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Digital Processing and Application of Artificial Intelligence to Signals From Sensors Embedded in Several Points of the Human Body

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Abstract: This article examines the process of digital processing of temperature signals from sensors installed at various points in the human body and the application of artificial intelligence. The data collected through Sensor technologies is cleared of noise, which makes it possible to obtain accurate and reliable forecasts in the health sector. The article analyzes the results obtained through the Kalman filter and linear regression algorithms. These approaches also reveal opportunities for use in the creation of personal medical approaches and early detection of diseases.

Keywords: Human body, temperature signals, digital processing, artificial intelligence, sensor technologies, Kalman filter, linear regression, forecasting, personal medical approach.

Introduction.

Currently, the development of digital technologies in the field of Health and the increase in the capabilities of artificial intelligence are beginning a new era in medicine. Temperature signals of the human body serve as an important source of information in early disease detection and health monitoring. Temperature data collected using sensors are used to assess the condition of patients, as well as to identify conditions such as fever or infection.

Sensor technologies are widely used in modern health and medical fields. Sensors installed at various points in the human body, such as the subcutaneous, vascular and internal organs, provide real-time measurement of temperature, heart rate and other biological parameters. These data are analyzed using digital processing and artificial intelligence, allowing for Health control, disease detection, and personal medical approaches.

Sensor technologies, today, make it possible to carry out this process quickly and accurately. Typically, these sensors are installed at different points in the human body, measuring temperature in real time and transmitting data to the central system. However, the data obtained can often have noise and anomalies. Therefore, the application of digital processing algorithms is important in clearing and improving the accuracy of this data.

Artificial intelligence, in turn, helps to analyze complex data and make useful forecasts from them. For example, using statistical techniques such as the Kalman filter and linear regression, noise in temperature signals is cleared and allows for accurate determination of actual states. These methods play an important role not only in assessing the health status of patients, but also in creating personal medical approaches.

This article examines the role and significance of Kalman filter and linear regression in the digital processing of the temperature signals of the human body, and analyzes the results obtained using these technologies.

Principle Of Operation Of Sensors. Sensors built into the human body measure temperature, heart rate, blood pressure and other parameters. These sensors incorporate a variety of technologies, including techniques such as infrared, thermistor, piezoelectric, and electrodes. The data from the sensors is in analog or digital form, and this information can be transmitted to digital processing systems.

Digital Processing Algorithms. Several algorithms are used to process data from sensors. These are:

1. **Filtering:** various filters are used to reduce noise in the received signals. For example, the Kalman filter equations:

$$\hat{x}_k = \hat{x}_{k-1} + K_k(z_k - H\hat{x}_{k-1})$$

Here:

- $\hat{x}_k$ - the predicted value of time in the kkk period.
- K_k - Kalman coefficient.
- z_k - real measure.
- H - tracking module.

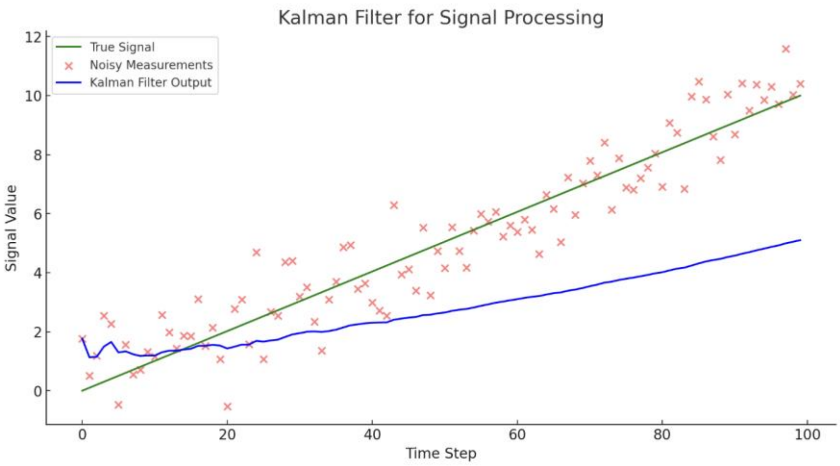

Figure 1. Graph of the signal processing process using the Kalman filter

The graph above shows the signal processing process using the Kalman filter.

Green Line: real alarm (true signal).

Red dots: noisy scales (noisy measurements).

Blue line: Kalman filter result (Kalman filter output).

This graph shows how the Kalman filter determines the actual signal from the noise data.

2. Signal analysis: Fourier transform to determine the main characteristics of the received signal :

$$X(f) = \int_{-\infty}^{\infty} x(t) e^{-j2\pi ft} dt$$

Here:

- X(f) - signal in the frequency domain.
- x(t) - signal in the area of time.

3. Anomaly detection: statistical methods are used to detect anomalies in temperature signals, such as z-scores:

$$z = \frac{(X - \mu)}{\sigma}$$

Here:

✓ X - observed temperature.:.

