Development of System for Monitoring and Forecasting of Employee Health on the Enterprise

Natalia Axak [0000-0001-8372-8432], Nataliia Serdiuk [0000-0002-0107-4365],

Matvii Ushakov [0000-0003-0230-1555] and Mykola Korablyov [0000-0002-8931-4350]

Kharkiv National University of Radio Electronics, Kharkiv, Ukraine
nataliia.axak@nure.ua[1], nataliya.serdyuk@nure.ua[2],
matvii.ushakov@nure.ua[3], mykola.korablyov@nure.ua[4]

Abstract. A system for the provision of remote production services to control the health of the employee has been developed. The system is implemented based on the proposed three-layer architecture for service-oriented systems, characterized by a combination of distributed methods and means of collecting, storing, processing heterogeneous data, which allows to use the results of remote monitoring in making decisions for timely response in case of emergency. One of the key components of the system is the application of the Hammerstein model, which allowed us to quantify the change in the health of the employee while performing the professional activity of the enterprise.

Keywords: service oriented system, remote monitoring and forecasting, employee health condition, Hammerstein model.

1 Introduction

A doctor's visit is the main component of ensuring a person's health, not only when he is sick, ill, but also for regular medical (dispensary or preventive) examinations. However, a visit to a doctor can be lengthy, costly, and sometimes unpleasant. Many diseases require regular visits to the doctor to monitor and observe health indicators, for example, blood pressure, heart rate, etc. Today, to go to a specific doctor, a person may have to travel a long distance, wait in line, etc., in the end, it can take most of the day, or even the whole day.

When visiting a doctor, people often complain about past conditions. However, the doctor can only check the current state of the patient and ask him a question to find out how the patient felt in the past. Patient records may be uninformative and unreliable. Patients may not remember things like instant heart rate, blood pressure, temperature, etc. Health problems may occur patients, as a result of lifestyle, or as a result of professional or paraprofessional (work-related) diseases. Hypertension, coronary heart disease, diseases of the musculoskeletal system are precisely diseases that are examples of work-related diseases. neuro-mental factors for their growth are harmful professional factors, physical or neuro-mental overload.

The development of special technologies for detecting and tracking human condition allows to carry out remote monitoring the state of enterprise workers in order to make a decision for timely response in case of deterioration on employee's condition, incident or emergency. The main focus is on the development and improvement models and methods for quantitative assessment and analysis condition of a particular employee in terms of their safety.

However, the issues related to the forecasting and prevention of accidents during the production processes at the enterprise remain practically unresolved. This situation arose from the fact that most existing models and methods can be considered as elements of a posteriori analysis of professional safety. A posteriori analysis is performed only after the events have occurred, caused by the influence of harmful factors of the production environment and have led to injury or deterioration of health. In this regard, it is relevant to develop new and improve existing models and methods that allow you to solve the problem of preventing accidents or eliminate the decline in productivity of enterprise processes due to the deterioration of employees. To solve this problem, proposed a system for remote monitoring and forecasting the state of the employee's health in the process of production activity (SRMF), which continuously monitors the state of human health in his daily work environment.

1.1 Scientific Literature Analysis and the Problem Statement

In the health care system, the information stored in the database has improved over the last ten years, leading to it being considered as big data. This industry has historically generated a wealth of data based on patient records and treatment [1]. This vast amount of data promises to support a wide range of medical and healthcare functions, including support for clinical solutions, sensor-based health and monitoring of food safety, disease surveillance, and health management and so on. [2, 3]. For example, for the diagnosis of cancer, petabytes of data from various sources are needed to determine the disease status and survival potential of the patient. Moreover, the use of information technology for major health care services today is reducing the cost of health care, improving its quality, relying on a proactive and personalized approach based on continuous monitoring [4].

