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Fusing Different Measurements and Algorithms to Improve RFID Localization Accuracy

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Abstract—This paper considers the topic of two-dimensional object localization using radio frequency identification (RFID) technology. One of the important problems that arise during the development of RFID positioning systems is choosing a localization algorithm and a type of measurement data. Usually developers try to find such a combination of an algorithm and measurement type that allows to achieve maximal localization accuracy for a particular scenario. However, in some situations there can be several combinations of algorithms and measurements with equally high accuracy. In order to simplify the choosing problem and to additionally increase accuracy it is developed a combinational localization method. The method is based on averaging position estimates formed by several point-based and zone-based algorithms that process different measurements. In our work there are used three point-based and three zone-based algorithms: a k nearest neighbors algorithm, trilateration, intersectional algorithm, the methods of support vector machine, artificial neural networks, and a naive Bayes classifier. As an input for the algorithms we utilized received signal strength, read rate, and proximity measurements. During the experiments we found that our method decreases the mean error by 15% and the maximum error by 14% compared to the best single algorithm.

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INTRODUCTION

Recently, systems for spatial two-dimensional indoor localization (positioning) became very popular in different spheres of economy, especially in the industrial sector. Such systems are used for searching and tracking of various objects indoors, for example, goods in warehouses and stores, books in libraries, personnel at work, patients in hospitals, etc. [1].

The indoor localization problem can be solved using different technologies; however, many of them have serious limitations. For instance, global satellite navigation systems are almost inapplicable indoors because of their low localization accuracy in cases when many obstacles, such as walls and ceilings, are present. Ultrasonic [2] and infrared [3] technologies are occasionally used for indoor applications, but they can provide high accuracy only for objects placed in the line-of-sight of transmitters. Wireless sensor networks [4] and wireless local networks [5] are free from this weakness but can be rather expensive.

The promising approach for localizing objects indoors is to use radio frequency identification (RFID) technology. During its utilization, localization objects are equipped with special RFID tags (active or passive) whose positions can be determined by an RFID system. Usually, when big amounts of objects need to be tracked, developers use passive tags because they are much cheaper and do not require internal power supply [6]. A typical RFID localization system contains a reader (interrogator), a set of antennas, a set of RFID tags, and a data processing unit. For calculating object position estimates the system processes measurement data obtained from tags. As measurement data, it can use different parameters of signals (for example, power levels) emitted by tags in response to system antennas' interrogation signals.

To process RFID tag measurement data, the data unit runs a localization algorithm. The algorithms used in RFID can be divided into two different types: point-based and zone-based. The output of a point-based algorithm is an estimate of tag position coordinates, whereas the output of a zone-based one is an estimate of a number of a zone in which the tag is placed or a vector of probabilities of the tag being in each of the zones into which the localization field is divided.

The most known point-based localization algorithms are trilateration [7], triangulation [7], multilateration [8], and the algorithm of k nearest neighbors [9]. Zone-based algorithms are represented by

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