

An optimized dynamic frame slotted ALOHA anti-collision algorithm

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Keywords: RFID, anti-collision, dynamic frame slot ALOHA (DFSA), improved dynamic frame slot ALOHA (IDFSA).

Abstract. The dynamic frame slot ALOHA (DFSA) algorithm is a typical anti-collision. For the shortcomings of DFSA algorithm, this paper presents an improved algorithm – IDFSA. On the one hand, IDFSA algorithm to improve the label estimation algorithm, so as to achieve dynamic adjustment. On the other hand, through the analysis of mathematics, the new grouping of labels is improved, and the phenomenon of landslide is improved. The simulation results show that the throughput of IDFSA algorithm is higher, and the total operations time is less.

1. Introduction

RFID (radio frequency identification, RFID) is widely used in logistics, identification, anti-theft and other fields. A traditional RFID system mainly includes two parts: the reader and the tag. In the case of the number of tags more dense, the reader must use the anti-collision to identify the individual tags. So, anti collision algorithm is very important in multi label application field.

Tag anti-collision protocols [1] can be categorized into two groups: probabilistic anti-collision methods and deterministic anti-collision methods. The probabilistic anti-collision methods are Aloha-based protocols [2] such as pure Aloha protocol, Slotted ALOHA (SA) protocol, Framed Slotted ALOHA (FSA) protocol and Dynamic Framed Slotted ALOHA (DFSA) [3, 4] protocol. In this paper, an improved dynamic frame slot ALOHA (IDFSA) algorithm is proposed.

2. Related work

Frame slotted ALOHA algorithm will be a plurality of time slots set as a frame, for a fixed frame length, when the tag number is less than the length of the frame appears waste the time slot, when the frame length is less than or equal to the number of tags conflict too frequent. In view of this situation, according to the number of tags in the reader range, dynamic adjustment of the next frame length, by a decrease or increase the length of the frame, you can solve the slot waste and tag identification time increased, this method is called dynamic frame slotted ALOHA (DFSA).

The analysis of DFSA algorithm shows that the throughput of the system is mainly determined by the estimation of the number of tags and the adjustment of the frame length. The estimation of the number of tags plays a key role in the performance of the algorithm. At present, there are three kinds of label estimation algorithms, Vogt, Schoute and Lowbound

3. The proposed protocol

3.1 Improved algorithm of tag estimation.

This paper is to optimize the Schoute algorithm. There is a linear relationship between the number of tags and conflict hypothesis slots. Using an adjustable coefficients multiplied by C_k .

The $i+1$ query is completed, the estimated value of tag is

$$n(i+1) = 2.39C_k(i+1) = bC_k(i) \quad (1)$$

Can be obtained

$$b = \frac{2.39C_k(i+1)}{C_k(i)} \quad (2)$$

Number of unrecognized tags is

$$n = \frac{2.39C_k(i)}{C_k(i-1)} \times C_k(i) \quad (3)$$

3.2 The principle of the improved algorithm

The frame length is L, the number of tags is n, the number of empty slots, the number of readable slots and the number of collision slots in a frame are respectively C₀, C₁, C_k. t₀, t₁, t_k are the time of idle slot collision slot and successful slot, so the efficiency of the system can be expressed as

$$P = \frac{C_1 t_1}{C_0 t_0 + C_1 t_1 + C_k t_k} \quad (4)$$

Set $\alpha = \frac{t_0}{t_1}$, $\beta = \frac{t_k}{t_1}$, simplified to

$$P = \frac{n \left(1 - \frac{1}{L}\right)^{n-1}}{(\alpha - \beta)L \left(1 - \frac{1}{L}\right)^n + (1 - \beta)n \left(1 - \frac{1}{L}\right)^{n-1} + \beta L} \quad (5)$$

In order to get the maximum efficiency of the system, the length of frame derivation, so $\frac{dP}{dL} = 0$

$$(\alpha - \beta) \left(1 - \frac{1}{L}\right)^n + \beta \left(1 - \frac{n}{L}\right) = 0 \quad (6)$$

According to the characteristics of the index function $L \geq n$

When the number of tags is less than 256, the corresponding frame length is adjusted once the number of tags reaches the critical point. When the number of tags is greater than 256, the labels are grouped. The number of group $M = \text{round}(n / 256) + 1$, the optimum frame length and the number of packets as shown in Table 1

Table 1 the optimum frame length and the number of packets

Number of tags to be identified	Frame length	Grouping number
1025~2048	256	8
513~1024	256	4
257~512	256	2
129~256	256	1
65~128	128	1
33~64	64	1
17~32	32	1
9~16	16	1
5~8	8	1

3.3 Improved algorithm process

IDFSA algorithm implementation steps as follows:

All tags enter the reader range, waiting for recognition, the algorithm begins.

The reader estimates the tags which in the range, using an improved Schoute algorithm

If the number of tags is less than or equal to 256, then the length of the frame is determined, and the tag is identified by DFSA algorithm and then transferred to (6). If the number of tags is greater than 256, then the label is processed for grouping, and go to step (4).

When the number of tags is greater than 256, the reader sends M instructions, tags are grouped according to the instruction of M, a packet counter each tag randomly selected 1~M in digital, as their packet number.

The reader chooses one of the groups for communication, estimates the number of tags for the group, and waits for the rest of the label waiting for identification.