However, in order to meet the above-mentioned health services, health information should be accessible to anyone participating in the healthcare system. In this regard, research [5] suggests that high-level data integration, interoperability, and sharing are important for different practitioners and healthcare providers to provide high-quality patient care. In addition, preventative work to ensure the health and occupational safety of workers, as well as the introduction of a systematic approach to work management, is the primary purpose of a preventive and personalized approach based on continuous monitoring of the standard requirements. [6].

Cloud computing is increasingly attracting the attention of healthcare organizations to overcome some barriers to eHealth [7, 8]. In 2014, cloud technologies in the context of healthcare meant that healthcare organizations would need fewer technicians

[9]. Recently, [10] identified factors that affect cloud computing adoption in Saudi health care organizations. In addition, an intelligent cloud data model for mobile multimedia applications was proposed [11]. The model mainly focuses on the intelligent central cloud broker for single, mixed and multiple images of food objects, offering a dynamic cloud distribution mechanism. In [12] the questions of application of some modern technologies for gathering and processing of knowledge about the behavior of workers in dynamically changing environments on the example of a construction company are considered. In [13] the problem of optimizing harvesting efficiency whilst minimizing the health risks to the operators is investigated, with the aim of demonstrating that it is possible to determine an optimum harvesting time which is a compromise between the harvesting efficiency and the operator safety. In [14] the approach to automatic data collection, processing and subsequent biomechanical analysis of workers' behavior is considered in order to prevent ergonomic risks in construction enterprises. It should be noted that these problems were solved using a minimum number of identify technologies and track the status of employees on the enterprise. In [15] the solution of the problem of recognition and analysis of workers' behavior with the use of methods of recognition of deep actions and Bayesian nonparametric hidden semi-Markov model is considered.

Thus, the development of new and improvement of existing mathematical models of changes analysis in the state of the employee is the most promising trend in development. Such models should quantify the condition and then predict dynamics of its change for each individual employee on the enterprise before starting their daily professional activities.

1.2 The Aim and the Tasks of the Study

The purpose of the work is to develop a system for monitoring human health in the process of its production activity on the basis of readings of biosensors, measuring instruments and video cameras, as well as predicting possible risk factors.

To achieve this goal, it is necessary to solve the following problems:

- develop a generalized model of the remote monitoring and forecasting process, its constituent components and their interaction;
- Hammerstein model for quantitative assessment of changes in health of an employee while performing professional activity on the industrial enterprise.

2 Generalized Model of System for Monitoring and Forecasting of Employee Health on the Enterprise

The actors of the proposed SRMF are employees for whom the task of quantitative control and analysis of the condition as an indicator of occupational safety and health is solved. The employee must be registered with a computerized healthcare facility for inclusion, have biosensors, gauges, and a video camera that reads the most important health indicators and connects to a mobile device that delivers the data via a cordless device to the main server. Based on these indicators are analyzed:

- skin,
- respiratory system,
- cardiovascular system,
- digestive system,
- urinary system,
- musculoskeletal system,
- endocrine system,
- nervous system and sense organs.

After registering at the Web-site of the enterprise employee receives a unique ID and its mobile set special application.

The three-tier architecture of the remote monitoring and health forecasting system [16] is shown on Fig. 1.

At the first (measuring) level of the system is placed the hardware (measuring instruments, CCTV cameras, cameras, etc.). Here, the readings of the devices are translated into a form suitable for further processing and sent via Bluetooth to a mobile device, which sends the received data to a Slave server of the second level, which is connected to the communication network and configured to:

- receive health information from your mobile device;
- register medical diagnostic information;
- pass the information to the third-level Master Cloud Server.

The following tasks are solved on the Master server:

- the data obtained determines the employee's health profile, which includes one or more projected health issues and health risks, in which each or more of the projected problems is defined as a potential health problem that the employee will face in the future, and in which the anticipated health problem includes the predicted physical injury;
- health information stored in the database which is updated to display the employee's health profile;
- body position (or individual body parts) of the employee is compared with the previous position to evaluate the harmful deviation from the determined body position based on the video;
- submit results into mobile device for display to employee health report containing at least one of the characteristics, health risks and a health profile indicating one or more of the foreseeable problems.

