

The First Search Right Algorithm for Redundant Reader Elimination in RFID Network

Jui-Wen Hung¹, I-Hui Li², Hsin-Hung Lin, Jyun-An Cai

Department of Information and Management

Ling Tung University

No. 1, Ling Tung Rd., Nantun District, Taichung City 408

TAIWAN (R.O.C.)

{¹harng, ²sanity}@mail.ltu.edu.tw

Abstract: - Radio frequency identification (RFID) applications increasingly widely in recent years. RFID System has been widely implemented in various fields. Such as baggage monitoring, warehousing management, transportation monitoring, protection control, library management and medical management. However, in a highly intensive RFID tags environment, it needs to use large number of tag reader access. It easily caused redundant reader's problem and waste construct cost. Many studies were not put forward a strategy to resolve the above problem, such RRE, LEO algorithm. This paper presents a hybrid algorithm to check reading the number of devices as a basis for discrimination, first of all, the whole environment to calculate the number of RFID tags, and then determine which RFID readers is redundant.

Key-Words: - RFID, RRE, LEO, Redundant Reader

1. Introduction

RFID technology has matured. It widely be used in automated system of many kind of industry and make work more perfect. Such as traffic control [14], healthy care [6] or supply chain management [8]. RFID in a large number of import systems will also use the relative number of tags and readers. In order to ensure tags are completely read, it usually use a large number of RFID readers to read. The most RFID reader read tags duplicate each other and cause redundant readers. Those readers may become extra costs for enterprise. Moreover, it will not only result in waste and also lead to signals conflict and cannot determine. In order to improve the excess reader situation, this paper proposal first search right algorithm to solve above problem. With this algorithm, to reduce the reader to repeat the action took place to read. Relativity, it will reduce construct cost or signal conflict and improve equipment available for enterprise.

RFID was developed by the U.S. Naval Research Office of the enemy recognition system in the Second World War. Major development in the early stage of military purposes, and therefore it does not spread in the civil. In recent years, RFID technology is mature so that the world major manufacturers have invested research RFID application. Especially in the retail leading department store Wal-Mart announced that the former will require its 100 largest suppliers to adopt RFID systems, before the RFID technology

has become the focus of the moment.

In a particular area, deploy large amount of tags and tag readers. Each reader has certain read scope. Each reader can detect tag in their read scope and record little information on detected tags. If a reader detects tags are the same as the other reader, then one of both reader is unnecessary. That's unnecessary reader is called redundant reader. Figure 1 topology is an example. There are three readers, marked as R1, R2 and R3. There are three tags marked as T1, T2 and T3. The circle is present the scope of reader detect. According the topology, R1 detect T1, R3 detect T1, T2 and T3, R2 detect T2, and therefore, only R2 can cover all tags. So R1 and R3 are all redundant and can be removed.

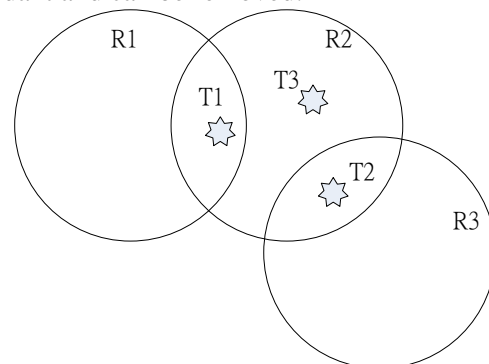


Fig. 1 Redundant reader example

This paper is present an algorithm to judge redundant reader then can save allocation cost and reduce signal collision occur opportunity

2. Relevant Research

2.1 RFID

RFID is a radio frequency identification system. Its main components include original readers, tag and application. Its main principle is fired by the reader a certain degree of radio wave energy to the tag, to drive the chip labels and then to non-contact means of communication to the chip in the digital information transmitted to the reader.

Reader will detect tag identification information and put this message to the back-end application system. Enterprise accords those gather information and make appreciate decision. We divide RFID into three parts: Reader, Tag and Application. Describe as follow.

- Reader: By the analog, digital, where the Central Office and the RF module unit (antenna, transceiver) components. Transmission of high-frequency electromagnetic waves can be used to flow with the signals identified in the hundreds per second RFID.
- Tag: Divided into passive and active two kinds of. Mainly by the analog, digital, memory function and the transceiver chip antenna composed of.
- Application: Reader through the antenna to send a certain degree of frequency. Retrieve or receive the information on tags and transmitted this information to the application. Depending on the application program to determine the legitimacy of the tag, Then according to tag the different settings to make deal and give signals to control. The main function of the application for the control of information sending and receiving RFID Reader, identification, and management.