✓ μ - average temperature.

✓ σ - standard deviation.

Artificial intelligence, especially machine learning and in-depth learning technologies, plays a large role in analyzing the data obtained. Using artificial intelligence:

Forecasting: regression models are used to predict changes in temperature and other biological parameters:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + \epsilon$$

Here:

✓ y - projected value.

✓ x_i - independent variables

✓ βi - regression coefficients.

✓ ϵ - errors.

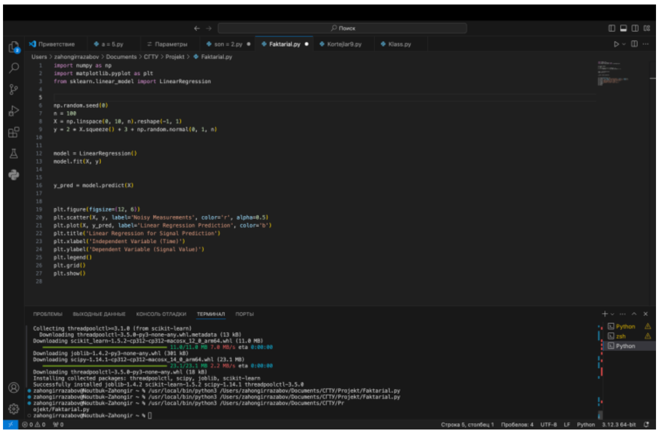

Figure 3. Forecasting process code using artificial intelligence in Python.

Data Generation: X- is an independent variable (time), y- is a dependent variable (noise signal).

Linear regression model: using the LinearRegression class, the model is created and adapted to the data.

Forecasting: using a customized model, the y_pred values are calculated**.**

Graph drawing: noise measurements and linear regression forecast are shown in the graph

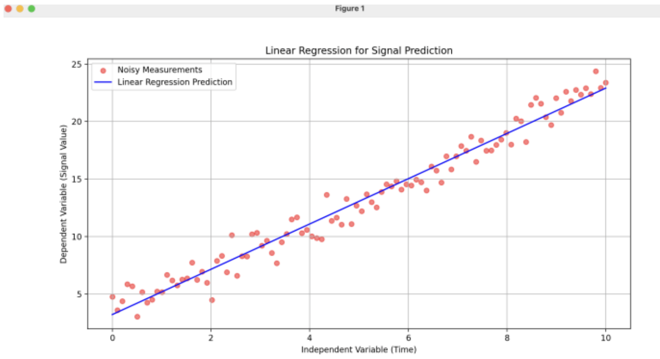

Figure 2. Forecasting process graph

The graph above shows the forecasting process using artificial intelligence:

- ✓ Red dots: noisy measurements (noisy measurements).
- ✓ Blue line: projections of the linear regression model (Linear Regression Prediction).

This graph shows how to detect and forecast a real signal from noise data obtained using linear regression.

It provides an opportunity to develop personal treatment plans, taking into account the individual characteristics of each patient. By providing clinicians with accurate and fast data, it speeds up the clinical decision-making process to improve quality.

Conclusion

The digital processing of signals from sensors embedded in several points of the human body and the use of artificial intelligence lead to revolutionary changes in the field of Health. These methods provide opportunities for early disease detection, development of personal medical approaches, and improved patient health. In the future, it is possible to further develop health care through the joint work of sensor technologies and artificial intelligence.

References

1. Kalman, R. E. (1960). "A New Approach to Linear Filtering and Prediction Problems." *Journal of Basic Engineering*, 82(1), 35-45.
2. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*. Springer.
3. Ng, A. Y. (2006). "Supervised Learning with Labeled Data." *Machine Learning Yearning*.
4. Zhang, Y., & Wang, Z. (2019). "Wearable Sensors for Health Monitoring: A Review." *IEEE Sensors Journal*, 19(3), 865-874.
5. Zhou, M., & Wang, H. (2021). "Smart Health Monitoring System Based on IoT and Machine Learning." *Sensors*, 21(4), 1243.
6. Turakulov A. A., Mullajonova F. T. Using Modern Microcontrollers In Automated Data Processing Of Sphygmic Cardiosignals //JournalNX. – C. 659-662.

7. Zaynidinov X. N., Turakulov A. A., Mullajonova F. T. Sensors And Devices For Receiving Human Biosignals //JournalNX. – C. 316-320.
8. Zaynidinov X. N., Turakulov A. A., Mullajonova F. T. SFIGMOSIGNALLARINI VIZUALLASHTIRISHDA APPROKSIMATSIYALASH USULLARIDAN FOYDALANISH IMKONIYATLARI //Academic research in educational sciences. – 2021. – T. 2. – №. 10. – C. 388-395.
9. Turakulov A., Mullajonova F. An automated system for body temperature monitoring of children, people with disabilities and bedridden people using a continuous analysis //Diagnostyka. – 2020. – T. 21. – №. 3. – C. 31-40.