Automated System Of Monitoring Of The Physical Condition Of The Staff Of The Enterprise

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Automated System Of Monitoring Of The Physical Condition Of The Staff Of The Enterprise

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Abstract. In the work the author solves an important applied problem of increasing of safety of engineering procedures and production using technologies of monitoring of a condition of employees. The author offers a work algorithm, structural and basic electric schemes of system of collection of data of employee’s condition of the enterprise and some parameters of the surrounding environment. In the article the author offers an approach to increasing of efficiency of acceptance of management decisions at the enterprise at the expense of the prompt analysis of information about employee’s condition and productivity of his work and also about various parameters influencing these factors.

1. Introduction

In modern machine-building or tool production the working personnel are succeeded by expensive and high-precision machines, still they are managed by people. Only training of the specialist in work at one of models of machines costs at least 200 000 rubles. Increase in demand for specialists controlling dangerous and expensive equipment leads to the intention to secure the employee and to increase the quality of his working space and life. Poisoning with toxic evaporations and gases, reduction of attentiveness and increasing of mistakes, a nervous stress and aggressive behavior are characteristic signs of any large production enterprise which do not only have a negative effect on quality of engineering procedures, but also attract danger to life of employees. The current state of information technologies allows developing telemedicine technologies, and also to move to a formulation of the question about automation of collection of data on psychophysical conditions of a person and further about forecasting of medical conditions [1]. Further development of technologies of monitoring of a condition of a person and forecasting of psychophysical conditions will allow to realize adaptive intellectual management systems which work algorithms directly depend on the operator and his indicators of health at given time.

It is well-known that as signals of a functional condition of a person indicators of skin and galvanic reaction, speech activities, arterial pressure, a tone of vessels, etc. are used. Based on the data obtained by means of these signals it is possible to determine a current condition of a person. Having a sufficient set of reliable data on a condition of a person and surrounding environment, it is possible to diagnose and predict his medical conditions starting with emotional changes and finishing with diseases of specific organs. And the chief engineer and the workshop manager will obtain exact and prompt information on a condition of employees of the workshop and will be able to develop.
engineering procedures more effectively and to optimize work of the workshop in general that will allow to increase product quality and amounts of its release thanks to the correct working schedule and distribution of employees on suitable technological transactions; to change working conditions by release from unskilled, monotonous, hard and harmful labor, improvement of safety conditions, decrease in losses of working hours from an industrial traumatism and professional diseases; economy and release of labor power.

In this connection it seems reasonable to develop new methods of getting information signals of a condition of a person and algorithms of data collection, and also to create combined dynamic methods of collecting information. Getting information in real time from devices of data collection generates super big data sets [2,3], and their handling requires accomplishment of optimization of algorithms of quick search. All this confirms relevance of developments of multiple parameter devices of collection of data on condition of an operator and reflects possibilities of development of the project.

Work purpose: increasing of safety of production and labor productivity of personnel.

2. Results and Discussion
The object of monitoring is personnel and their workplace and the object of automation is the equipment of personnel. With the purposes of increasing of safety of engineering procedures and labor productivity of working personnel the following requirements were imposed to the system:

1. Collection of data on a biometric condition and location of a person (monitoring of the electrocardiogram and skin and galvanic reaction, determination of location on GPS).
2. Collection of data on a surrounding situation: temperature, moisture content, concentration of dangerous gases in the air (methane, carbon dioxide, compounds of nitrogen).
3. Data transmission from the portable device, located on the worker's body, to the safety operator by means of Bluetooth transceivers.
4. Handling of collected information, reduction of information to some general form.
5. Comparison of collected information with reference values of biometric parameters of a condition of a person and determination of deviations.
6. The alarm system on an automated workplace of the safety operator about extraordinary deviations of parameters with indication of an employee’s name, all obtained data at the given moment and his location for rendering the urgent help to him.
7. The analysis of the reasons of deviations of the compared parameters depending on a surrounding situation.
8. In the long term: Ensuring issue of negative results of monitoring for the emergency services and forecasting of medical conditions of the person.

Proceeding from the stated problem we carried out the choice of equipment necessary for creation of a prototype of the automated hardware and software system of monitoring of a condition of personnel, then the block diagram of a complex was constituted, it is represented in the figure 1.
As we can see from the figure, a power supply of +9 V is brought to the hardware computing platform Arduino, from Arduino a power supply of +5 V moves to the sensors (the light sensor, the sensor of concentration of hazardous gases, the sensor of pressure, temperature and altitude and the sensor of vibration), and via the built-in voltage regulator +3.3V moves to other sensors (the sensor of the skin and galvanic response, electrocardiogram, GPS module for determination of location), and also to the module of wireless data transfer Bluetooth HC-06 transmitting a signal to an automated workplace of the operator (personal computer) with the installed program where data on each user of the device are displayed. The data contain information about user’s parameters and a light signaling in case of an output of any parameter out of limits of an admissible norm.

