A Method for Increasing the Capacity of Radio Systems of Short-Range Navigation

Ivan Shevtsov
dept. of Microprocessor Technologies and Systems
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
ivan.shevtsov@nure.ua

Sviatoslav Starokozhev
dept. of Microprocessor Technologies and Systems
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
sviatoslav.starokozhev@nure.ua

Anton Sierikov
dept. of Microprocessor Technologies and Systems
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
anton.sierikov1@nure.ua

Serhii Datsko
dept. of Microprocessor Technologies and Systems
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
serhii.datsko@nure.ua

Dmytro Sukhorukov
dept. of Microprocessor Technologies and Systems
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
dmytrosukhorukov10@gmail.com

Tadas Machonis
dept. of Microprocessor Technologies and Systems
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
machonis7@gmail.com

Oleksii Korotich
dept. of Microprocessor Technologies and Systems
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
oleksii.korotich@nure.ua

Valeriia Chumak
dept. of Microprocessor Technologies and Systems
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
valeriia.chumak@nure.ua

Oleksii Bilotserkivets
dept. of Microprocessor Technologies and Systems
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine
oleksii.bilotserkivets@nure.ua

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***Abstract*—In the presented work, based on the representation of the total flow of range request signals, as well as intentional correlated and uncorrelated interference to a range-finding radio beacon as a Poisson flow, the capacity of both the range-finding beacon range transponder and the short-range radio engineering system as a whole is estimated based on the implementation of the method for extracting synchronous sequences of incoming range interrogation signals in the ground range transponder. It allows on a succession basis to move from the service signal to a requester service and, as a result, increase the throughput of the long -range radio beacon in question.**

Keywords—Global navigation satellite systems (GNSS), distance measuring equipment (DME), throughput.

REFERENCES

[1] D. Egea-Roca et al., "GNSS User Technology: State-of-the-Art and Future Trends", *IEEE Access*, vol. 10, pp. 39939-39968, 2022. doi: 10.1109/access.2022.3165594.

[2] Lo, Sherman, Enge, Per, Niles, Frederick, Loh, Robert, Eldredge, Leo, Narins, Mitchell, "Preliminary Assessment of Alternative Navigation Means for Civil Aviation," *Proceedings of the 2010 International Technical Meeting of The Institute of Navigation*, San Diego, CA, January 2010, pp. 314-322.

[3] O. Kim, C. Kim, J. Song, T. Lee, B. Park and C. Kee, "A Single Distance Measuring Equipment (DME) Station-Based Positioning System for Alternative Position Navigation and Timing (APNT)", *Navigation*, vol. 62, no. 4, pp. 313-327, 2015. doi: 10.1002/navi.121.

[4] M. Dzunda, L. Melnikova and P. Koscak, "Assessing the Effects of the Construction of a Logistics Center on the Operation of DME System", *2020 New Trends in Aviation Development (NTAD)*, 2020. doi: 10.1109/ntad51447.2020.9379115.

[5] R. Burczyk et al., "Voice Multilateration System", *Sensors*, vol. 21, no. 11, p. 3890, 2021. doi: 10.3390/s21113890.

[6] I. Obod, I. Svyd, O. Maltsev, G. Zavolodko and S. Leonov, "WAM Systems: Comparative Analysis of Information Support Quality", *2020 IEEE International Conference on Problems of Infocommunications. Science and Technology (PIC S&T)*, 2020. doi: 10.1109/picst51311.2020.9468085.

[7] E. Kim, "Analysis of DME/DME Navigation Performance and Ground Network Using Stretched-Front-Leg Pulse-Based DME", *Sensors*, vol. 18, no. 10, p. 3275, 2018. doi: 10.3390/s18103275.

[8] I. Svyd, I. Obod, O. Maltsev, V. Andrusevich, B. Bakumenko and O. Vorgul, "Optimal Measurement of Signal Data Parameters of Requesting Radar Systems", *2021 IEEE 3rd Ukraine Conference on Electrical and Computer Engineering (UKRCON)*, 2021. doi: 10.1109/ukrcon53503.2021.9575235.

