DOI: 10.21917/ijct.2012.0077

ADVANCED DYNAMIC FRAMED SLOTTED ALOHA

T. Raja[1] and V. Perumal[2]
Department of Computer Science and Engineering, Saveetha Engineering College, India
Email: [1]raaja_as@yahoo.co.in and [2]v.perumal23@gmail.com

Abstract
RFID is a technology that used to identify the objects automatically. But identifying multiple objects simultaneously caused for collision which reduces the efficiency of the system. Because of the collision, some tags cannot be identified. This is a major disadvantage of the RFID system. The collision will lead to loss of data and tag identification. There are various anti-collision algorithms used to avoid the collision in multi-tag environment. Every anti-collision algorithm is efficient than earlier algorithms including time complexity. But the problem exists. The anti-collision algorithms are basically classified into two categories. They are ALOHA based algorithms and tree based algorithms. The new anti-collision algorithm that introduced in this paper is based on the ALOHA protocol which can improve the time complexity. And different anti-collision algorithms are analyzed.

Keywords:
Algorithms, RFID, ALOHA, Frame Size Estimation, Tags

1. INTRODUCTION

RFID stands for Radio Frequency Identification Devices. The RFID is one of the automatic technologies to identify the objects and collect data quickly through Radio Frequency digital signals. With this technology, the objects to be identified are attached with RFID tags and a reader is used to scan all the tagged objects without direct contact with the objects. The main components of a typical RFID system are host computer, reader and tag [8]. The reader has a transmitter-receiver module and antenna. The tag consists of integrated circuit, memory, and antenna. The tag is attached to the object for identification. Each tag has a unique identification number. It can store the details about the object also. The major advantages of RFID technology over barcodes are that the RFID-tagged objects do not require being in line-of-sight with the reader for their identification and multiple objects can be read simultaneously. Since RFID reader can scan multiple tags simultaneously, there is a problem of collision. So it is important to design a good anti-collision algorithm for collision avoidance and to improve the performance of the system.

Though several anti-collision algorithms have been developed, the problem of collision still occurs in RFID system. Since the reader has no prior knowledge about the actual number of tags to be scanned, the reader has to know when to stop scanning the tags [8]. When a reader communicates with single tag, there is no possibility for collision. If a reader communicates with more than one tag, the collision will occur. The collision rate will be high if the number of tags is high in a system. There are three types of collisions will occur in the RFID system. They are tag-tag collision, reader-tag collision and reader-reader collision.

In tag-tag collision, there are multiple tags with single reader. When more than one tag is available in the reader's interrogation area, the collision will occur in the system. After the reader is triggered signal to the multiple tags, the multiple tags will try to respond to the reader at the same time through a single channel [9]. So the tag-tag collision will occur in such a situation.

When the tag is trying to respond to a reader, the signal of neighbouring reader interferes with the responding signal of the tag. In this situation the collision will occur in the system. This is known as reader-tag collision.

In reader-reader collision, multiple readers are trying to send query to a tag at the same time. In such a situation, the tag may not be able to respond to any one of the readers.

To avoid these collisions, there are several anti-collision algorithms used in the RFID system. The major classifications of the algorithms are ALOHA based protocols and tree based protocols. The Pure ALOHA, Slotted ALOHA, Framed Slotted ALOHA, Dynamic Framed Slotted ALOHA are ALOHA based protocols.

There are three factors to be considered when designing an anti-collision algorithm. They are frame size estimation, tag estimation and stopping criteria. The system doesn't aware of actual number of tags. So the system doesn't have idea of completion of identification process. So the stopping criteria technique is used to stop the identification process. In this paper, a new anti-collision algorithm based on the ALOHA protocol is introduced.

2. RELATED WORK

There are several anti-collision algorithms introduced. Different types of frame size estimation techniques, tag estimation techniques and stopping criteria techniques are used in anti-collision algorithms.

2.1 PURE ALOHA

The ALOHA network was developed in the early 1970s by Norm Abramson at the University of Hawaii to create a wireless communication network to link up the different campuses in Hawaii together [9]. The main purpose of this system was to transmit wireless packets over a switched network using a shared medium. Each station is allowed to access the channel whenever it has to send the data and the station can determine if its data is transmitted successfully or not by comparing the received data with the sent data. In case of collision, the data is sent again after a random period of time. The throughput of the pure ALOHA is [9],

$$T = Ge^{-2G} \quad (1)$$

where, G is the rate at which transmission occurs.

The maximum throughput of the pure ALOHA is 18.4%.

2.2 SLOTTED ALOHA (SA)

The slotted ALOHA is an enhanced version of pure ALOHA. In this protocol, the time is divided in to equal size intervals known as slots and the transmission time of the data is equal to the slot size. Each station can transmit its data at the beginning of the next available time slot. In case of collision, the collided data overlap completely and the stations involved in the collision retransmit the data in other available time slots after some random time intervals to reduce the possibility of re-collision. The throughput of the system is [9],

$$T = Ge^{-G} \tag{2}$$

The throughput of the system is 36%.

