

FAST CAPTURE OF RFID OBJECTS USING TAG IDENTIFICATION PROTOCOL

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Abstract

Radio Frequency Identification (RFID) system is a new emerging technology used to identify a tag attached to an object. They are designed for fast and accurate identification of multiple RFID tags. It was widely used in various applications such as supply chain management, inventory control, and object tracking. The most important technical issue in Radio Frequency Identification (RFID) is to identify RFID tags in a given tag population. The Tree Walking (TW) protocol has become the industrial standard for identifying RFID tags. In this paper, we propose the Tree Hopping (TH) protocol to formulate tag identification as an optimization problem and find the optimal solution that ensures the minimal average number of queries or identification time as per the requirement.

Keywords: *Reader, Radio Frequency Identification (RFID), tags.*

1. Introduction

RFID uses radio frequency waves to track and identify objects. RFID system consists of tags and readers. RFID systems mostly work in a query-response fashion where a reader transmits queries to a set of tags and the tags respond with their IDs over a shared wireless medium. RFID systems are being increasingly used in various applications such as supply chain management, indoor localization, 3-D positioning, object tracking, inventory control, electronic toll collection, and access control.

An RFID system consists of tags and readers. A tag is a microchip combined with an antenna in a

compact package that has limited computing power and communication range. There are two types of tags: 1) passive tags, which do not have their own power source, are powered up by harvesting the radio frequency energy from readers, and have communication ranges often less than 20 ft; 2) active tags, which come with their own power sources and have relatively longer communication ranges. A reader has a dedicated power source with significant computing power. A tag contains information about the particular product, to which it is attached. RFID reader is used to interrogate the tag to get the identity of the product attached with. RFID has numerous applications such as inventory management, asset tracking, library management etc.

One of the major problems with RFID system is that whenever a reader interrogates a tag, all the tags residing in the read zone of the reader responds to the reader, which results in a collision at the reader's side. Thus makes it impossible to read the tags in time. To minimize the problem of collision at the reader side several anti collision algorithms has been proposed. In this paper, we first focus on the single-reader version of the tag identification problem.

2. Related Work

The industrial standard, EPC Global Class 1 Generation 2 (C1G2) RFID [1], adopted two tag identification protocols, namely framed slotted Aloha and Tree Walking (TW). In framed slotted Aloha, a reader first broadcasts a value to the tags in its vicinity, where represents the number

of time-slots present in a forthcoming frame. Then, each tag whose inventory bit is 0 randomly picks a time-slot in the frame and replies during that slot. Each C1G2 compliant tag has an inventory bit, which is initialized to be 0. In any slot, if exactly one tag responds, the reader successfully gets the ID of that tag and issues a command to the tag to change its inventory bit to 1. The key limitation of framed slotted Aloha[2] is that it cannot identify large tag populations due to the finite possible size of f .

TW was proposed as an RFID tag identification protocol by Law *et al.* in [3]. In TW, a reader first queries 0, and all the tags whose IDs start with 0 respond. If the result of the query is a successful read (i.e., exactly one tag responds) or an empty read (i.e., no tag responds), the reader queries 1, and all the tags whose IDs start with 1 respond. If the result of the query is a collision, the reader generates two new query strings by appending a 0 and a 1 at the end of the previous query string and queries the tags with these new query strings. All the tags whose IDs start with the new query string responds. This process continues until all the tags have been identified. Here, a successful read is exactly one tag responds to the query, an empty read is no tag responds to the query and a collision is more than one tag responds to the query. Using this method, the RFID tags can be identified. The key limitation of TW-based protocols is that they visit a large number of collisions, which makes the identification process slow.