For the most part of RFID systems comprise three principal components. The first is the transponder, which is affixed to the item that is to be tracked or identified within the supply chain by the RFID system; the reader, which has a number of varied responsibilities including powering the transponder, identifying it, reading data from it, writing to it, and communicating with a data collection application; and the data collection application, which receives data from the reader, enters the data into a database, and provides access to the data in a number of forms that are useful to the sponsoring organization.[10]

2.2 Redundant Reader Elimination algorithm

2.2.1 RRE algorithm

Redundant Reader Elimination in RFID System (RRE) was proposed in 2005. The purpose of the algorithm is to use a minimum number of readers to read all tags. RRE algorithm is to use the main concept of the greedy method. Each round of judge will choice best favorable. In other words, RRE algorithm will choose the largest number of tags that reader own.

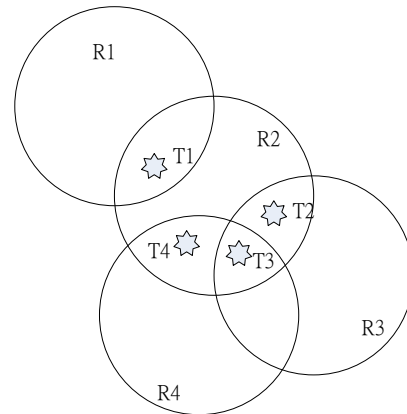


Fig. 2 RRE algorithm miscarriage topology example

Figure 2 is a topology example of RRE algorithm Elimination redundant reader. The start is present locate of tag, marked from T1 to T4. In accordance with the modalities of implementing RRE, Its implementation steps are as follows:

1. At first, all readers are send a signal to each tag within detect scope. Each tag will reply their tag's id to detect reader. In figure 2 as an example, R1 can detect on tag (T1). R2 has four tags (T1, T2, T3, and T4). R3 has two tags (T2 and T3). R4 has two tags (T3 and T4).
2. All reader sends a signal and asked to scan the scope of the reader have to write the count of tag. If the tag reader note on a blank, then the reader will write count of tag that reader read and reader ID into the tag. If the tag returns other reader ID, then compare the number of tags. When the count of reader more than the number inside the tag, then covers the tag note, and vice versa to give up. In figure 2, R2 can detect most tag. Therefore, whatever detects sequence change, the owner of T1, T2, T3 and T4 is R2.
3. When each reader finish detective and write reader owner into tags, then readers ask tags on each Detection range again. If reader ID has not in any tags, then the reader is judged a redundant reader. In table 1, because all tag holder is R2, then determines R1, R3, R4 is the redundant reader

Table 1. RRE algorithm removes the redundant reading device result

	T1	T2	T3	T4
R1	(1,R1)			
R2	(4,R2)	(4,R2)	(4,R2)	(4,R2)
R3		(2,R3)	(2,R3)	
R4			(2,R4)	(2,R4)
final	(4,R2)	(4,R2)	(4,R2)	(4,R2)
Redundant Reader	R1,R3,R4			

2.2.2 LEO Algorithm

LEO algorithm was proposed at 2007. It different from RRE algorithm, LEO algorithm obtains control power preferentially for the persons who are read first. If the label that can be read of the reading device in reading the range, has already been read first by other reading devices, that should reading device judges it for the surplus reading device. The LEO algorithm execution step describe as follows:

1. All reads transmit a signal to inquire in the swath range the volume sign whether to have the holder record.
2. If the tag feedback has not had the holder, then record reader ID in this tag, otherwise, directly slightly crosses. In Figure 3, T1 and the T2 holder is R1. T3 and the T4 holder is R2. Tag in R3 range, already been written into id by R1, R2, so, R3 has been considered as the redundant reading device.

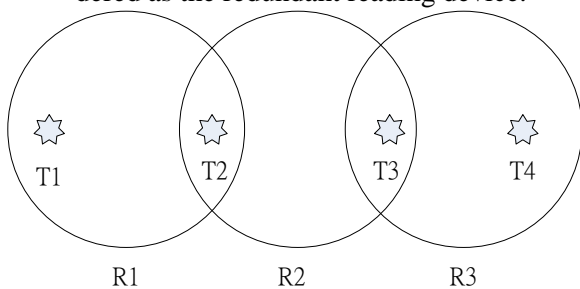


Fig. 3 LEO algorithm miscarriage topology example Table 2. LEO algorithm removes the redundant reading device result

	T1	T2	T3	T4
R1	R1	R1		
R2			R2	R2
R3				
final	R1	R1	R2	R2
Redundant Reader	R3			

Compare LEO and RRE algorithm. LEO reduced the tag quantity comparison step, therefore LEO could save many time than RRE. But LEO algorithm's reading order usually is operates by the stochastic way, therefore each time carries out the result is possibly different, possibly must undertake some risks to the user.