[9] F. Neindre, G. Ferre, D. Dallet, F. Letellier and K. Pitois, "A Successive Interference Cancellation-based Receiver for Secondary Surveillance Radar", *IEEE Transactions on Aerospace and Electronic Systems*, pp. 1-12, 2022. doi: 10.1109/taes.2022.3193649.

[10] I. Svyd, I. Obod and O. Maltsev, "Interference Immunity Assessment Identification Friend or Foe Systems", *Data-Centric Business and Applications*, pp. 287-306, 2021. doi: 10.1007/978-3-030-71892-3_12.

[11] V. Semenets, I. Svyd, I. Obod, O. Maltsev and M. Tkach, "Quality Assessment of Measuring the Coordinates of Airborne Objects with a Secondary Surveillance Radar", *Data-Centric Business and Applications*, pp. 105-125, 2021. doi: 10.1007/978-3-030-71892-3_5.

[12] M. Barbary, A. Hafez and T. Crew, "An Industrial Design and Implementation Approach of Secondary Surveillance Radar System", *2021 International Telecommunications Conference (ITC-Egypt)*, 2021. doi: 10.1109/itc-egypt52936.2021.9513961.

[13] V. Semenets, I. Svyd, I. Obod, O. Maltsev, O. Vorgul and B. Bakumenko, "Comparative Quality Processing Analysis of Request Signals in Secondary Radar Systems", *2021 IEEE 8th International Conference on Problems of Infocommunications, Science and Technology*, 2021. doi: 10.1109/picst54195.2021.9772158.

[14] I. Svyd, I. Obod, O. Maltsev, O. Vorgul, V. Chumak and A. Sierikov, "Analysis of the Impact of Interference on the Time Position of Signals in Requesting Airspace Observation Systems", *2021 IEEE 8th International Conference on Problems of Infocommunications, Science and Technology (PIC S&T)*, 2021. doi: 10.1109/picst54195.2021.9772138.

[15] I. Ostroumov et al., "Modelling and simulation of DME navigation global service volume", *Advances in Space Research*, vol. 68, no. 8, pp. 3495-3507, 2021. doi: 10.1016/j.asr.2021.06.027.

[16] I. Obod, I. Svyd, O. Vorgul, O. Maltsev, O. Datsenko and N. Boiko, "Optimization of Data Processing Structure for Multi-Position Radar Surveillance Systems", *2021 IEEE 3rd Ukraine Conference on Electrical and Computer Engineering (UKRCON*), 2021. doi: 10.1109/ukrcon53503.2021.9575286.

[17] J. Guo and X. Zhang, "DME pulse interference mitigation for airborne BDS and flight test results", *Advances in Space Research*, vol. 63, no. 9, pp. 3043-3052, 2019. doi: 10.1016/j.asr.2018.05.012.

[18] I. Svyd, I. Obod, O. Maltsev, O. Vorgul, V. Chumak and B. Bakumenko, "Estimation of the Spatial Coordinates of Air Objects in Synchronous Radar Networks for Airspace Observation", *2021 IEEE 8th International Conference on Problems of Infocommunications, Science and Technology (PIC S&T)*, 2021. doi: 10.1109/picst54195.2021.9772227.

[19] F. Baccelli and P. Brémaud, "Poisson Streams", *Palm Probabilities and Stationary Queues*, pp. 84-94, 1987. doi: 10.1007/978-1-4615-7561-0_18.

[20] I. Svyd, I. Obod, O. Maltsev, O. Vorgul, I. Vorgul and I. Shevtsov, "Method for Increasing the Interference Immunity of the Channel for Measuring of the Short-Range Navigation Radio System", 2022 IEEE 16th International Conference on Advanced Trends in Radioelectronics, Telecommunications and Computer Engineering (TCSET), 2022. doi: 10.1109/tcset55632.2022.9767069.

[21] X. Du, X. Shen and K. Liao, "Secondary Surveillance Radar Signal Processing Based on Two-channel Deep Residual Network", *2020 IEEE International Conference on Signal Processing, Communications and Computing (ICSPCC)*, 2020. Available: 10.1109/icspcc50002.2020.9259499.

