A RFID Tag Collision Avoidance Algorithm Based on Variable Frame Length

Jin Zhi

Chongqing College of Electronic Engineering, Chongqing, 401331, China

Email: scbzjinzhi@163.com

Keywords: RFID, Tag, Collision Avoidance, Variable Frame

Abstract: With the development of logistics industry, there is an urgent need for effective means to realize the identification of a large number of goods transfer stations. Wireless identification technology is based on the information exchange between radio frequency tags and wireless card reader to achieve label identification without manual intervention. Because of the huge quantity of goods in the transit station, the hardware design of the card reader must consider the complexity of implementation, so the collision of wireless label information exists in the process of identifying the wireless label of goods. The current probabilistic tag anti-collision algorithm has a low rate of tag recognition, and its efficiency is limited in the face of a large number of tags to be identified. In this paper, an adaptive frame length anti-collision algorithm for wireless identification tag is proposed, which can adjust the detection frame length adaptively and improve the tag recognition rate.

1. Introduction

Modern logistics distribution involves a large number of complex products, the accuracy and timeliness of information requirements are very high. The distribution of picking operations is the most onerous and error-prone works, compared with the traditional way for the out of the warehouse, the use of electronic tag picking can achieve paperless operation, which can greatly improve the efficiency and accuracy of the operation, so that users greatly reduce the time out of the warehouse. In Japan and South Korea, electronic labels have become the standard allocation for most logistics distribution centers.

Due to the limitation of scanning time for identifying electronic tags, when the number of electronic tags to be scanned is large, the reader may receive information from multiple electronic tags at the same time, it results in the reader can not identify the information from which electronic tag. This phenomenon is called collision in RFID technology. In order to achieve effective and reliable identification of electronic tags, how to solve the collision problem is called one of the key points in RFID technology research. In view of the huge base number of tags to be identified, wireless identification algorithm does not need to ensure that all tags are recognized at once, but only needs to detect electronic tags with a certain probability mean. The current anti-collision algorithm is based on time division. for example: Basic Aloha Algorithm(BAA), Slot Aloha Algorithm (SAA）,Frame Slot Aloha Algorithm，(FSAA）and so on.

BAA algorithm is the easiest anti-collision algorithm to achieve the identification of wireless tags by the way that wireless tags actively send their own tag numbers to the reader. BAA algorithm has no mechanism to prevent collision. To solve this problem, SAA algorithm defines a uniform clock in the time dimension, and specifies that wireless tags send messages at each specified time, which reduces the probability of collision. On the basis of studying SAA algorithm, FSAA algorithm divides multiple time slots into one frame, increases the probability of radio tags being recognized in each transmission cycle, and further reduces the collision probability.

However, these algorithms can not solve the problem of conflict probability fluctuation caused by the uncertain number of tags to be identified. Although the FSAA algorithm has a relatively good ability to reduce collision, when the frame length setting of the FSA algorithm does not match the number of tags to be detected, the performance of the algorithm is greatly reduced. This paper presents an adaptive frame-based anti-collision algorithm (AFAA) for RFID tags. AFAA algorithm

  DOI: 10.25236/systca.18.073

adaptively adjusts the frame length according to the detection of collision to further reduce the collision probability, so as to solve the above problems.

2. The existing algorithms

2.1 Basic Aloha algorithm (BAA)

The basic Aloha algorithm (BAA) collects the tag identification numbers sent by each wireless tag during each detection cycle. Collision occurs when two or more wireless tags send their own identification numbers simultaneously in a detection cycle. The test results for this cycle are invalid. The tag that produces the collision will wait a certain time and send its own identification number again until it is recognized by the reader.

2.2 Slot Aloha algorithm (SAA)

Aiming at the high collision probability of BA algorithm, SAA algorithm quantifies the time dimension. The SAA algorithm specifies a finite time length of one slot. The time axis is arranged according to the time slot, thus forming the time slot start time point with equal spacing. All wireless tags follow the rules of initiating their own label number transmission at the time slot start time point. In this way, the tag collision probability in BAA algorithm is greatly reduced.

2.3 Frame time slot Aloha algorithm (FSAA)

Frame slot algorithm (FSAA) defines several slots as a frame based on SAA algorithm, and the frame length is fixed. Within each frame, the wireless label initiates the transmission of its own label number. Wireless tags need to choose the time slot to send their own numbers in the current frame. In this way, the collision probability of different tags in the same slot is reduced. Therefore, the FSAA algorithm has lower collision probability than the SAA algorithm.