Model SRMF Ξ is expressed as the conversion of input values H into output values Y [17]:

$$\Xi \subset H \times Y, \tag{1}$$

where $H(i)=\{H_D(i)\}$, $(i=\overline{1,M})$ – matrix representation of input data: medical and diagnostic data of measuring instruments, an image whose element brightness values are indicated h_{kj} – $(h_{kj}=\overline{0,255},\quad k=\overline{1,m},\quad j=\overline{1,n},\quad)$, $Y=\{Y_D\}$, $(Y\subset\Upsilon)$ – a set of formalized properties.

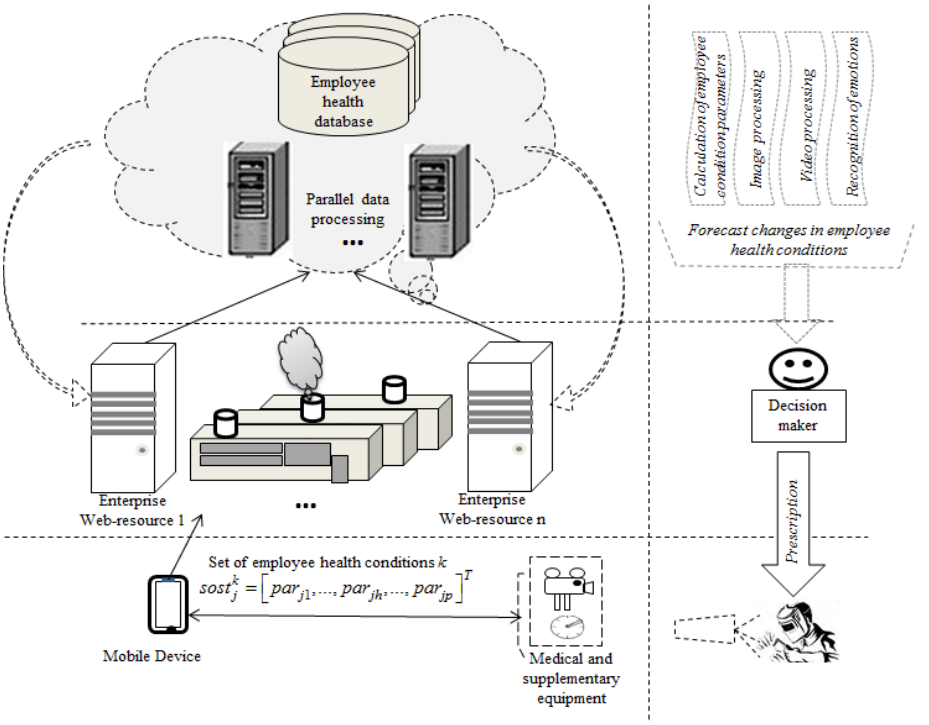


Fig. 1. Functioning scheme of remote monitoring and health forecasting system in horizontal and vertical planes

Thus, the space (universum) $\Sigma=\mathrm{X}\times\Upsilon$ includes $\Xi\subset(H\times Y)$, this means, that there is a subset *H*, $(H\subset\mathrm{X})$ and the relationships between them on which the model is built Ξ $(\Xi\subset\Sigma)$.

For output values Y_D made a plural of tasks, the solution of which belongs to the set $D_\Xi=\{D_{Hr}, D_{Hst}, D_{Hdn}, D_{Hem}\}$, where $D_{Hr}=\{Par_1, Par_2, \ldots, Par_n\}$ – task of processing medical-diagnostic data of measuring devices (Par_1 – the level of systolic blood pressure, Par_2 – the level of diastolic blood pressure, Par_3 – heart rate, Par_4 – reaction time to the light stimulus, ...); $D_{Hst}=\{M_1, M_2,\ldots, M_{st}\}$ – the task of processing images of objects in calm state (M_1 – highlight areas of interest, M_2 – binarization, M_3 – skeletonization, …); $D_{Hdn}=\{D_1,D_2,\ldots,D_{dn}\}$ – task of image processing of objects in the state of motion (rectilinear, rotary, translational, equilateral and other kinds); D_{Hem}

={F_1, F_2,…, F_{em}} – the task of recognizing emotions (F_1 – amazement, F_2 – fear, F_3 – happiness, …).