Based on the block diagram the circuit diagram is constructed. It is given in figure 2.
For creation of a prototype of the system we chose the hardware computing platform ArduinoUno due to the simplicity of its connection to the selected sensors and programming. For convenient programming of the interface and data output from analog sensors the Processing language was selected [4]. It allows to obtain data from Arduino and to output necessary information in real time easily. The Processing language is based on Java, so the code created in it doesn't require compilation and is executed line by line. As a development environment we selected PDE (ProcessingDevelopmentEnvironment) which is similar to Arduino IDE. After final debugging of the program the page html-code with Java applet is created. It can be posted on the website and provides remote system management.

The algorithm of system operation is provided in figure 3. After execution of standard procedures of connection of libraries and initialization of variables the program realizes primary data collection from sensors. Further it is necessary to make calibration of the device. It is necessary as the user can have normal values of the skin and galvanic response and a heart rhythm different from standard. For calibration the device takes off data from sensors three times, at the same time the user shall confirm consent to calibration by means of the button to provide protection against false operation. So, for example, each person has his own physiological level of skin resistance. The individual normal range of the signal levels for a person is set and we can judge stressful influence according to a deviation from this range. Thus it becomes possible to reveal events which had stressful or psychotraumatic character for this person [5].
Figure 3 - Algorithm of work of the system
After accomplishment of calibration the cycle in which the obtained data are compared to limits of normal values is carried out. In case of detection of extreme indications the secondary measurement of indicators is performed to exclude a mistake, then the obtained data are compared to reference values again and if they go beyond admissible limits again, then the device displays the message on a request for sending the message on emergency situation.

In figure 4 we provide the picture of display of parameters of the employee in a window of the operator realized in IDE Processing [6]. To display the graph we will require the following part of a program code in a cycle with a precondition:

```java
for (int x=150; x < width-1; x++)
{
    check (x, 255,0,0);
    line ((width) - x, 6+ (height/6) *0) + ((height-1-getY (valuesA[x-150]))/6),
         (width) - 1-x, 6+ (height/6) *0) + ((height-1-getY (valuesA[x-149]))/6));
    check (x, 0,255,0);
    line ((width) - x, 4+ (height/6) *1) + ((height-1-getY (valuesB[x-150]))/6),
         (width) - 1-x, 4+ (height/6) *1) + ((height-1-getY (valuesB[x-149]))/6));
    check (x, 0,0,255);
    line ((width) - x, 2+ (height/6) *2) + ((height-1-getY (valuesC[x-150]))/6),
         (width) - 1-x, 2+ (height/6) *2) + ((height-1-getY (valuesC[x-149]))/6));
    check (x, 255,255,0);
    line ((width) - x, 0+ (height/6) *3) + ((height-1-getY (valuesD[x-150]))/6),
         (width) - 1-x, 0+ (height/6) *3) + ((height-1-getY (valuesD[x-149]))/6));
    check (x, 255,255,0);
    line ((width) - x, 2+ (height/6) *4) + ((height-1-getY (valuesE[x-150]))/6),
         (width) - 1-x, 2+ (height/6) *4) + ((height-1-getY (valuesE[x-149]))/6));
    check (x, 255,0,255);
    line ((width) - x, 4+ (height/6) *5) + ((height-1-getY (valuesF[x-150]))/6),
         (width) - 1-x, 4+ (height/6) *5) + ((height-1-getY (valuesF[x-149]))/6));
}
```

Having analyzed the data it is possible to draw the conclusions:
- the third from above graph displays a maximum permissible air pollution in 452 c.u. in case of the maximum harmless level of 454 c.u.
- the fourth graph SGR (skin and galvanic reaction) specifies that the employee experiences the feeling of hunger.

The indications of the sensors and the system are checked at the control stand for aero gas control shown in figure 5. It includes high-precision sensors with sensitive elements from the Honeywell [7] and Lamtec [8] companies with a permissible error no more than 2%.
3. Conclusion
As a result of the conducted applied researches the automated system of monitoring of a condition of working personnel is developed. It represents a portable individual block allowing to realize monitoring of movements of employees in a workshop, deviations in a psychophysiological condition of a person and deviations in parameters of aerogasdynamic control. The received prototype allowed to research a condition of working personnel on different industrial enterprises in various working conditions. For example, in case of excess of content of carbon dioxide [9] in the air to 9%
productivity decreases by 12%, and in case of feeling of hunger productivity of workers decreases by 18%. The developed system can become a part of large system of monitoring of safety of industrial enterprises, and also be used in municipal economy for monitoring of a condition of city resources and processes that will allow to improve quality of human life at the urbanized territory[10]. Similar systems do not only allow to reduce time of response to emergency, but also to optimize engineering procedures and an enterprise management system in general. All developments are conducted with the assistance of a grant of the Russian President and are regularly registered in Ruspatent that confirms their innovation and relevance.

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