3. Adoptive Frame based Anti-collision Algorithm(AFAA）

3.1 Principle of AFAA

In the above algorithm, the FSAA algorithm has the lowest collision probability. The performance of FSAA algorithm is closely related to the selected frame length. The more the number of wireless tags to be detected and the longer the frame is, the more likely each slot will collide. When the tag is relatively small, the performance of the algorithm will be improved. In practical applications, it is difficult to guarantee the stability of FSA algorithm because the number of tags to be detected can not be known beforehand.

To solve the problem of FSAA algorithm, this paper proposes an adaptive frame length RFID tag anti-collision algorithm (AFAA). Aiming at the shortcomings of FSAA algorithm, AFAA has made the following improvements:

To the FSAA algorithm, when the number of tags is large and the time slot of frames is less, the time slot of collision will increase. On the contrary, when the number of tags is small and the slots of frames are large, the number of idle slots in each frame is too large, which affects the efficiency of the algorithm.

The AFAA algorithm defines idle time slot, successful time slot and collision time slot, and solves the relationship between the probability of occurrence of the three slots and the frame length and the number of tags to be detected, so as to find the suitable frame length with the lowest collision probability and the least idle time slot. By periodically performing the above detection during the running of AFAA algorithm, the adaptive frame length adjustment function is realized. Finally, reduce the collision probability and improve the efficiency of the algorithm.

3.2 AFAA algorithm implementation steps

Based on the above analysis, the flow chart of the reader side of the AFAA algorithm is shown in Figure 1.

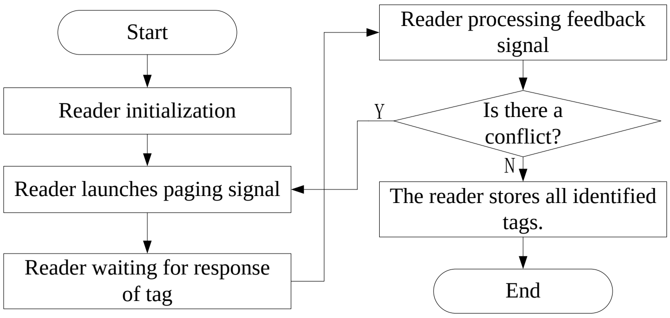

Fig. 1 Flow chart of reader side of AFAA algorithm

The detailed description of the implementation of AFAA algorithm is described as flows:

Step1: activate the reader and complete the initialization of the reader's own system.

Step2: reader initiates radio signal notification for wireless labels. The notification contains clock information to synchronize the wireless tag with the reader.

Step 3: After the reader transmits the broadcast signal, it enters the receiving phase and waits for the numbering signal of the wireless label sent at each time slot in each frame.

Step4: processing the received signal of the current frame at the end of each frame. During the processing, the reader demodulates and decodes the received signal level according to each time slot, and obtains the serial number of the wireless label contained in the signal. If the serial number of the wireless tag is successfully solved, it indicates that the label is successfully identified. If the sequence can not be solved or the value of the meaningless sequence is obtained, then the slot will be clashed. For frames in conflict, the reader will immediately send an update broadcast, including the slot number of the previous frame in which the collision occurred. The wireless label sent to the corresponding slot in the previous notification has been clashed.

Step 5: If there is no more collision in the frame, the tag recognition is completed, the reader records all the identified tags, and displays the detection results on the system screen. Complete the testing process.

The algorithm steps on the wireless label side are described as follows:

Step1: wireless tags are dormant under normal circumstances to save their power consumption. The wireless tag side first receives the reader specific activation signal to activate the tag. When the received signal meets the preset activation information, the tag is activated.

Step2: the wireless label extracts the clock used by the reader in the activation signal. In a given frame, a time slot is selected randomly to send its own label.

Step 3: The wireless tag is waiting in the remaining slot of the current frame. When entering the beginning of the next frame, the wireless tag will detect the reader's feedback signal. The radio tag demodulates the collision slot number in the previous frame from the feedback signal and compares it with the transmission slot number itself. If the two slots have the same number, it indicates that they have encountered a collision, and will wait for a certain frame to repeat step 2.