Reflection $T: H_D \to Y_D$ allows for everyone $H_D(i)$ find such $Y_j \in Y_D$ ($j = \overline{1,Q}$, Q – number of classes), which is the solution to the problem D_H.

Value $Y_j \in Y_D$ used to formulate decisions about a person's health with the help of a neural network classifier and to develop further behavioral tactics.

The status of k employee is defined as $\mathrm{sost}^k{}_j \in \mathrm{SOST}$, $j = \overline{1,n}$.

Any state of a *SOST* set is determined by a set of *k*-worker organism functioning parameters

$$sost^k{}_j = \left[par_{j1},..., par_{jh},..., par_{jp} \right]^T , \tag{2}$$

where par_j – value, *j*-body parameter of the *k* employee, *j*= 1,…*h,…,p*.

In order to describe the change in the state of an employee under the influence of environmental factors, it is necessary to take into account the initial state of the employee and the complex of those factors directly affecting the employee $ф^1$, ..., $ф^m$, $i = \overline{1,m}$, $ф^i$ – *i*-th factor that affect on the body

$$sost^k{}_j \in SOST = \vec{w}(t_0) + \Delta\vec{w}(t) , \tag{3}$$

where $\vec{w}(t_0)$ - the state of the employee's body at the initial time; $\Delta\vec{w}(t)$ - a change in the state of the employee’s body under the influence of a complex of factors over time *t*, $t \in \left[0,...,t_j,...,T \right]$.

To determine the change in the state of the employee’s body under the influence of a complex of factors, we use the Hammerstein model [18] for a system (organism) with *n* internal parameters – system state vector and $\vec{ф}(t)$ – *m* time-dependent external influences:

$$\Delta\vec{w}(t) = \Gamma\ (\vec{ф}(t), t_1, t_2) = \int_0^{t_2 - t_1} \vec{w}(\tau) \cdot \vec{f}(\vec{ф}(t_2 - \tau))\, d\tau, \tag{4}$$

where $\vec{f}(\vec{ф}(t_2 - \tau))$ - vector function of converting the input factors of the human’s body into a description reaction’s of a particular organism.

This expression can be considered as a model of a change in the state of an employee under the combined influence of a complex of production factors. Based on the assumption that at the initial moment of the work process, the internal state of the employee remains unchanged, model (4) will be [19]:

$$\Delta\vec{w}(t) = \Gamma\ (\vec{ф}(t), 0, T) = \vec{w}(\tau_0) \cdot \int_0^T \sum_{i=1}^{m} \left[\int_0^{\infty} \omega(\tau) ф^{ik}(t - \tau) d\tau \right] , \tag{5}$$

where $\vec{w}(\tau_0)$ – vector function that determines the internal state of the human body at the initial time τ_0, moreover, any state is determined by a set of parameters by the expression (2); $\omega(\tau)$ – an impulse transition matrix-function of size $m \times n$, which reflects the specific and unchanging relationship between factors and a set of parameters characterizing a person's state at a time τ; ϕ^{ik} - i-th production factor acting on the k-th employee of the enterprise.

The main method for solving the problem of finding the transition function, establishes a specific type of dependence between the results of measuring the influence of production factors and the reaction of the organism of the observed employee to this effect, is to compile the Wiener-Hopf equation. There are a number of methods for solving the Wiener-Hopf equation based on further parameterization of the problem by expansion $\omega(\tau)$ according to a given system of functions, or transition to discrete time. This function allows you to establish the dependence of the reaction of any organism to the combined effect of production factors.

