Method of Reduction the Redundant Reader Based on RFID Reader Communication Protocol

Yunhua Gu, Bao Gao, Jin Wang

Jiangsu Engineering Center of Network Monitoring, School of Computer & Software, Nanjing University of Information Science & Technology, Nanjing, 210044, China, {yhgu6655@163.com, gtb900206@163.com, wangjin@nuist.edu.cn}

Abstract: For the insufficient of existing algorithms of redundant reader elimination, the paper proposes a algorithm based on the RFID reader communication to eliminate the redundant reader. This algorithm is no longer dependent on the tag to send information between the RFID readers, but to transmit information directly through communication among the readers to determine that the tag belongs to which reader and the redundant reader. This paper does a lot of experiments to verify the effectiveness of the algorithm.

Keywords: RFID, redundant reader, reader communication

1 Introduction

RFID [1] (Radio Frequency Identification, RFID) is a non-contact automatic identification technology. It can provide data information for the application real-time and efficiently, so it is widely used in various fields. However, the readers may be densely deployed in some practical applications, so the detection range of the RFID readers overlap, which produces a lot of redundant data and limits the large-scale implementation of an RFID system. So before the original data be sent to the high-level applications, the redundant data must be cleaned.

The redundant data in the RFID systems can be divided into two categories: the redundant reader and the redundant tag data. The redundant reader belongs to Spatial redundancy, which means that the detection range of the readers overlap spatially and result in redundant data. This is to say, in an RFID system of readers densely deployed, all the tags in the detection range of a reader be read by at least one other reader. The redundant tag data belongs to temporal redundancy, which emphasize that a tag is read many times by the same reader, thus a large number of duplicate records emerge.

This paper studies the problem of the redundant reader, which is an important reason to affect the performance of an RFID system. There are some existing classical methods of redundant reader elimination, such as RRE [2](Redundant Reader Elimination)algorithm ,proposed by Carbunar Et al., and LEO algorithm [3] (Layered Elimination Optimization) ,proposed by Hsu et al. There are also some improved algorithms based on the above algorithms [4-7].

This paper will firstly study and analyze the RRE algorithms, and point out its
deficiencies. And then we propose a algorithm based on RFID reader communication to eliminate the redundant reader. This algorithm requires the reader can directly communicate with its adjacent readers. The reader that holds the maximum number of tags will lock the tag in its detection range and then notify its adjacent readers. The adjacent reader eliminates the data if the tag be locked by other reader. Until all tags have been locked, the readers that do not lock the tag are redundant reader.

2 Redundant Reader Elimination algorithm analysis

RRE algorithm solves the problem that multiple readers read a tag simultaneously and upload the data to the data center, which results in redundancy. But RRE has some shortcomings. First, the RRE algorithm requires the readers to write to the tags in their detection range continuously, which will result in high time complexity. If there is an RFID system that has n tags and m readers, and the readers can read the tags and write to the tags. So the complexity of writing operation of the reader is O (nm). Second, RRE algorithm assumes that the relative position of the reader and the tag does not change over a long period of time, but this assumption is not established for RFID applications that have the dynamic tags. Third, in some scenarios of RFID systems, readers whose interrogation zones overlap equal numbers of tags. In this case, RRE algorithm does not obtain the optimal results. As shown in Figure 1.

![Fig. 1. Readers whose interrogation zones overlap equal numbers of tags](image_url)

3 A algorithm Based on the RFID reader communication to eliminate redundant reader

In this paper, according to the insignificance of RRE algorithms and LEO algorithm, a algorithm is proposed based on the RFID reader communication redundancy to eliminate redundant reader.

3.1 Algorithm prerequisite

1. The Topology of RFID system is not limited.
2. Before using this algorithm, the tag conflicts and readers conflicts in the RFID system have been resolved.
3. The adjacent readers can communicate with each other directly in the RFID system [8]. This paper will present a communication protocol between the adjacent readers, as shown in Figure 2, and we will make a explanation for it.
Fig. 2. The communication protocol of the adjacent readers

1) The reader sends information to its adjacent reader, and the format of the information is \(<\text{reader identifier, tag identifier, tag count}>\).