[22] I. Obod, I. Svyd, O. Maltsev and B. Bakumenko, "Comparative Analysis of Noise Immunity Systems Identification Friend or Foe", *2020 IEEE 40th International Conference on Electronics and Nanotechnology (ELNANO)*, 2020. doi: 10.1109/elnano50318.2020.9088856.

[23] M. K. Abdul-Hussein, O. Strelnytskyi, I. Obod, I. Svyd and H. Alrikabi, "Evaluation of the Interference's Impact of Cooperative Surveillance Systems Signals Processing for Healthcare", *International Journal of Online and Biomedical Engineering (iJOE)*, vol. 18, no. 03, pp. 43-59, 2022. doi: 10.3991/ijoe.v18i03.28015.

[24] E. Kim and K. Sivits, "Blended secondary surveillance radar solutions to improve air traffic surveillance", *Aerospace Science and Technology*, vol. 45, pp. 203-208, 2015. doi: 10.1016/j.ast.2015.05.018.

[25] I. Obod, I. Svyd, O. Maltsev and B. Bakumenko, "Spatial Methods for Increasing the Bandwidth of a Mobile Information Network", *2020 IEEE 15th International Conference on Advanced Trends in Radioelectronics, Telecommunications and Computer Engineering (TCSET)*, 2020. doi: 10.1109/tcset49122.2020.235388.

[26] R. Morales-Ferre, P. Richter, E. Falletti, A. de la Fuente and E. Lohan, "A Survey on Coping With Intentional Interference in Satellite Navigation for Manned and Unmanned Aircraft", *IEEE Communications Surveys & Tutorials*, vol. 22, no. 1, pp. 249-291, 2020. doi: 10.1109/comst.2019.2949178.

[27] O. Strelnytskyi, I. Svyd, I. Obod, O. Maltsev, O. Voloshchuk and G. Zavolodko, "Assessment Reliability of Data in the Identification Friend or Foe Systems", *2019 IEEE 39th International Conference on Electronics and Nanotechnology (ELNANO)*, 2019. doi: 10.1109/elnano.2019.8783397.

[28] I. Obod, I. Svyd, O. Maltsev and S. Starokozhev, "The Effect of Masking Interference on the Quality of Request Signal Detection in Aircraft Responders of the Identification Friend or Foe Systems", *2020 IEEE International Conference on Problems of Infocommunications. Science and Technology (PIC S&T)*, 2020. doi: 10.1109/picst51311.2020.9467955.

[29] I. Obod, I. Svyd, O. Maltsev, G. Maistrenko, O. Zubkov and G. Zavolodko, "Bandwidth Assessment of Cooperative Surveillance Systems", *2019 3rd International Conference on Advanced Information and Communications Technologies (AICT)*, 2019. doi: 10.1109/aiact.2019.8847742.

[30] L. Davis, P. Enge and G. Gao, *Global navigation satellite systems*. Washington, D.C.: National Academies Press, 2012. doi: 10.17226/13292.

[31] I. Svyd, I. Obod, O. Maltsev and A. Hlushchenko, "Secondary Surveillance Radar Response Channel Information Security Improvement Method", *2020 IEEE 11th International Conference on Dependable Systems, Services and Technologies (DESSERT)*, 2020. doi: 10.1109/dessert50317.2020.9125018.

[32] S. Starokozhev, M. Tkach, A. Hlushchenko, O. Datsenko, M. Chernyshov and V. Chumak, "Frequency Efficiency Evaluation of Query Airspace Surveillance Systems", *2021 IEEE 8th International Conference on Problems of Infocommunications, Science and Technology (PIC S&T)*, 2021. doi: 10.1109/picst54195.2021.9772190.

[33] S. Starokozhev, M. Tkach, A. Hlushchenko, O. Datsenko, M. Chernyshov and V. Chumak, "Optimization of the Probability of Transmission of Flight Data in the Response Channel of Secondary Radar Systems", *2021 IEEE 8th International Conference on Problems of Infocommunications, Science and Technology (PIC S&T)*, 2021. doi: 10.1109/picst54195.2021.9772199.