Determining the state of an employee using a set of parameters in accordance with expression (2) and taking into account all the proposed improvements, model (5) can be represented as follows:

$$\Delta w(\tau) = \Gamma_2(\mu_{\phi^k(t)}, t_1, t_2) = \int_0^{t_2 - t_1} \begin{bmatrix} par_1(0) \\ \dots \\ par_h(0) \\ \dots \\ par_n(0) \end{bmatrix} \cdot \begin{bmatrix} \sum_{i=1}^{m} \int_0^{\infty} \omega_1(\tau)\, \mu_{\phi^{ik}(t)}(t-\tau) d\tau \\ \dots \\ \sum_{i=1}^{m} \int_0^{\infty} \omega_h(\tau)\, \mu_{\phi^{ik}(t)}(t-\tau) d\tau \\ \dots \\ \sum_{i=1}^{m} \int_0^{\infty} \omega_n(\tau)\, \mu_{\phi^{ik}(t)}(t-\tau) d\tau \end{bmatrix} dt, \tag{6}$$

where $par_1(0), \dots, par_h(0), \dots, par_n(0)$ - employee body parameters to determine the state at the initial time; $\omega_1(\tau), \dots, \omega_h(\tau), \dots, \omega_n(\tau)$ - impulse transition matrix function of describing the body's response to the effects of existing production factors; $\mu_{\phi^{ik}(t)}$ - the harmfulness indicator of the process per employee for m values of the i-th factor acting on the k-th employee at time t.

Thus, it becomes possible to determine with the help of expressions (2, 3) the state of the employee by the measured parameters of the employee's body immediately before the start of his shift. Model (6) allows you to determine the change in the state of the employee's body under the influence of production factors during the execution of production tasks by this employee.

To assess the quality of the functioning process of the proposed system, a set of criteria for evaluating the effectiveness is used $K = \{k_1, k_2\}$. The most important criterion is the response time of the system when solving a general problem D_{Ξ}

$k_1 : \tau = \min(\tau^r, \tau^{st}, \tau^{dn}, \tau^{em})$, where τ^r – processing time parameters of the human body state, τ^{st} – image processing time at subject's quiescence, τ^{dn} – image processing time at object's motion, τ^{em} – emotion recognition time.

Another criterion is the accuracy of solving the general problem $k_2 : \varsigma = \min(\varsigma^r, \varsigma^{st}, \varsigma^{dn}, \varsigma^{em})$, where ς^r – the decision error of a task D_{Hr}, ς^{st} – the decision error of a task D_{Hst}, ς^{dn} – the decision error of a task D_{Hdn}, ς^{em} – the decision error of a task D_{Hem}.

The criterion for the efficiency of development is to meet the following requirements

$$K : \forall (D_i \in D_{\Xi})[(\tau < \tau^{\max}) \,\&\, (\varsigma < \varsigma^{\max})] \Rightarrow \Xi, \quad (7)$$

where D_i – is the subtask of the joint problem D_{Ξ} ($i = \{H_r, H_{st}, H_{dn}, H_{em}\}$), $\tau^{\max}$ – the maximum allowable time for solving the problem $\varsigma^{\max}$ the maximum permissible error.

3 Imitation Simulation of a System for Monitoring and Forecasting of Employee Health on the Enterprise

To evaluate the performance of the algorithms, an experimental Hadoop cluster was created consisting of 9 computers (Intel Core i 3-7100, 3.9 GHz, OS Microsoft Windows 12) with a physical “star” topology consisting of 8 Datanodes and one Namenode. The tasks were managed by the YARN manager.

Implemented a private formulation of the problem: determination of the health status of a team of welders performing electro-gas welding of particularly complex and responsible structures and pipelines of high carbon steel, intended for work under dynamic and vibrational loads and high pressure. The impact of a complex of harmful factors on a person may be critical for the cardiovascular and nervous systems of his body.

The results of measurements of the state of the body of one of the employees of the welder brigade have the start time of the shift (8.00), day of the week (Thursday), systolic blood pressure (125 mmHg), diastolic blood pressure (84 mmHg).

