

Fig. 4. Dependence of the efficiency metric of ROI outline algorithms on the distance between the camera and the bioobject

VII. CONCLUSION

The paper is devoted to the comparative analysis of algorithms for ROI outline on face images in the task of contactless heart rate measurement. The operation of four algorithms based on color segmentation and the use of facial landmarks was studied under different illumination conditions of the subject's face and also at different distances between the camera and the subject's face. The results suggest that the algorithm based on the grid with the nodes at facial landmarks with independent videoplethysmogram calculation for each sector shows best measurement accuracy and stability.

REFERENCES

- [1] Cennini G., Arguel J., Akşit K., van Leest A., "Heart rate monitoring via remote photoplethysmography with motion artifacts reduction". *Opt Express.*, Vol. 18, 2010, № 5, pp.4867-4875.
- [2] Semchuk, I.F., Zmievskoy, G.N., Muravskaya, N.P., Volkov A.K., Murashko M.A., Samorodov A.V., "An Experimental Study of Contactless Photoplethysmography Techniques", *Biomed Eng.*, № 53, 2019, pp.1-5.
- [3] Przybylo J, Kantoch E, Jablonski M, Augustyniak P., "Distant measurement of plethysmographic signal in various lighting conditions using configurable frame-rate camera", *Metrology and Measurement Systems*, Vol. 23, 2016, № 4, pp 579–92.
- [4] Yoshizawa M., Sugita N., Tanaka A., Ichiji K., Homma N., Yambe T., "An Optimization Technique to Extract Video Pulse Wave for Non-Contact Remote Monitoring of Autonomic Nervous System and Blood Pressure Variability", IEEE 7th Global Conference on Consumer Electronics(GCCE), 2018, pp 425–28.
- [5] Semchuk I., Muravskaya N., Samorodov A., "The study of facial ski surface bloodflow dynamics", AIP Conference Proceedings, 2019, 2140:1
- [6] S. Thakur, S. Paul, A. Mondal, S. Das, A. Abraham, "Face detection using skin tone segmentation", 2011 World Congress on Information and Communication Technologies, Mumbai, 2011, pp. 53-60.
- [7] A. Adouani, W. M. Ben Henia and Z. Lachiri, "Comparison of Haarlike, HOG and LBP approaches for face detection in video sequences", 2019 16th International Multi-Conference on Systems, Signals & Devices (SSD), Istanbul, 2019, pp. 266-271.
- [8] Kaur A., Kranthi B. V., "Comparison between YCbCr color space and CIELab color space for skin color segmentation" *International Journal of Applied Information Systems*, Vol. 3, 2012, №. 4. pp. 30-33.
- [9] J. Fritsch, S. Lang, A. Kleinehagenbrock, G. A. Fink and G. Sagerer, "Improving adaptive skin color segmentation by incorporating results from face detection", *Proceedings. 11th IEEE International Workshop on Robot and Human Interactive Communication, Berlin*, 2002, pp. 337-343.
- [10] МИ 3280-2010 Пульсовые оксиметры и пульсоксиметрические каналы медицинских мониторов. Методика поверкиб 2010 – с.12