To estimate the number of tags has not been identified, if the number of tags is not recognized as zero, that all of the identified, the end of the algorithm, or jump to the (3).

The improved ALOHA algorithm processes as shown below:

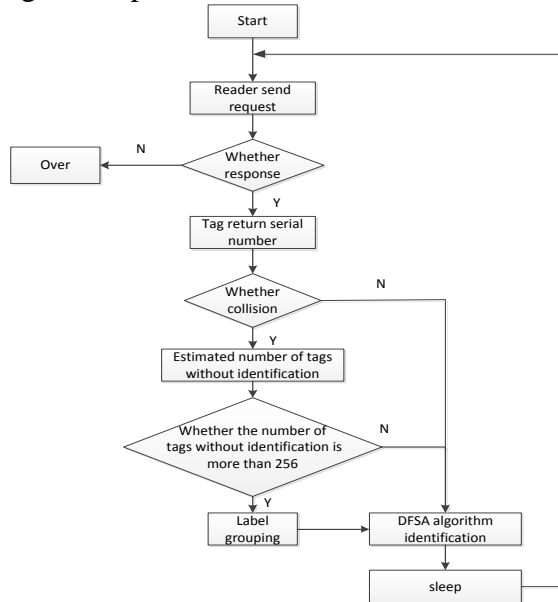


Fig.1 Proposed anti-collision procedures.

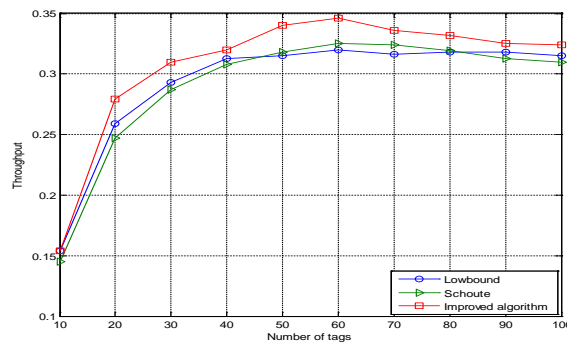


Fig.2 Throughput of the three algorithms

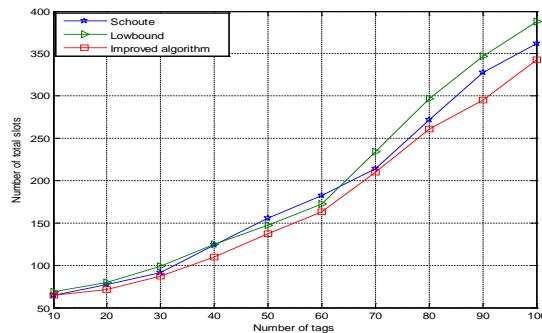


Fig.3 Slots of the three algorithms

4. Simulation

4.1 Algorithm analysis of tag estimation

In order to analyze the performance of the improved tag estimation algorithm, set the initial frame is 64 and the test times is 500. The DFS algorithm is simulated by the improved Schoute algorithm, the original Schoute algorithm and the Lowbound algorithm respectively. From the throughput and the required time slot number comparison, as shown in Figure 2 and figure 3. It can be seen that the

throughput of the DFSA algorithm using the improved Schoute algorithm is the highest, and the required time slot number is the least.

4.2 Performance of IDFSA algorithm

In order to evaluate the performance of IDFSA algorithm, compared with DFSA algorithm. In the case of a certain number of tags, the throughput and total number of operations are shown in Figure 4 and 5.

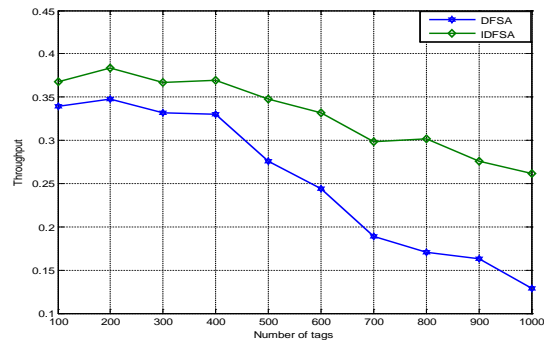


Fig.4 Throughput of the two algorithms

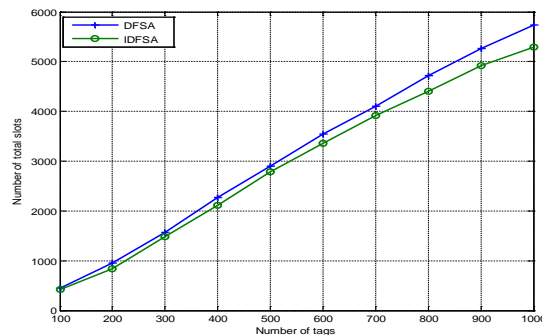


Fig.5 Operations of the two algorithms

As shown in Figure 4, the throughput of the IDFSA algorithm is higher than that of the DFSA algorithm, when the tag number is greater than 256, "Landslide" phenomenon improved. Figure 5 shows that with the increase of the number of tags, the advantages of IDFSA algorithm become more obvious.

5. Conclusions

This paper mainly studies the tag collision problem in RFID system. For the shortcomings of DFSA algorithm, an improved dynamic frame time slot ALOHA (IDFSA) algorithm is proposed. Then, the algorithm of IDFSA is simulated using MATLAB platform. The simulation results show that, the proposed algorithm can significantly improve the system throughput and the total number of operations.

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