The measurements result of external production factors are given in Table 1. Data on external factors were interpolated between changes in the value of the EMR level = 0 and the value of the air temperature = 20 ° C.

Data on the measured state parameters of an employee interpolated by the Aitken-Lagrange method. Time series were obtained for the studied parameters, which were centered. The Wiener-Hopf equation was solved by discretizing it and reducing it to four systems of linear equations. Numbering of environmental factors: 1 - level of electromagnetic radiation; 2 - air temperature. Numbering: 1 - level of systolic blood pressure; 2 - the level of di a with high blood pressure.

Table 1. Measurement results.

The day of the week on which measurements were taken	Time of holding measurement	Level ESA, W / m2	Temperature, ° C
Thursday	8.00	0	26
Thursday	10.00	83	29
Thursday	12.00	86	31
Thursday	14.00	95	32
Thursday	16.00	131	32

In order to regularize the solution, the smoothing of the results was applied. Using graphical analysis of results for functions $\omega_{11}(\tau)$, $\omega_{21}(\tau)$ the formula was chosen

$$\omega(\tau) = Ce^{-a\tau} . \quad (8)$$

For function $\omega_{22}(\tau)$, the formula was chosen

$$\omega(\tau) = C\tau^{b} e^{-a\tau} . \quad (9)$$

For function $\omega_{12}(\tau)$ the formula was chosen $\omega(\tau) = C = Const$.

The relations (8), (9) were linearized by logarithm, the coefficients were determined by the least squares method, as a result of which the following relations were obtained: $\omega_{11}(\tau) = 083e^{-0,161\tau}$; $\omega_{21}(\tau) = 5,6 \cdot 10^{-3}\ e^{-0,3402\tau}$; $\omega_{12}(\tau) = -0,00324$; $\omega_{22}(\tau) = 0,277 \cdot \tau^{1,409} e^{-0,5498\tau}$.

Consider the application of model (6) using the example of a calculation made on the basis of data measured on Thursday at the time the shift began (see Table 1 and 2). At first, we consider an example of changes assessment calculations in the state of worker in the process of professional activity under the influence of production factors after 2 hours from start of the shift. The response of the human body to the effects of production factors is calculated using this formula:

$$f\left(\mu_{\phi^{ik}(t)}\right) = \sum_{i=1}^{N} \omega(\tau_i)\mu_{\phi^{ik}(t)}(t-\tau_i)\Delta\tau_i = \sum_{i=1}^{N} \begin{bmatrix} (R_{\mu\mu})_{11} & (R_{\mu\mu})_{12} \\ (R_{\mu\mu})_{21} & (R_{\mu\mu})_{22} \end{bmatrix} \cdot \begin{bmatrix} \omega_{i1} \\ \omega_{i2} \end{bmatrix} , \quad (10)$$

where $\omega(\tau)$ - pulsed transition matrix function of describing the body's response to the influence of factors in size $m \times n$; $\mu_{\phi^{ik}(t)}$ - the indicator of the harmfulness of the process per employee for m values of the value of the i-th factor acting on the k-th employee at time; $R_{\mu\mu}$ - element of matrix to calculate total harmful index; N - number of measurements of factors.

Then

$$\Delta\vec{w}(\tau)=\begin{bmatrix} par_1(0) \\ par_2(0) \end{bmatrix}\int_0^T\left(\int_0^\tau\begin{bmatrix}(R_{\mu\mu})_{11} & (R_{\mu\mu})_{12} \\ (R_{\mu\mu})_{21} & (R_{\mu\mu})_{22}\end{bmatrix}\times\begin{bmatrix}\sum_{i=1}^{N}\omega_{11}(\tau)+\omega_{12}(\tau) \\ \sum_{i=1}^{N}\omega_{21}(\tau)+\omega_{22}(\tau)\end{bmatrix}d\tau\right)dt=$$