3. Redundant reader removes Algorithm

This study is hoped that through removing redundant reader, thus saving management cost and reduces the depletion of the reader power and reduces the occurrence of the collision problem. Mentioned earlier RRE and LEO algorithm still has spare the reader does not judge the situation, so this study propose a new algorithm, hoping to improve the misjudgment of the situation.

3.1 RRE and LEO miscarriage situation

In the previous chapter, our predecessors made by RRE, LEO algorithms, topology, in some circumstances, lead to miscarriage of justice, and thus failed to identify redundant reader, in this section will explain individual misjudgment of the situation. At first, RRE algorithm is based on can be read while reader up to the label-first search, but this idea will not meet every case, Figure 4 for an example of misjudgment graphics RRE.

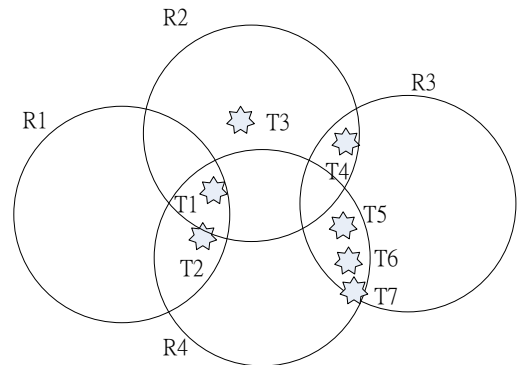


Fig. 4 RRE misjudgment graphics Table 3. RRE algorithm result

	T1	T2	T3	T4	T5	T6	T7
R1	(2,R1)	(2,R1)					
R2	(3,R2)		(3,R2)	(3,R2)			
R3				(4,R3)	(4,R3)	(4,R3)	(4,R3)
R4	(5,R4)	(5,R4)			(5,R4)	(5,R4)	(5,R4)
final	(5,R4)	(5,R4)	(3,R2)	(4,R3)	(5,R4)	(5,R4)	(5,R4)
Redundant Reader	R1						

By the Table 3 demonstrations, uses the RRE algorithm will discover R1 is redundant reader. But in fact, R3 is a redundant reader too. Therefore, under certain topologies, RRE algorithm will have the miscarriage of justice condition. Figure 5 is a situation that LEO algorithm has miscarriage of justice redundant reader. Because LEO is decided that which read first searches for the label by random order, therefore, we will change the reader order to explain the miscarriage of justice the situation.

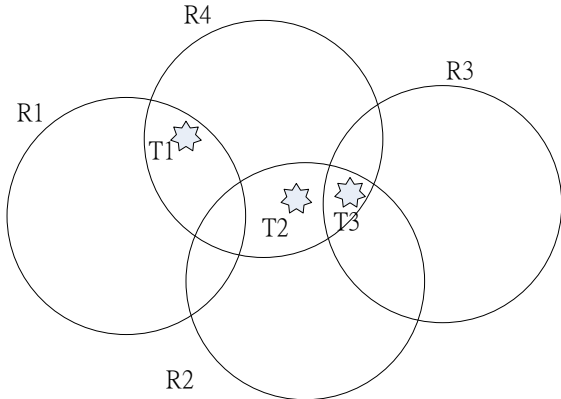


Fig. 5 the Example of LEO algorithm can find optimal solution.

- Situation 1: Reading sequence R1, R2, R3, R4
Table 4. Reading sequence R1, R2, R3, R4 results

	T1	T2	T3
R1	V		
R2		V	
R3			V
R4			
final	R1	R2	R3
Redundant Reader	R4		

- Situation 2: Reading sequence R2, R1, R3, R4
results

Table 5. Reading sequence R2, R1, R3, R4 results

	T1	T2	T3
R1	V		
R2		V	
R3			V
R4			
final	R1	R2	R3
Redundant Reader	R4		

- Situation 3: Reading sequence R3, R1, R2, R4

Table 6. Reading sequence R3, R1, R2, R4 results

	T1	T2	T3
R1	V		
R2		V	
R3			V
R4			
final	R1	R2	R3
Redundant Reader	R4		

- Situation 4: Reading sequence R4, R1, R2, R3
Table 7. Reading sequence R4, R1, R2, R3 results

	T1	T2	T3
R1			
R2			
R3			
R4	V	V	V
final	R4	R4	R4
Redundant Reader	R1 · R2 · R3		

As can be seen from the above results, although the LEO be able to find the optimal solution, but cannot find the optimal solution each time.