Step 4: When the conflicting slot number in the feedback signal demodulated by the wireless frame is different from the slot number used by the wireless tag, the default serial number of the wireless tag itself has been correctly identified. The wireless label will return to dormancy because of the reason of saving power consumption of wireless tag. The identification process of the wireless tag ends.

4. Algorithm performance analysis

4.1 Best frame length estimation

If the binary tag number is L and the total number of tags to be detected is n, the system throughput efficiency is:

$$\eta = (n / L)(1 - 1 / L)^{n-1} \quad (1)$$

The derivative of the formula (1) is obtained when the derivative is 0， the corresponding n is:

$$n = \lceil -1/(\ln(1-1/L)) \rceil \tag{2}$$

4.2 system throughput

It is assumed that the number of labels sent to the reader at the same time per second obeys Poisson distribution. Therefore, the number of tags to send messages in t seconds is:

$$P(n) = (\lambda t)^n e^{-\lambda t} / n! \tag{3}$$

The definition of traffic is as follows:

$$G = \lambda T \tag{4}$$

For the BAA algorithm, the throughput can be written as:

$$S_{BA} = Ge^{-2G} \tag{5}$$

For SAA algorithm, due to the time slot requirement, it reduces the collision time by half compared with BAA algorithm, so its throughput is:

$$S_{SA} = Ge^{-G} \tag{6}$$

The FSAA algorithm has a fixed frame length, and its throughput is:

$$S_{FSA} = (n/L)(1-1/L)^{n-1} \tag{7}$$

The AFAA algorithm proposed in this paper can dynamically adjust the frame length on the basis of FSAA to maintain the optimal frame length. Its throughput can be expressed as follows:

$$S_{AFA} = (1-1/n)^{n-1} \tag{8}$$

The performance of AFAA algorithm is compared with that of FSAA algorithm, as shown in the following figure.

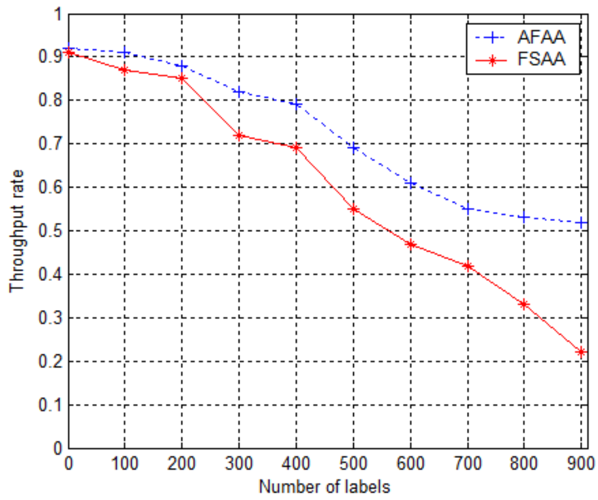

Fig. 2 Comparison diagram of system throughput between AFAA algorithm and FSAA algorithm

As can be seen from the above diagram, AFAA algorithm can dynamically adjust the frame size to keep the system throughput stable at the optimal value, and its overall performance is better than FSAA algorithm.

5. Summary

RFID technology has attracted wide attention in the field of logistics. Because the number of tags to be detected is huge, the collision of readers receiving information is inevitable. The existing detection algorithm has low throughput and is not conducive to fast identification of RFID tags. This paper proposes an adaptive frame length RFID tag anti-collision algorithm. Theoretical analysis shows that the proposed algorithm can significantly improve system throughput and reduce data conflicts effectively.

Refrences

[1] Song B, Mitchell C J. Scalable RFID security protocols supporting tag ownership transfer [J]. Computer communication. 2011, 34(4):556-566.

[2] Zhang Xuejun, Ye Chuanling, Ma Junfei. An improved anti-collision algorithm with intelligent separation for RFID system [J]. International journal of advancements in computing technology, 2012, 4(22):823-831.

[3] Biao L, Aiqun H, Zhongy Q. Trends and brief comments on anti-collision techniques in radio frequency identification system[C], 2006 6th international conference on ITS telecommunications proceedings, 2006:241-245.

[4] Eom J B, Lee T J. Accurate tag estimation for dynamic framed-slotted ALOHA in RFID systems [J]. IEEE communication letters, 2010, 14(1):60-62.