аппаратный комплекс, программный комплекс, технологический комплекс, сигналы контроля и управления, проектирование.

Human Machine Interface is a set of technical tools designed to provide direct interaction between the operator and the equipment, and it allows the operator to manage and control the operation of the equipment. And the success of the entire automated control system ultimately depends on how convenient, reliable, understandable and functional these tools are [2].

The problem of designing an HMI

The human-machine interface (HMI) used in commercial, industrial, and consumer systems evolves to incorporate modern technologies like touch screens, voice activation, and gesturing while simultaneously attempting to accommodate diverse functions and making the result intuitive and easy to use. Taken together, they are enormous challenges combining hardware, software, psychology, and sometimes cognitive neuroscience. Even consumer products that are at the forefront of user interface design have to achieve a fully satisfactory solution. Fortunately, the solutions for the shortcomings of current HMIs throughout the world are developed.

One of the greatest impediments to modern HMI design is the belief that HMI has to recreate familiar analog controls by digital means. This makes sense but imposes strict limitations on what can be achieved, as well as the tools that can be employed to realize it. Consequently, some designers have effectively started with a «clean sheet of paper» and many come from people targeting automotive telematics and infotainment systems that have some of the most complex HMIs [1].

The HMI in an automobile is defined as a mission-critical system. It accommodates not just a few different functions, but potentially dozens while making them easy to invoke without distracting the driver. The auto industry has attempted to achieve these goals using multiple techniques,

usually together, and the results until recently have mostly been unsatisfactory. It is also an example of nonoperational analog controls using advanced digital user interface techniques to replicate functions formally orchestrated.

It is unfair to be too harsh on this industry though because the users of its equipment are from technically proficient (who are probably already trying to figure out how to jailbreak their car's infotainment system) to downright antagonistic and fearful. Trying to serve such a diverse user community is a challenge for anyone. Consider also the number of completely independent systems that an automotive HMI must control, which include all entertainment functions, display of vehicle status (speed, distance, engine RPM, tire pressure, door ajar and many others), alerts for traction control, overheating, and other potentially serious events, heating and air-conditioning, and navigation [4].

Selecting components for HMI

Designers today face a truly astonishing range of choices in electromechanical components that encompass not only the type of device, electrical specifications, environmental sealing, and mounting and termination styles, but also ergonomic considerations such as configuration, size, illumination, and tactile feelings.

Electromechanical devices, including switches, keypads, keyboards, and other elements such as indicators and alarms, are critical aspects of the human-machine interface (HMI) for controlling equipment and systems. HMI component technology has been adapted over the years to serve the increasingly specialized needs of industrial, transportation, telecommunications, audio/visual, public access/security, and lifting/moving applications.

Today's advanced HMI components are precisely crafted devices, made to exact design specifications with very close tolerances using high-grade plastics, metals and meticulously calibrated springs. To achieve reliable, long service lives, they are engineered like fine watches with the performance, feeling, and look required in modern HMI systems.

Ergonomics play a key role in modern switch design, assuring the right switch for each application—whether it is a flush-mount design to avoid inadvertent actuation or an emergency-stop switch with a mushroom actuator for fast palm-slap shutdown and safe twist or key release. When designing an HMI system for demanding applications, design engineers must carefully select the appropriate HMI components to ensure the safety, longevity, and ergonomic appeal of their equipment [6].

HMI design

HMI design is not just about being creative; it has to take into account who will be seeing it on a regular basis and what it will be used for [3].

A proper interface between a machine and its human operator impacts efficiency greatly and is easy for the use and should promote a harmonized connection between them two. This tutorial provides guidance on how to build that connection best through a human-machine interface (HMI).

A highly reliable HMI system that delivers safe, cost-effective, consistent and intuitive performance relies on the application of engineering best practices throughout design, panel layout, production, testing, and quality assurance processes. Just as critical, in-depth knowledge of and compliance with all relevant ergonomic, safety, and industry standards must inform each step of the design and manufacturing cycle. Clear definitions of the functional requirements, the operator's level of expertise, and any communications/interactions with other systems provide the starting point in the knowledge-intensive design process.

Before the development, it important to decide how many functions are controlled by this interface; what kind of visual, auditory, or tactile feedback will best serve the operator in performing the defined functions; what is the planned complexity of the input; what environmental factors should be taken into account; how do distribute items on the control panel and so on [5].

When designing HMI, it is necessary to take into account that the user has been working with the system for a long time, so it is important to feel tension. The choice of the right color design is vital to do this. For the convenience of work with the transferred parameters on the screen, there has to be a scale with admissible values. It is better to set up several layers of the screen for quickly switch between functions [3].

The study of human-machine interfaces (HMI) is an actively developing field that combines the achievements of several sciences, such as ergonomics, cognitive psychology, psychology of work, computer science, theory of automatic control, usability engineering, technical aesthetics, industrial design, etc.

With the right choice of the interface and its configuration, users can control technological processes with greater accuracy and carry out diagnostics and preventive maintenance, seeking to increase equipment availability and productivity by reducing downtime.

Every HMI application is different and therefore the same the solutions will be to modernize them ultimately. In each case though, the best approach will be the one that not just performs every required function but does so in a way that is highly intuitive, fast, and most important, easy to use. While advanced technologies such as face and voice recognition, large touchscreens, and gesturing may represent many of the leading-edge technologies being applied to HMI, in some cases they simply may not be necessary.

On the one hand, it can be assumed that it is impossible to create one universal HMI used in all spheres of life because some systems simply do not need more than a reasonably large display, a few buttons, and perhaps a few knobs [4]. On the other hand, it may be resort to Light Touch technology. Recreate all sensors, switches, indicators in electronic form and project on any surface, organize a variety of downloadable programs and in each case run your own.

REFERENCES

1. Ивлев П. «Панель оператора как средство создания высокоэффективного HMI» // Control Engineering [Электронный ресурс], режим доступа: URL: https://controlengrussia.com/apparatnye-sredstva/otobrazhenie-informatsii/panel-operatora/ (дата обращения 02.12.2018).

2. Шугаев А. «Актуальные тенденции в развитии средств человеко-машинного интерфейса в производственной сфере» // Control Engineering, 2015 [Электронный ресурс], режим доступа: URL: https://controlengrussia.com/cheloveko-mashinny-j-interfejs-hmi/magelis-gtu/ (дата обращения 02.12.2018).

3. Cortivo D. «Human machine interface (HMI) design: It takes more than just pretty pictures» // Control Engineering, 2015 [Электронный ресурс], режим доступа: URL: https://www.controleng.com/articles/human-machine-interface-hmi-design-it-takes-more-than-just-pretty-pictures/ (15.11.2018).

4. Manz B. «In Search of the «Ideal» Human-Machine Interface» // Mouser Electronics [Электронный ресурс], режим доступа: URL: https://www.mouser.com/applications/industrial-human-machine-interface/ (15.11.2018).

5. Pannone J. «The future of the human-machine interface» // Control Engineering, 2015 [Электронный ресурс], режим доступа: URL: https://www.controleng.com/articles/how-to-best-design-an-hmi-system/ (15.11.2018).

6. Torzillo J. «How Proper Component Selection is Crucial to Enhancing the Human Machine Interface» // Appliance Design, 2017 [Электронный ресурс], режим доступа: URL: https://www.appliancedesign.com/articles/95437-how-proper-component-selection-is-crucial-to-enhancing-the-human-machine-interface (05.11.2018).