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A Novel Enhanced Anti-collision Algorithm for RFID Systems

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Abstract—Internet of things technology is inseparable from RFID (RFID). Tag collision and information security are two main problems in the application of RFID system.This paper is mainly proposed in the time slot ALOHA algorithm on the basis of an enhanced collision algorithm, it uses a fusion algorithm for dynamic adjusting frame timeslot number. The results of MATLAB simulation shows that when the frame length was shorter and the number of the tag, it was close to the time gap, the throughput rate of the transponder was 0.693, which was nearly 88% higher than the general throughput rate of 0.368.

***Keywords*—RFID system; throughput rate; Aloha algorithm; EGDFSA; transmission efficiency**

IINTRODUCTION

It is recognized that the first thing to come up with the term Internet of Things is professor Ashton of MIT's auto-id center. He introduced this concept in 1999 when he studied RFID (RFID) [1].The RFID system is used in the non-contact automatic identification technology. Because of the simple, large amount of information, safe performance, fast response, and strong adaptability to environment, it has been widely used in manufacturing, logistics, automation and intelligent transportation, other areas etc. This paper mainly analyzes the anti-collision algorithm of RFID system network on passive ultra-high frequency band.

Globally the RFID (radio frequency identification) technology develops rapidly, but its key technologies are still mainly security protocols and collision algorithm. This paper mainly analyzes the latter. In order to ensure that RFID technology development implements multiple tags at the same time to identify the accurate data, we need to adopt a reasonable algorithm, namely the RFID system collision algorithm, to effectively solve the multiple tags in the process of the RFID system's reading, speaking, collision occurring during data reading and writing.

Tag collision technical analysis can be used in a TDMA (time division multiplex), FDMA (frequency division multiplex), SDMA (air separation multiplex), CDMA (code multiplexing) 4 methods, one of the most common is the TDMA technology[2], probabilistic Aloha algorithm and a deterministic binary search tree algorithm are the typical representatives of matching collision algorithm. Aloha algorithm is more adopted, because the time of the tag sending information is random, and the design and implementation is relatively simple and the physical cost is low [3].So this paper is based on Aloha algorithm for grouping dynamic frame Slot-time anti-collision algorithm, which improves the analysis and proposes an enhanced algorithm.

IIALGORITHM BASING

RFID transponder are the main situation of collision system collision, a read/write device within the scope of work at the same time is more than a transponder, and response to commands from the read/write device, leading to read and write is unable to correctly identify a transponder,so system transponder collision is happened [4].It is divided into two situations: partial collision and complete collision, and collision avoidance is the problem of solving the collision, as shown in figure 1,the Aloha algorithm does not have an partial collision.

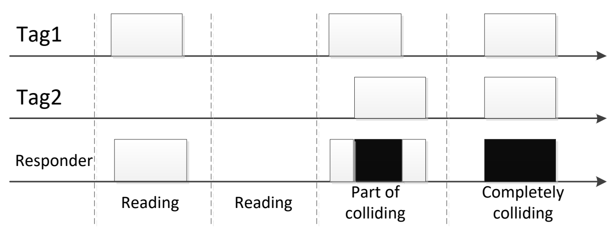

Figure1 Responder collision

Based on the development process of the anti-collision algorithm based on Aloha, it has experienced five stages of the Aloha algorithm: the traditional Aloha, the Slot-time Aloha, the Frame Slot-time Aloha, the Dynamic Frame Slot-time Aloha, and the Grouping Dynamic Frame Slot-time Aloha algorithm.

The traditional Aloha algorithm is easy to implement, and when the tag doesn't receive the reader's response, it indicates collision, so it doesn't apply to more complex RFID system. In this algorithm, the relationship between the data information sent by the tag and the transmission efficiency (throughput rate) is satisfied:

$$S = G \cdot e \quad (1)$$

The tags sending data conform to the poisson distribution rule. When the formula (1) has a differential value of zero, transmission efficiency can achieve the maximum value S_{max}

of 0.184 [5],request must wait a while, the tags will send data again, until the read/write device response.

