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Wykorzystanie sieci neuronowej oraz systemu rozmytego do predykcji pozycji i wyboru ścieżki poruszającego się obiektu w lokalnym systemie pozycjonowania opartym na technologii UWB

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The use of the neural network and fuzzy system in predicting the position and selecting the path of a moving object in the local positioning system based on UWB technology

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Abstract

Though widely used and necessary, the positioning system still has some disadvantages, of which the biggest is a relatively large delay in relation to the real and up-to-data position of an object which can be a human, an automobile or a self-propelled trolley. This problem is important due to the continuously developing cities and industry in which the requirements for flow and safety of the transport of people and goods are constantly increasing. An increase in the speed of moving objects increases the difference between the current position and the position determined with the use of positioning systems. A temporary lack of communication with the sensor or lack of useful data cannot significantly affect the operation of the positioning systems. This is why the prediction of a moving object's path is essential, which not only allows to smooth out the displacement, but also ensures a continuous determination of a position over short-term data fading from the positioning system. When analyzing an object's movement data, the reference data has to be obtained from another system at least one order of magnitude more accurate than in the tested system. This system should have an accuracy of the order of millimetres to verify the position obtained from the UWB system, which is hard to achieve in field conditions. The solution to this problem is the system simulator which allows to imitate the operation of the real system and thus provides reference data. Due to the problems mentioned above, it was decided to develop a decision system for positioning moving objects based on data from the UWB system and an inertial navigation located in critical infrastructure places. The paper proposes a cooperative positioning system which uses data from various systems and technologies in order to improve the positioning quality as well as to eliminate delays introduced by the UWB positioning system. The paper proposes the approach of UWB system data processing including: filtration and data cleaning, distance correction, position correction and an expert system based on fuzzy logic which specifies whether in order to obtain the current position of an object, the position from the path built with the use of current data should be used or data coming from prediction or the possessed position data is not sufficient to determine the position of the object. The correction function of UWB system distances which uses a polynomial function, reducing system inaccuracies is proposed. The simplex algorithm is adopted for determining the object's position in the trilateration process. The prediction of the moving object position using the LSTM neural network, which decreases the UWB positioning system delay and allows for uninterrupted positioning of the object is proposed as well as the UWB system data analysis approach, which led to the UWB positioning system simulator design, which reflects a real system owned. The times of individual's stages in the object position determining process, from data acquisition to position prediction determination, is proposed in the paper. The paper also proposes safety areas resulting from errors and possible shifts ensuant from the time of acquisition and UWB system data processing, divided into AGV and automobile. On the basis of the obtained results, it can be stated that the following purpose of the work was achieved: Development of the decision system for the moving objects positioning based on data from the UWB system and inertial navigation system INS (AHRS) located in critical infrastructure places, operating in real-time.