APPROACHES TO AUTOMATION OF PROCESSES OF IDENTIFICATION OF SEAFARER'S PHYSIOLOGICAL PARAMETERS

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Introduction. It is well known that monitoring and analysis of physiological indicators allow for the timely identification and elimination of factors that may adversely affect the performance of a ship's crew in difficult conditions. This contributes to the successful and safe passage of the navigation watch and ensures the high efficiency of the entire crew [1-5].

Analysis of physiological indicators is important for successful and safe navigation watchkeeping in difficult conditions. Here's how they can negatively affect a navigator's performance:

1. High physical exertion: If the heart rate and target heart rate zone can indicate excessive exertion, that can reduce the reaction and concentration of the navigator. In difficult conditions, when quick and accurate decision-making is required, a tired navigator can make mistakes that can lead to serious consequences.

2. Blood pressure disorders: Too high or too low blood pressure can cause dizziness, headaches, lack of coordination, and decreased concentration. In difficult navigational conditions, this can lead to critical errors and accidents.

3. Low oxygen saturation: If the oxygen saturation level is insufficient, the seafarer will have shortness of breath, headaches and reduced performance. As a result, they may make poor decisions that can lead to incidents at sea.

4. Body temperature abnormalities: elevated or abnormally low body temperature can be a sign of illness, stress or fatigue. All of this reduces the seafarer's performance and ability to respond adequately to difficult situations during the watch.

Therefore, the creation of automated systems for identifying the physiological parameters of navigators in real-time is essential to ensure successful and safe navigation watchkeeping in difficult conditions. Such systems will allow timely detection and correction of factors that may adversely affect the navigator's performance, thereby improving the safety and efficiency of the entire crew.

Main research material. In this study, we analyzed the physiological parameters of seafarers, such as pulse rate, blood pressure, oxygen saturation, and body temperature. For this purpose, we used various methods of data calculation and analysis, including the determination of maximum heart rate, pulse pressure index, mean arterial pressure, and methods of statistical analysis of saturation data, such as mean, median, mode, variance, and standard deviation [6-11].

In addition, we will analyze the time series of body temperature using the autocorrelation function, fourier transform, exponential smoothing, and moving average. As a result of this analysis, we will be able to better understand how physiological indicators affect the work of navigators and how their condition can be adjusted in time to ensure a successful and safe navigation watch. In turn, creating a computer program in Python to automate the calculation of seafarers' physiological indicators is a necessary and useful step. Automation of these calculations will allow you to quickly and accurately process large amounts of data, simplify and speed up the analysis process. The structure of the program is shown below (Fig. 1):

```
1. Import Libraries
     ├── numpy as np
     └── collections.Counter

2. Define Functions
     ├── MHR(age)
     ├── target_pulse_zone(MHR)
     ├── PPI(systolic, diastolic)
     ├── MAP(systolic, diastolic)
```

```
            ├── mean_saturation(saturation_data)
            ├── median_saturation(saturation_data)
            ├── mode_saturation(saturation_data)
            ├── variance_saturation(saturation_data)
            ├── standard_deviation_saturation(saturation_data)
            └── autocorrelation_function(x, k)

        3. Assign Values
            ├── age = 30
            ├── pulse = 150
            ├── systolic_pressure = 120
            ├── diastolic_pressure = 80
            ├── saturation_data = np.array([95, 96, 97, 96, 95, 98, 95, 97])
            └── temperature_data = np.array([36.6, 36.7, 36.5, 36.8, 36.7, 36.6])

        4. Calculate Health Metrics
            ├── mhr = MHR(age)
            ├── lower_target, upper_target = target_pulse_zone(mhr)
            ├── ppi = PPI(systolic_pressure, diastolic_pressure)
            └── map_value = MAP(systolic_pressure, diastolic_pressure)
        5. Print Health Metrics
            ├── Print Maximum heart rate
            ├── Print Target heart rate zone
            ├── Print Pulse pressure index
            └── Print Mean arterial pressure

        6. Calculate Saturation Metrics
            ├── mean_s = mean_saturation(saturation_data)
            ├── median_s = median_saturation(saturation_data)
            ├── mode_s = mode_saturation(saturation_data)
            ├── variance_s = variance_saturation(saturation_data)
            └── std_dev_s = standard_deviation_saturation(saturation_data)

        7. Print Saturation Metrics
            ├── Print Average saturation
            ├── Print Median saturation
            ├── Print Saturation mode
            ├── Print Saturation dispersion
            └── Print Saturation standard deviation

        8. Set Shift Value
            ├── k = 3

        9. Calculate Autocorrelation Function
            ├── acf_temperature = autocorrelation_function(temperature_data, k)

        10. Print Autocorrelation Function Value
            └── Print Autocorrelation function with shift k
```

Figure 1 – Python program code

The Python-based program will enable real-time monitoring and control of the condition of navigators, which will allow timely identification and elimination of factors that negatively affect their performance. As a result, higher efficiency and safety of the navigation watch will be ensured, which is important for the successful completion of the crew's tasks.