$$=\begin{bmatrix}125 \\ 84\end{bmatrix}\cdot\begin{bmatrix}0 & 13 \\ 13 & 26\end{bmatrix}\cdot\begin{bmatrix}\sum_{i=1}^{2}0{,}083e^{-0{,}1613\tau}-0{,}00324 \\ \sum_{i=1}^{2}5{,}6\cdot10^{-3}e^{-0{,}3402\tau}+0{,}277\cdot\tau^{1{,}409}e^{-0{,}5498\tau}\end{bmatrix}+$$

$$+\begin{bmatrix}83 & 112 \\ 112 & 29\end{bmatrix}\cdot\begin{bmatrix}\sum_{i=2}^{2}0{,}083e^{-0{,}1613\tau}-0{,}00324 \\ \sum_{i=2}^{2}5{,}6\cdot10^{-3}e^{-0{,}3402\tau}+0{,}277\cdot\tau^{1{,}409}e^{-0{,}5498\tau}\end{bmatrix}=\begin{bmatrix}3 \\ 0{,}3\end{bmatrix}.$$

The results of calculations of changes in the values of the employee’s state parameters when exposed to production factors from 2 hours after the start of the shift are given in table. 2. According to the results in table 2, we can draw the following conclusion. As a result of professional activity, within 2 hours after the start of the shift, the state parameters of the employee's body changed. An increase in parameters of organism state also indicates an increase in $\mathrm{sost}^{k}{}_{j}\in SOST$ from the expression (2). Based on the assumption that increase of this value corresponds to a deterioration of state, we come to the conclusion that there is some deterioration in employee’s condition after 2 hours from start of the shift.

Table 2. The result of performing calculations to predict changes in employee status parameters 2 hours after the start of shift.

Used parameter	The value of the parameter at time the shift started	Calculated value of parameter change	Value of estimated parameter
par_1 (t)	125	+3	128
par_2 (t)	84	+0,3	84,3

In the same way, an assessment of the change in the state of an employee in the course of professional activity was carried out using a mathematical model for assessing changes in the state of an employee under the influence of production factors 4 and 6 hours after the start of the shift. The results of these calculations are shown on Fig. 2.

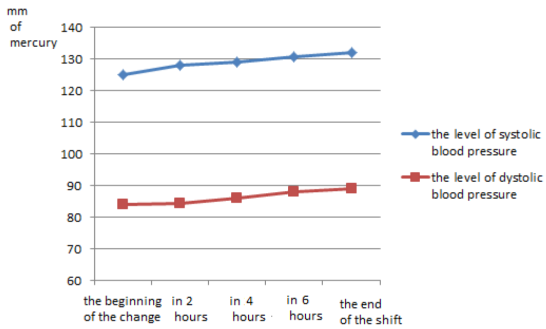


Fig. 2. The result of change in state of employee in professional activity process

Thus, based on the assumption that it is impossible to determine changes in the state of an employee's body from direct measurements, the problem of assessing changes in the body state (blood pressure) was solved by observing the factors influence of the working environment using an improved mathematical model of changing the employee state on the enterprise (6).

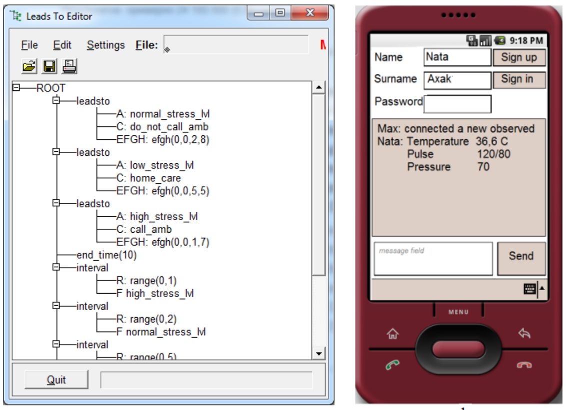
Simulation based on employee observations based on sensor performance. The dynamic characteristics are described using the temporal tracing language (TTL). For expressing dynamics in TTL, important concepts are states, times, and traces. The simulated processes were translated into a feasible subset of TTL called leadsto. The simplified leadsto format allows us to model direct temporal relationships between two state characteristics. Let α and β characteristics of literal conjunction (where literal – is an atom or an atom matching), and e, f, g, h – not negative real numbers. In language LEADSTO term