2) If the adjacent readers also contain a tag that the reader sent to the adjacent readers in its detection range, the adjacent reader will answer. Depending on the tag count within the detection range to determine which reader can lock the tag, and thus we can judge the redundant reader and the reserved reader.

3) The readers that are marked as redundant reader and reserved reader are no longer involved in the response.

3.2 Specific steps of proposed algorithm

Step 1: Each reader detects tags within its detection range, and statistics the number of tags within its detection range.

Step 2: According to the sequence of the tag identifier, the reader that hold the first tag sends information to its adjacent readers, and the format of the information is \(<\text{reader identifier, tag identifier, tag count}>\).

Step 3: Determine whether a tag is read by the adjacent readers simultaneously. If it be read, go to step 4, and if it not be read, go to step 5.

Step 4: The adjacent readers that contain the tag will answer. If they are marked as redundant reader or reserved reader, they do not make response although they cover the tag. The information of responses depends on the tag count within their detection range, and determines the ownership of the tag in turn. If the tag count of the reader is smaller than the tag count of adjacent reader, this tag is be considered to belong to adjacent reader, and the tag count of reader subtract 1: If the tag count of the reader is greater than or equal the tag count of adjacent reader, the reader is the owner of this tag and the tag count of the adjacent reader subtract 1. Once the tag count of a reader becomes 0, it is marked as redundant reader.

Step 5 if the tag is not included in any adjacent reader, it means that the tag is read only by the reader, so the reader is certainly not redundant reader and need to be reserved. If this reader also cover other tags, the reader send information to inform the adjacent readers that it is the owner of these tags, so the adjacent readers will update their tag count.

Step 6 If the relative position of the reader and the tag changes, the reader will send a message to its adjacent readers, and go back to step one. Therefore we can redefine the dynamic changes of ownership of the tag.
3.3 Algorithm Analysis

The proposed algorithm in this paper base on reader communication directly, so the readers don’t write on tags. The time complexity of algorithm is reflected in the exchange of communication between the readers. The reader through an interaction to determine the ownership of each tag. If an RFID system with n readers, the time complexity of the algorithm is O (n). Compared to the RRE algorithm, the time complexity of the algorithm can be reduced, at the same time the algorithm is more stable than LEO algorithm. This is to say, the reliability of the algorithm is better. And the algorithm also overcomes the problem that LEO algorithm and RRE algorithms require the unchanged relative position of the reader and tag for a long time. So the proposed algorithm can better determine the ownership of dynamic tag and be adapted to the practical application of RFID systems.

4 Experiments and Results

In this paper, the experimental environment is generated by RFID systems network based on simulation and experimental parameters are set consistent with the literature [2].

Experiment One: The experimental range is 1000×1000m2, 500 readers and 1000-8000 tags are randomly deployed in this range. The results of each algorithm to eliminate the redundant readers as the change of the number of tags are shown in Figure 3. The algorithm proposed in this paper has high redundant reader detection rates than RRE algorithm, LEO algorithm and LEO + RRE algorithm. The main reason is that the RRE algorithm, LEO algorithm and LEO + RRE algorithm has the problem of misjudgment. But the proposed algorithm does not exist the problem.

Experiment Two: The experimental range is 1000×1000m2, 0-500 readers and 1000 tags are randomly deployed in this range. In the process of the number of readers changing from 0 to 500, the number of redundant readers detected by the
RRE algorithm, LEO algorithm, LEO + RRE algorithm and the algorithm proposed in this paper is also increasing respectively, as shown in Figure 4. The proposed algorithm is almost the same with the other three algorithms, when the number of readers is less than 100. But when the number of readers is more than 100, the number of redundant readers detected by the algorithm proposed in this paper begins to appear obvious growth. And with further increase in the number of readers, redundant readers detected by the algorithm proposed in this paper increase correspondingly.

5 Conclusions

This paper proposes an algorithm based on the RFID reader communication to eliminate the redundant reader directly. The readers do not need to run the operation of writing information to the tags, but exchange the information among the readers directly in this algorithm. Experimental results show that the algorithm reduces the time complexity greatly, and increases the rate of detection of redundant reader, and overcome the problem of the change in the relative position between the reader and the tag. Eliminating redundant reader can optimize the deployment of RFID systems, and then the system performance can be improved.

References