3.2 FSR algorithm

According to the previous section shows, LEO and the RRE algorithm in determining the excess reader slightly errors, we propose FSR algorithm to improve the situation of miscarriage of justice. FSR algorithms reader interactions with tags are shown in Figure 6. In order to explain the FSR mode of operation, we are still using figure 3 and figure 4 to explain this algorithm.

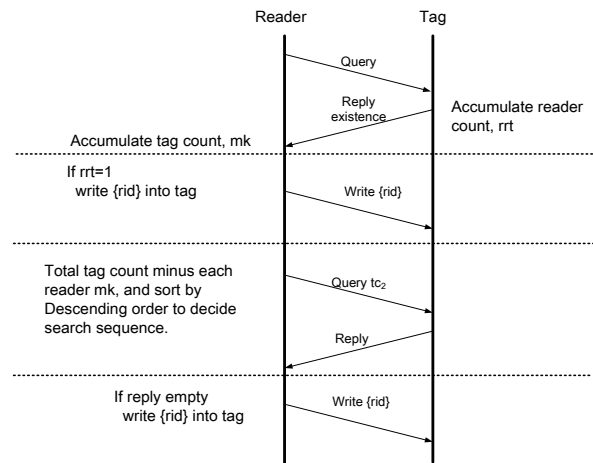


Fig. 5 Reader and Tags interaction diagram
In Figure 3, for example, instructions into the next steps:

- Step 1. All the reader issues a query signal to calculate all the readers to read the tag by the number of mk, and that all tags are calculated by several readers can read the total number of rrt.
- Step 2. determine T3's rrt = 1, indicated that T3 can only be read by R2, so R2 can be read tags the best-first search, the search will end Rid write tags, T1, T3, T4's Rid of R2.
- Step 3: mk by all tag minus the right to be given priority in the search, the smaller the value the more priority to the search. R1 calculated for 5, R3 is 3, R4 is 2. R2 as it has been searched so skip.

- Step 4. from the previous step, in accordance with the tag reader can read the number, from small up to sort, to be the order of R4, R3, R1, so by R4-first search, R4 can be read on the tag issued a query signal, asked if it was read, if no one will read Rid written tag, T2, T5, T6, T7 to Rid for the R4, because T1 has been R2 written Rid just so I do not taken into account.

Table 8. Using FSR algorithm in Figure 4 result

	T1	T2	T3	T4	T5	T6	T7
R1							
R2	(3,R2)		(3,R2)	(3,R2)			
R3							
R4		(5,R4)			(5,R4)	(5,R4)	(5,R4)
final	(3,R2)	(5,R4)	(3,R2)	(3,R2)	(5,R4)	(5,R4)	(5,R4)
Redundant Reader	R1,R3						

In Figure 5, for example, instructions into the next steps:

- Step 1. All the reader issues a query signal to calculate all the readers to read the tag by the number of mk, and that all tags are calculated by several readers can read the total number of rrt.
- Step 2 The first judge did not make $rrt = 1$, so the next step.
- Step 3. mk by all tags minus the right to be given priority in the search, the smaller the value the more priority to the search. R1 to 5, R3 is 3, R4 is 2, since R2 has been searched so skip.
- Step 4. from the previous step that the priority for the R4, R3, R1, so by R4-first search, R4 can be read on the tag issued a query signal, asking if anyone reading, if no one will read Rid written label, T2, T5, T6, T7 to Rid for the R4, because T1 has been R2 written Rid just so will not taken into account.

Table 9. Using FSR algorithm in figure 5 result

	T1	T2	T3
R1			
R2			
R3			
R4	V	V	V
final	R4	R4	R4
Redundant Reader	R1,R2,R3		

4. Experimental results

We use the system simulation approach to experiment RRE, LEO, and FSR algorithms. The way of experiment has described as follow sections.

4.1 Experimental environment

In this research, we design simulation experiment environment by using C ++ language. In the fixed area size 1000 X 1000 units are away from the scope to carry on the stationing, carries on the experiment in view of the read reading scope and the label quantity's change.