$\alpha \rightarrow\rightarrow \varepsilon_{f,g,h}\beta$ means:

```
if the characteristic of state α  is in a certain time
interval with duration g
then, after some delay (between e and f )
the characteristic of state β is in a certain time inter-
val of length h
```

Private problem statement was implemented – worker blood pressure monitoring and measures to health maintain. For modeling and implementation is used LEADSTO language, LEADSTO Editor, and the TTL Editor for checking the modeling correctness modeling and building the right tracks.

In a blood pressure-related task, pressure-related variables: `high_stress_lvl`, `normal_stress_lvl`, `low_stress_lvl`. Also, variables to indicate what to do with pressure indicators: `home_care, call_amb, do_not_call_amb`. The time for the final simulation is set and the intervals for each of the arterial thousand variables are added (for example, 10 units), as well as the beginning of the trail and the end (see Fig. 3a). The end of a trace indicates the beginning of a consequence for a given variable. Change in `high_stress_lvl` signals that you need to call an ambulance and provide immediate assistance. It has been explained by all timestamps that if an expression is true with a duration of *g*, then the whole expression will have a value of duration *h* with **a** delay of 0.0.



a b

Fig. 3. Simulation results: a – Time intervals for all LEADSTO conditions; b – Screenshot of user interface on mobile device

An imitation of the employee registration process is shown in Figure 3b. A unique identifier is issued upon successful registration.

To check the correct operation of the specification, the LEADSTO Simulation Tool is launched and, if there are no errors when entering the specification, then we will see such a result (see Fig. 4).

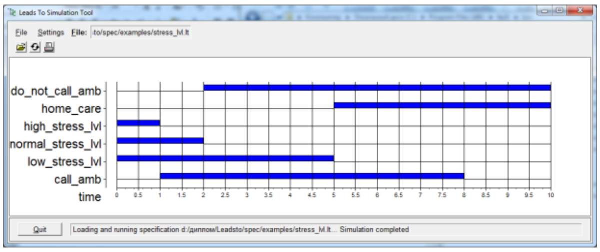


Fig. 4. Successfully completed specification

The developed experimental system is in good agreement with the proposed architecture of the remote monitoring system and the prediction of the health of the employee [20].

This system includes four types of software.

1. Personal software is installed on the patient's personal digital device, and interacts with Hardware (sensors, measuring devices, etc.) that collect employee information and send digital information to the Master server.
2. Maintenance software connects to the Master server and receives data according to user requirements. This software allows you to interact with employee status data regardless of the observer location.
3. The server software is installed on the Master server using .NET Framework platform using the object-oriented C # programming language. It processes and stores employee data. MS SQL Server database is selected to store user information. The database is connected using ORM (Object-Relational Mapping).
4. Data backup and playback is a mechanism that provides data security when servers fail.

4 Conclusion

A set of interrelated tasks is proposed, the solution of which is to develop models and methods for organizing effective interaction between a person and a service-oriented system at different architectural levels, both in horizontal and vertical planes.

The proposed architecture of the employee's remote monitoring and forecasting system allows interacting with a large number of heterogeneous sources, including digital photographs and medical diagnostic information, and timely responding to changes in health conditions.

According to the results of the implementation, it was found that the proposed model of SRMF:

- uses and timely manages knowledge of the employee's health;
- provides interaction between the parties involved;
- sends the necessary information to users at the right time;
- provides the most rational solutions according to proper requests.

Software modules based on the proposed SRMF model are developed, which are integrated into a single complex of a service-oriented computer system, which made it possible to increase its productivity in terms of the quality of decisions and the timing for obtaining results.

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