The following toolbox and means can be used to ensure real-time automation of the process of monitoring the physiological parameters of seafarers on board:

Use of sensors and devices for continuous data collection: It is necessary to equip seafarers with reliable and accurate sensors (e.g., heart rate monitors, tonometers, pulse oximeters, thermometers, etc.) that will collect data on their real-time physiological parameters.

Wireless data transmission: the collected data from the sensors shall be transmitted to the ship's central computer or server via wireless networks such as Wi-Fi, Bluetooth, ANT, or other suitable communication protocols.

Data processing on board the vessel: the central computer or server should be equipped with software developed in Python to automatically process and analyze the received data. This will allow for the timely detection of anomalies and notification of relevant specialists.

Data visualization: data can be visualized in the form of graphs, charts, and other forms on specialized displays or monitors to clearly present the state of the ship's crew and possible risks.

Production of an alert system: In case of detection of anomalies or dangerous indicators, the system should automatically send alerts and notifications to responsible persons (e.g., the doctor on board, the ship's captain, or the officer on duty) for appropriate action.

Feedback support: the system must be able to receive feedback from specialists and adjust analysis and monitoring algorithms in accordance with the data and recommendations received.

Description of the automated system structure (Fig. 2):
Nodes of the main components.
"A", "1. Sensors and devices for data collection"
"B", "2. Wireless data transmission"
"C", "3. Central computer or server on board the vessel"
"D", "4. Data visualization"
"E", "5. Notification system"
"F", "6. Feedback and adjustment of algorithms"

Device nodes
"A1", "1.1. Heart rate monitors"
"A2", "1.2. Blood pressure monitors"
"A3", "1.3. Pulse oximeters"
"A4", "1.4. Thermometers"
"B1", "2.1. Wi-Fi"
"B2", "2.2. Bluetooth"
"B3", "2.3. Other communication protocols"
"C1", "3.1. Python software"
"C2", "3.2. Data processing and analysis"
"C3", "3.3. Detection of anomalies and alerting specialists"
"D1", "4.1. Graphs"
"D2", "4.2. Charts"
"D3", "4.3. Other forms of data visualization "
"E1", "5.1. Notifications for the doctor on board"
"E2", "5.2. Alert for the ship's master"
"E3", "5.3. Alert for the officer on duty"
"F1", "6.1. Receiving feedback from specialists"
"F2", "6.2. Adjustment of analysis and monitoring algorithms"

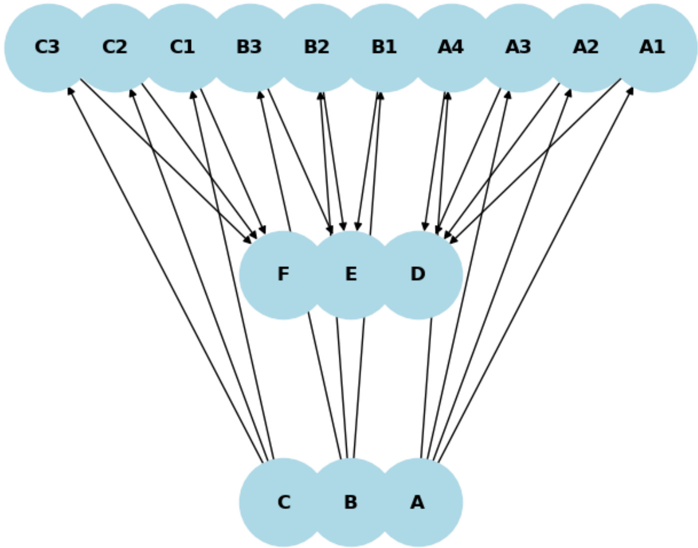

Figure 2 – Block diagram of the automated system for monitoring physiological parameters of ship's officers

The analysis of the structural diagram of the automated system for monitoring the physiological parameters of seafarers shows that the system is capable of providing reliable real-time monitoring of the seafarers' condition [12-19]. Thanks to the use of modern data collection and information transmission technologies, the system can promptly identify and respond to abnormal indicators, thereby reducing the risks to the safety of the vessel and its crew.

Conclusion. The developed concept of an automated system for monitoring the physiological parameters of the ship's crew offers significant prospects for improving the safety and efficiency of shipping. In the long term, the system can be adapted to a wide range of use cases, including crew monitoring in other transportation modes such as aviation, rail, and road transport.

In addition to the system's current capabilities, integration with other technologies, such as artificial intelligence and machine learning, can be envisioned to further improve the analysis and monitoring algorithms. This can lead to more accurate detection of anomalies and prevention of possible health problems of seafarers before they occur.

In general, an automated system for monitoring seafarers' physiological parameters is an innovative and promising tool for ensuring the safety and health of the crew on board ships, which will ultimately lead to increased operational efficiency and reduced risks at sea.

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