2.3 BASIC FRAMED SLOTTED ALOHA (BFSA)

The slotted ALOHA performance degrades when large number of tags in the system. FSA system consists of frames and read cycles in addition to the slots. A frame is a group of time slots and a read cycle is the process of identifying tags which involves a frame. Each tag can transmit its data at most once in a frame.

After the reader is triggered signal to the tags, the tags send their data to the reader. The data are randomly distributed through the time slots. The data are randomly picked the time slots. If single datum only passed through a time slot, the data transmission is said to be successful transmission. If more than one data simultaneously passed through a time slot, the time slot is said to be collision time slot. Even a datum is not passed through a time slot, it is said to be ideal time slot. If the collision occurred, the data will be transmitted in the next read cycle [9]. This process continues until all the tags transmit their data successfully.

The maximum throughput is 36.8% [9].

2.4 DYNAMIC FRAMED SLOTTED ALOHA (DFSA)

In the Basic Framed Slotted ALOHA, the frame size is fixed. If there are too many tags, most of the time slots experience with collisions and none of slots identified as successful transmission slots. So, none of tags are identified for a long time. If the number tags are low, most of the time slots will be idle. So the speed of the identification process will be affected [9]. To solve this issue, the DFSA was introduced. In DFSA, the frame size can be changed dynamically after every read cycle. After every read cycle, the number of tags is estimated using tag estimation techniques and the frame size is changed for next read cycle according to the number of tags. So the speed of the identification process can be improved than BFSA.

2.5 ENHANCED DYNAMIC FRAMED SLOTTED ALOHA (EDFSA)

Even though the frame size is changed dynamically in the DFSA, the maximum frame size is fixed. So it is not fit for large number of tags. In EDFSA, if the number of unread tags is sufficiently large, the tags can be grouped and allowing only one group to respond. The number of groups can be obtained by modulo operation.

$$M = \text{unread tags} / N \tag{3}$$

where, N is the number of time slots used in the read cycle.

3. PROPOSED SYSTEM

3.1 ADVANCED DYNAMIC FRAMED SLOTTED ALOHA (ADFSA)

In ADFSA algorithm, the maximum frame size will be fixed after every read cycle. To fix the frame size, the knowledge about number of tags present in the system is needed. Actually the system doesn't have prior knowledge about the number of tags in the system. So, the tag estimation techniques are used to estimate the number of tags. The new frame size estimation is used in this algorithm.

Algorithm.1. Procedure for Frame Size Estimation

```
F=32,T=100
FOR I=0
    FOR N=1
        IF T< 2^N
            BREAK
        ENDIF
    ENDFOR
FIND MEAN VALUES OF 2^(N-1) AND 2^N
        IF T<= MEAN (2^(N-1),2^N)
            F=2^(N-1)
          ELSE
            F=2^N
        ENDIF
CALCULATE C1,C0,CK
CALCULATE TAG ESTIMATION
        IF (C1 AND CK ) = 0
          BREAK
        ENDIF
ENDFOR
```

Here, the C1 indicates the number of successful time slots, the Ck indicates the number of collision time slots and the C0 indicates the number of ideal time slots. The C0, C1 and Ck values are used to estimate the number of tags. If the number of tags is less than 2^N, the mean values for 2^{N-1} and 2^N are calculated. If the number of tags is less than or equal to the mean value, the frame size will be 2^{N-1}. Otherwise the frame size will be 2^N. The initial frame size (N) is assumed as 32, as it gives better performance [8].

4. RESULTS

In the ADFSA algorithm, new frame size estimation is used. For every read cycle, the frame size is estimated using the new frame size estimation. The frame size is estimated by finding mean values of the frame size (2^N) which is just greater than the number of tags present in the system and the frame size (2^{N-1}) which is just less than the number of tags present in the system. If the number of tags is less than or equal to the mean value, the frame size fixed as 2^N. Otherwise the frame size is fixed as 2^{N-1} for the next read cycle.

The efficiency of BFSA and EDFSA is evaluated and compared with ADFSA. In the performance evaluation [8], the number of read cycles and total time slots that can be used to identify all the tags in the system are calculated. The performances of the algorithms are evaluated by finding the values that shown in the table.

Table.1. Simulation results of Anti-collision Algorithms

		50 Tags	100 Tags	200 Tags	500 Tags
BFSA	Read Cycles	5	12	13	21
	Collision	36.6	213.3	426.61	1731.31
	Ideal	137.3	134.71	333.39	712.69
	Total Slots	173.9	348.01	760	2444
EDFSA	Read Cycles	6	7	9	13
	Collision	27.63	56.86	116.24	571.93
	Ideal	74.36	131.16	251.76	424.07
	Total Slots	101.99	188.02	368	996
ADFSA	Read Cycles	9	11	13	19
	Collision	57.21	116.52	235.27	658.02
	Ideal	35.01	71.78	145.24	356.59
	Total Slots	92.22	188.3	380.51	1014.61

The values are plotted as a graph and the efficiency of the ADFSA and earlier algorithms are analysed.