In the Slot-time Aloha algorithm, the tag collision only has a complete collision, no partial collision will occur, and the relationship between the data information sent by the tag and the transmission efficiency (throughput rate) is satisfied:

$$S = G \bullet e^{-G} \quad (2)$$

$$S_{max} = 0.368 \quad (3)$$

The throughput rate has doubled, but the algorithm is still relatively simple [6].General component is the current time slot response time slot, the idle time slot collision and time slot, the three types of response time slot can correctly identify a tag, idle time slot refers to not identify any tags, the collision time slot refers to a time slot with multiple tags at the same time send reply form the collision, completely without parts and collision. The characteristics of the Slot-time Aloha algorithm are mainly to decompose the response time of the tags and avoid the waste in different time slots. But it also has its disadvantage, when the frequency of conflict is too high, it is easy to cause the significant delay of the tags and the recognition time [7].

The characteristics of the Frame Slot-time Aloha algorithm adopt the fixed frame length in time of bits per frame,in order to choose a time slot to send data, found the tag collision, end immediately and exit the current loop, waiting to participate in the next frame time slot cycle[8].The throughput rate of the algorithm is slightly improved, But when the number of tags is less than the frame length, the free time slot will be more, and then result in the waste.

Dynamic Frame Slot Aloha algorithm adopts a dynamic adjustment frames, the system is more stable ,but the maximum throughput rate is still 0.368, reading and writing implement frame is noticeably shortened, when the tags increases gradually, the system throughput rate and identification efficiency significantly declines [9].

Therefore, Group Dynamic Frame Slot-time Aloha algorithm make further improvement , the characteristics of the algorithm is to group the tags first, then using dynamic frame timeslot algorithm, which can identify the characteristics in the time slot to send reply information, which improve the system throughput rate. Actually, it is relatively easy to implement in hardware [10]. Therefore, a new enhanced algorithm is proposed.

III Description of EGDFSA

GDFSA algorithm is an Enhanced Aloha algorithm, based on grouping Dynamic Frame Slot-time Aloha algorithm, the full name is Enhanced Group Based Dynamic Frame Slot Aloha algorithm. it characterizes by a combination of Aloha algorithm and binary search tree based algorithm, an effective coding identification tag collision time slot, mainly in binary search tree algorithm is used for grouping tags. It is divided into three parts:

(1) Estimate frame length and tags number

Use Schout prediction algorithm to estimate the number of tags, the literature proposed a called to predict dynamic frame to check after time slot Aloha algorithm (FBVDFSA algorithm) [11]. It is different from ordinary Schout prediction algorithm, when there is free time query time slot number, single tag number and collision time slot number for forecasting that referred to in the preceding paragraph, to estimate the tag number of the next round of query, the query is estimated based on the existing numerical to check after the tag number.

The simulation results show that when the frame length is shorter and the number of the tag is close to the time slot, the throughput rate can reach 0.693, which is nearly 88% higher than the general throughput rate of 0.368, using the following equation:

$$n = c_k * \frac{c_1(i) + 2.39 c_k(i}{c_k(i+1)} \qquad i \geq 1 \text{ and } c_k(0) = n_{tot} \quad (4)$$

In the (4), the number of collision time slot is expressed, and the tags can be obtained by means of normal identification of the time slot.

(2) Binary search tree algorithm grouping

According to the estimation of the frame length, when a large number of tags appear at the same time, we can use a regressive binary search tree search algorithm. When the frame length increases, tags recognition will significantly shorten the time, and take up less storage space. Practically the register in the tag is 8 bits [12], using the unique UID encoding method, the group can be effectively implemented according to the physical tagling code and the highest sequence number. The Dynamic binary search tree algorithm identification can refer to figure 2,the transponder is obtained by paging instruction.

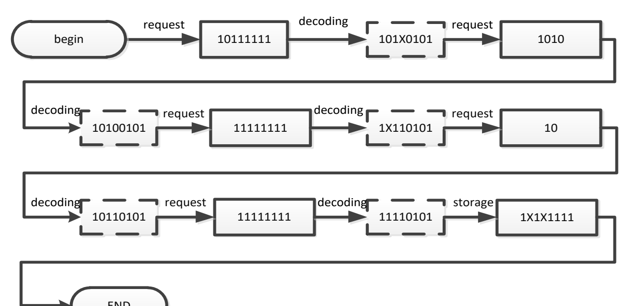

Figure2 Dynamic binary search tree algorithm

when frame length is $2^8 = 256$, the grouping conditions are shown in table 1, the length of frame is grouped by L= 256. The reader must send a command to the transponder many times, and each command divides the transponder into two groups, after multiple groups, it ends up with a single transponder, If the tag is activated by a reader, it is active and inactive. This can significantly shorten the data transmission of system recognition within a time slot between the reader and the tag.