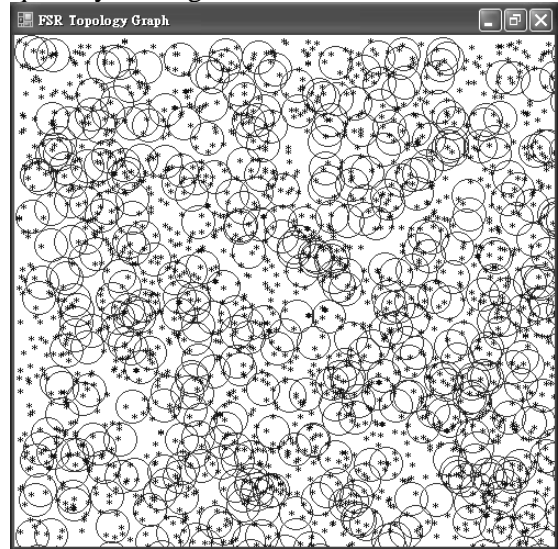


Fig. 7 The topology of random Readers and tags

4.2 Experimental result

This experiment, mainly RRE, LEO algorithm is compared with the FSR. X-axis for the reader's read range and y-axis is to remove excess number of readers too. We set the number of readers take device volume 500, the label number of volume in 2000, the reader reads the range from 30 to 70 compare the results are as follows:

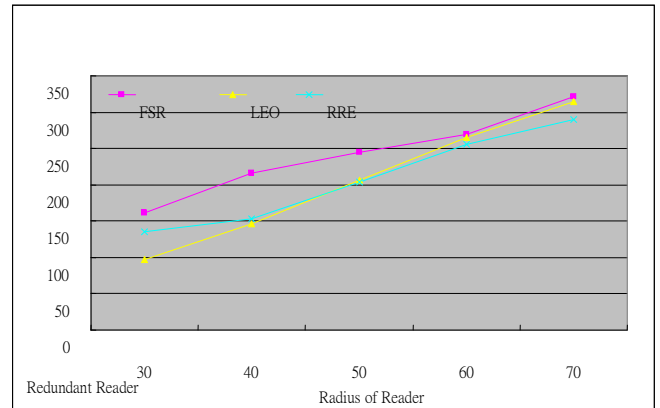


Fig 8. The result of detect redundant reader by different readers' radius

From the figure we can see, RRE in the read range of 30 to 40 better performance than LEO, but

the greater the read range when the time to remove excess amount of reading on less than LEO. The LEO is in the range greater than 50, the performance has improved significantly. Although the FSR algorithm is larger in the scope of the performance of the reader no significant increase, but the overall performance still seems good compared with RRE and LEO.

We have revised the x-axis variable is the number of volume and set the volume number of readers taking device 500, scanning a radius of 50, the number of volume compared to 1000 ~ 8000 results are as follows.

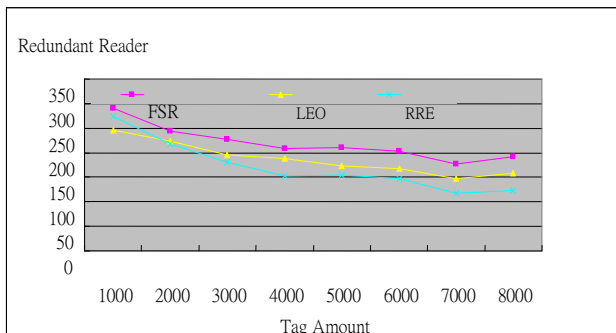


Fig. 9. The result of detect redundant reader by different amount of tags.

We can observe by figure 4.1 results. When the tags total number in 1000, RRE algorithm is better than the LEO algorithm. But LEO is better than RRE when tags number more than 2000. In respect of FSR, although FSR is not good performance when tags number are 1000 and 2000. But with an increasing number of tags, FSR is better than LEO and RRE.

5. Conclusion

For enterprise, RFID technology application does improve management efficiency. When more and more readers and tags are deploying on work environment, it will occur redundant reader or signal collision problem. In this research, we proposes FSR algorithm to solve RFID reader redundant problem. Although FSR process stages are more complex than RRE and LEO, but experiment result can observe show that FSR can detect more redundant readers. When we detect more redundant reader, we can shutdown those redundant readers temporarily and saving operating cost. In our future research, we will focus on detect performance and other algorithm to detect more redundant readers. Finally we expect it can use in real environment so that can get more reality reply.

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