3. Proposed System

To address the fundamental limitations that lie in the heuristic nature of prior TW-based protocols, proposing a new approach to tag identification called Tree Hopping (TH). The key novel idea of TH is to formulate the tag identification problem as an optimization problem and find the optimal solution that ensures either minimal expected number of queries or minimal expected

identification time, as per the requirement. In Tree Hopping, it first quickly estimates the tag population size. Second, based on the estimated tag population size; it calculates the optimal level to send queries so that the expected number of queries or expected identification time is minimal. It hops directly to the optimal level query and identify the tags. This process continues until all the tags have been identified. In C1G2 standard, the id of the each tag is 64 bit which uniquely represents that particular object. Based on the bit of tag, it chooses the optimal level to query the tag. In TH, a reader first queries a bit which might be less than or equal to the bit of the RFID tag, and all the tags whose IDs start with that bit respond. The result of the query is a successful read (i.e., exactly one tag responds) or an empty read (i.e., no tag responds). If the result of the query is a collision, the reader generates two new query strings by appending a 0 and a 1 at the end of the previous query string and queries the tags with these new query strings. It skips large number of collision queries. It identifies all the tags with minimal number of queries or identification time.

3.1 Population Size Estimation:

TH first uses a framed slotted Aloha-based method to quickly estimate the tag population size. For this, TH requires each tag to respond to the reader with a probability q . As C1G2 compliant tags do not support this probabilistic responding, we implement this by “virtually” extending the frame size $1/q$ times. To estimate the tag population size, the reader announces a frame size of $1/q$, but terminates it after the first slot. To terminate a frame, the reader issues a SELECT command, specified in the C1G2 standard, with its *position*, *target*, and *action* parameters set to 0. This command “resets” all tags, and they go into a state where they expect a new frame to start. The reader issues several single-slot frames while reducing with a geometric distribution until the reader gets an empty slot. Suppose the empty slot occurred in

the i th frame, TH estimates the tag population size to be $1.2897 \cdot 2^{i-2}$ based on Flajolet and Martin's algorithm used in databases.

3.2 Finding Optimal Level:

Tree Hopping identify the optimal level based on the bits per each tag. To calculate the optimal level in which the TH hops to will reduce the number of queries required to identify the tag in the reader's coverage area. It is based on the formula $1 \leq \gamma \leq b$, where b is the number of bits in each tag ID (which is 64 for C1G2 compliant tags). TH skips all the nodes from level 1 to $\gamma-1$. If γ is small, more collision will occurs, while if it is large more empty read will occurs. Based on the population size and the bit of the tag ID the optimal level varies to identify the tags. As the optimal level is mainly based on the bit of tag ID b , it will be one time cost to find them.

In this uniform distribution after identifying the tags based on the optimal level the TH hops to another query to identify the tags. If TH chooses new optimal level as 1 means it will be wasteful because it will result in identifying the tags once again which was already identified. Or else it will result in tags that are not identified.

To avoid both scenarios, i.e., same query is repeated multiple times and some query was not send by the reader after the optimal level is recalculated, TH hops to the query that contain next tag but does not the previously identified tags. The level recalculated must but greater than the previous optimal level query.

3.3 Tag Identification:

The reader generates queries based on the optimal level. If the result of query is collision then append '0' and '1' at the previous string and identify the tags. If the result of query is successful read then exactly one tag will respond. If the result of query is empty read then no tags will respond.

If only one tag responds, the reader receives the message. But if more than one tags respond, their messages would collide on the communication channel, and thus the response of the tag cannot be received by the reader. In this case, the reader detects a collision on the channel but nothing else. Using this, the reader can identify all the tags.

2.4 Conclusion

The proposed work provides the first effort to formulate the tag identification to minimize the expected number of queries and expected identification time. The Tree Hopping protocol is a fundamental multiple access protocol and has been standardized as an RFID tag identification protocol. Besides static optimality, the Tree Hopping protocol dynamically chooses a new optimal level after each query was processed by the reader in a uniformly distributed population. The experimental results show that TH protocol can identify the tags with minimal number of queries and minimal identification time.

References

- [1] EPCGlobal, Inc., "EPC radio-frequency identity protocols generation- 2, Protocol for communications at 860 MHz–960 MHz," 2.0.0 edition, Nov. 2013.
- [2] B. Zhen, M. Kobayashi, and M. Shimizu, "Framed ALOHA for multiple RFID objects identification," *IEICE Trans. Commun.*, vol. 88, pp. 991–999, 2005.
- [3] C. Law, K. Lee, and K.-Y. Siu, "Efficient memoryless protocol for tag identification," in *Proc. 4th Int. Workshop Discrete Algor. Methods Mobile Comput. Commun.*, 2000, pp. 75–84.