Table 1 tag frame length and grouping table

Frame length	Q	Tags	Group	Group conditions
…	8	…	…	…
256	8	867-1000	Ⅳ	256，256，256，else
256	8	611-866	III	256，256，256，else
256	8	355-610	II	256，else
256	8	256-354	I	all
128	7	128-255	I	all
64	6	64-127	I	all
16	4	16-63	I	all
4	2	1-15	I	all

(3) Identificating tag by Dynamic Frame Slot time Aloha algorithm

The Dynamic Frame Slot-time Aloha algorithm mainly adjusts frame length according to the tag number to improve the tags recognition efficiency. The detailed steps are described as follows, contained figure 3:

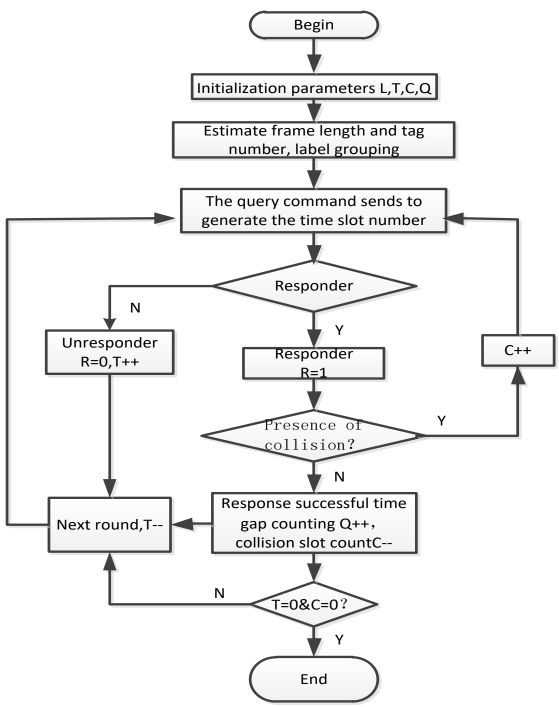

Figure3 The algorithm Flow chart

Step 1 Initialization parameters: C= 0, frame length L= 4, response successful time gap count Q= 0, free time slot count T= 0.

Step 2 Estimate frame length and tag number, use the Schout prediction algorithm, the calculation formula (1), each frame in the time slot in line with the poisson distribution, and the number of tag collision time slot is 2.39, using the forward prediction and backward validation query tag number.

Step 3 The tag group is carried out by the estimation value, and its UID coding is performed, and the grouping category is followed by step 4.

Step 4 Issue the query command, the tags randomly select the time slot, and generate the random number of the time slot, the tags response assignment R= 1. When

a.When R= 0, the tag responds, the transponder query the tag information, in two cases:

The first kind of circumstance: there is a collision time slot count C + 1, according to extract information, enter the new query command, if it do not collide into the step 5, if a collision return query command, and query the collision response, until the packet loss [9] [10], enter step 5;

In the second case, the tag has no collision, the response success counts Q plus 1, the collision time gap counts C minus 1, enter step 5.When

b.When R= 1, the tags is in the sleep state, and the free time slot counts T plus 1, and the value of the non-response value is R= 0.

Step 5 Transponder send feedback command, into the next round of the query, the other does not respond within the scope of the query tags for testing, a crash into a, no collision to b, free time slot count T minus 1, collision time slot count C reset, reply the successful time slot count Q keep original value;

Step 6 Loop the response until each tag has been iterated through the query, i.e., the free time slot count T is 0, and the collision Slot-time count C is 0, and the query ends.

Ⅳ ALGORITHM SIMULATION

The algorithm simulation results show that the enhanced group dynamic frame tags throughput time slot algorithm is higher than other algorithms, when N = 64, obtain the maximum value of 0.693, with the tag number increase, can also be stable at around 0.35, and the tags has a high traffic, as shown in figure from 4 to 6,the relationship between RFID system frequency and magnitude is shown in figure 7,the relationship between tag number and Data transmission is shown in figure 8.