The analysis shows that the BFSA performance is very low as the frame size is fixed for every read cycle. The total time slots to identify all the tags in EDFSA are higher than ADFSA for 100 tags and below. ADFSA performance is higher than EDFSA for below 100 tags.

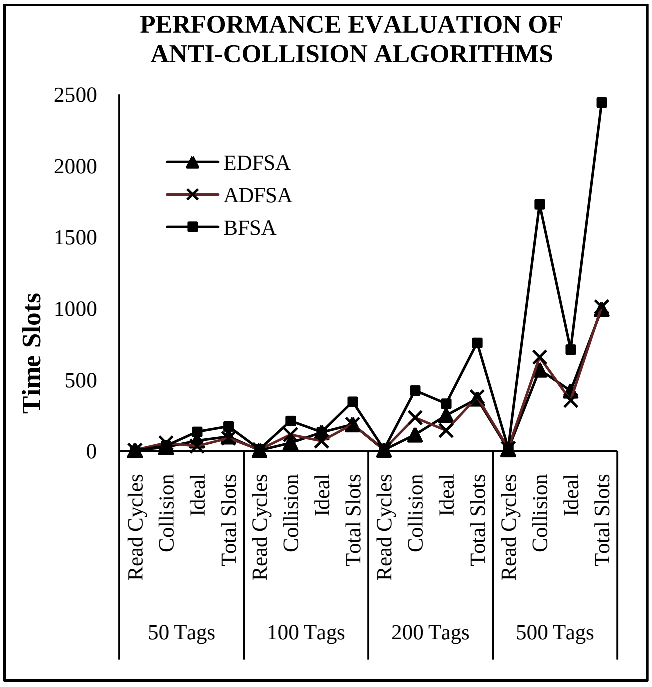

Fig.1. Performance of BFSA, EDFSA and ADFSA

So the results proved that the speed and accuracy of the ADFSA is higher than earlier algorithms for 100 tags and below. For the authorization applications, the ADFSA will be faster than the EDFSA.

5. CONCLUSION

We have analysed the ADFSA with BFSA and EDFSA by estimating total number of time slots, collision time slots and ideal time slots. The total time slots that have taken for identification process are lower than earlier algorithms. So the time complexity is improved than earlier algorithms. Therefore, we find the ADFSA is suitable for authorization applications where the number of tags is low. And it has high speed and accuracy. In future, the ADFSA can be enhanced to high number of tags.

REFERENCES

[1] Yan Xin-qing, Yin Zhouping and Xiong Youlun, "QTS ALOHA: A Hybrid Collision Resolution Protocol for Dense RFID Networks", *IEEE International Conference on e-Business Engineering*, pp. 557-562, 2008.

[2] Jung-Sik Cho, Jea-Dong and Sung Kwon Kim, "RFID Tag Anti-Collision Protocol: Query Tree with Reversed IDs", *10th International Conference on Advanced Communication Technology*, Vol. 1, pp. 225-230, 2008.

[3] Liang Biao, Hu Ai-qun and Qin Zhong-yuan, "Trends and brief comments on anti-collision techniques in radio frequency identification system", *Proceedings of the 6th International Conference on ITS Telecommunications*, pp. 241-245, 2006.

[4] Jae-Min Seol and Seong-Whan Kim, "Collision-resilient multi-state query tree protocol for fast RFID tag identification", *International Conference on Computational Intelligence and Security*, Vol. 2, pp. 1159-1162, 2006.

[5] Lean Liu, Zhenhua Xie, Jingtian Xi and Shengli Lai, "An improved anti-collision algorithm in RFID system", *2nd International Conference on Mobile Technology, Applications and Systems*, pp. 1-5, 2005.

[6] Jongho Park, Min Young Chung and Tae-Jin Lee, "Identification of RFID Tags in Framed-Slotted ALOHA with Robust Estimation and Binary Selection", *IEEE Communications Letters*, Vol. 11, No. 5, pp. 452-454, 2007.

[7] Murali Kodialam and Thyaga Nandagopal, "Fast and Reliable Estimation Schemes in RFID Systems", *Proceedings of the 12th Annual International Conference on Mobile Computing and Networking*, pp. 322-333, 2006.

[8] Dheeraj K. Kliar, Kwan-wu Chin and Raad Raad, "On the Accuracy of RFID Tag Estimation Functions", *International Symposium on Communications and Information Technologies*, pp. 1401-1406, 2007.

[9] Kamineni Neelima and Xinrong Li, "Analysis of anti-collision multi-tag identification algorithms in passive RFID systems", *International Conference on Computing Communication and Networking Technologies*, pp. 1-8, 2010.