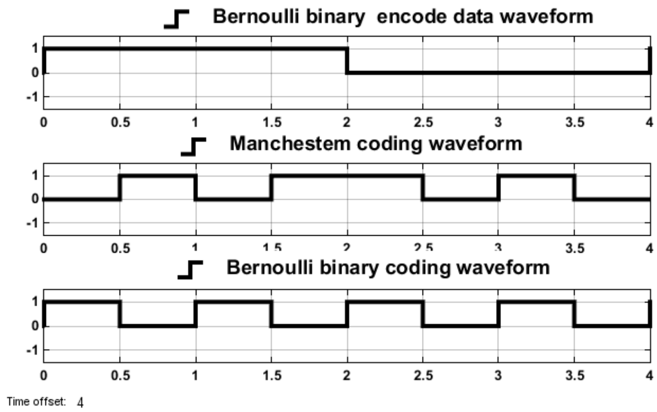

Figure 4 Manchester code

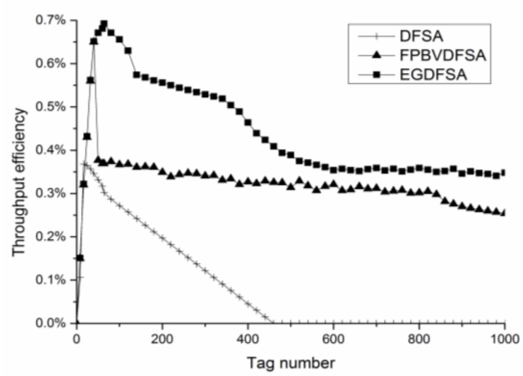

Figure 5 RFID System throughput efficiency

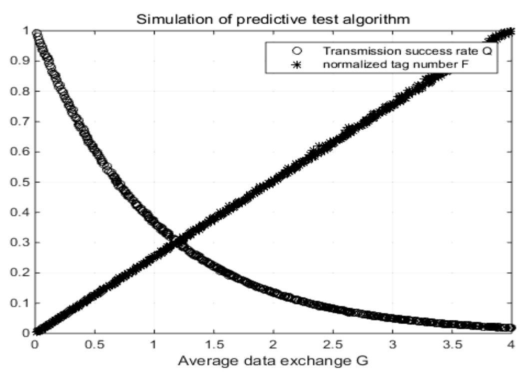

Figure 6 RFID Enhanced Anti-collision algorithm efficiency

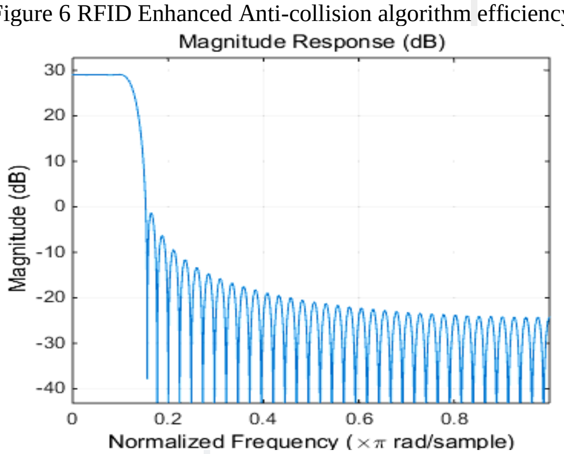

Figure 7 RFID system simulation of frequency and magnitude

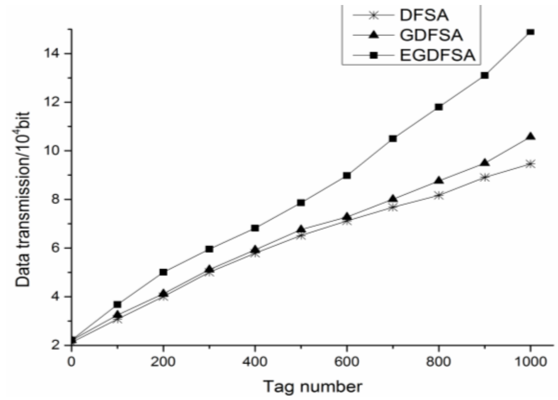

Figure 8 RFID Enhanced simulation of Data transmission

The improved performance of the new algorithm can effectively solve the problem of RFID system tags collision prevention.

V SUMMARY

In fact, it is one of the key problems of RFID system and the core link of the development of Internet of things.In this paper, passive uhf RFID system forecast test of collision algorithm, effective coding identification tag, tags group using binary search tree decomposition method, easy to implement in hardware.In the follow-up work, we will explore how to further optimize the performance of RFID system tag anti-collision algorithm.

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