

# RFID in Library

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## 1 Background Introduction

Radio-frequency identification (RFID) is a technology to record the presence of an object using radio signals. It is used for inventory control or timing sporting events. RFID is not a replacement for the barcoding, but a complement for distant reading of codes. The technology is used for automatically identifying a person, a package or an item. To do this, it relies on RFID tags. These are small transponders (combined radio receiver and transmitter) that will transmit identity information over a short distance, when asked. The other piece to make use of RFID tags is an RFID tag reader.

An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader. Most tags carry a plain text inscription and a barcode as complements for direct reading and for cases of any failure of radio frequency electronics.

Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and de-modulating a radio-frequency (RF) signal, and other specialized functions. The second is an antenna for receiving and transmitting the signal.

There are generally two types of RFID tags: active RFID tags, which contain a battery, and passive RFID tags, which have no battery.

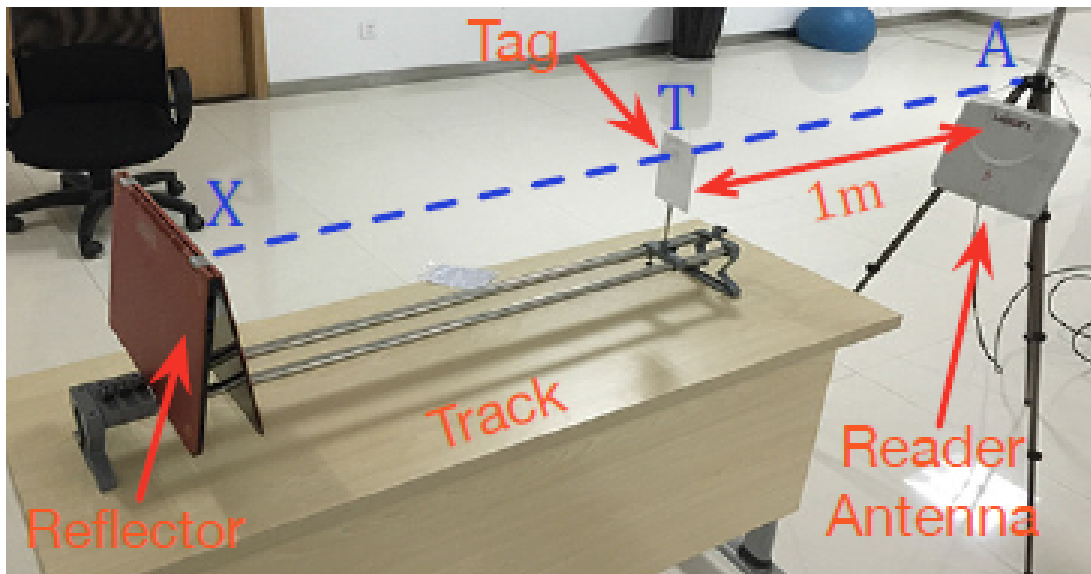


Figure 1: RFID sample

## 2 Introduction of PinIt(proposed by MIT)

### 2.1 Brief introduction of PinIt

PinIt is an application of RFID which is proposed by Jue Wang and Dina Katabifrom Massachusetts Institute of Technology. The name of their paper is "Dude, Where's My Card? RFID Positioning That Works with Multipath and Non-Line of Sight". Copyright is held by the owner. Publication rights licensed to ACM. In this paper I will give a introduction of their location idea and show its advantages and disadvantages.

### 2.2 Why not using single path

To illustrate the disadvantage of using single path, here is an example in Fig.2. As shown in the figure, there are three tags. The blue one is the one we want to locate while the red and green tags are the reference tags which we already know their location. And the below chart show the signal received by the reader. If we only compare the dominant path(the path with the largest energy), we will conclude that the blue tag is near the red tag since there is only one degree shift. However, according to the graph above, we know this conclusion is wrong, the blue tag should be closer to the green tag, so that only consider the information of single path is not enough to locate the tag precisely.

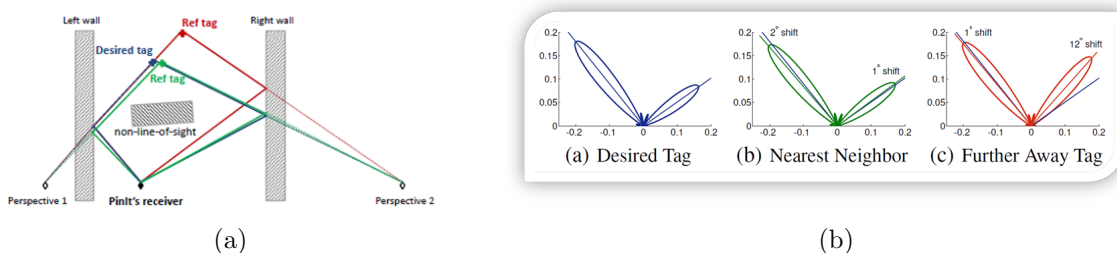


Figure 2: Comparison of single-path and multipath.

### 2.3 Steps' of PinIt

First, PinIt queries the RFID tag attached to the object, as well as the reference tags. Second, PinIt acquires a multipath profile of each queried tag based on its replies. Third, by comparing and matching the desired tag's multipath profile with the reference tags', PinIt identifies the NEAREST neighbors of the desired tag. Finally, based on the position of these nearest neighbors, it estimates the desired tag's position.

### 2.4 Dynamic Time Warping of Multipath

In Fig.3, there are two tags which are near to each other. As the figure shows, if we only consider the difference of their peak, they are 17,14,-12. It seems no orderliness. So it is necessary for us to define a more specific metric to represent the difference. The cost metric is defined as:

$$C_{\alpha,\beta} = |B_i(\alpha) - B_j(\beta)| \quad (1)$$

In Fig.4, the left graph is the cost matrix we have defined. What we need to do is to find a path from (0,0) to (160,160) which minimize the total cost. And in the right graph is result of the alignment.

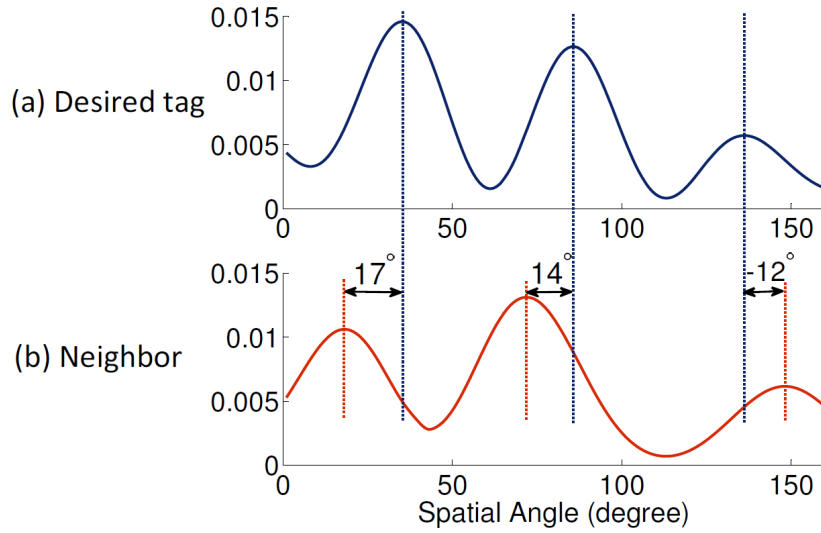


Figure 3: Multipath profiles of two tags

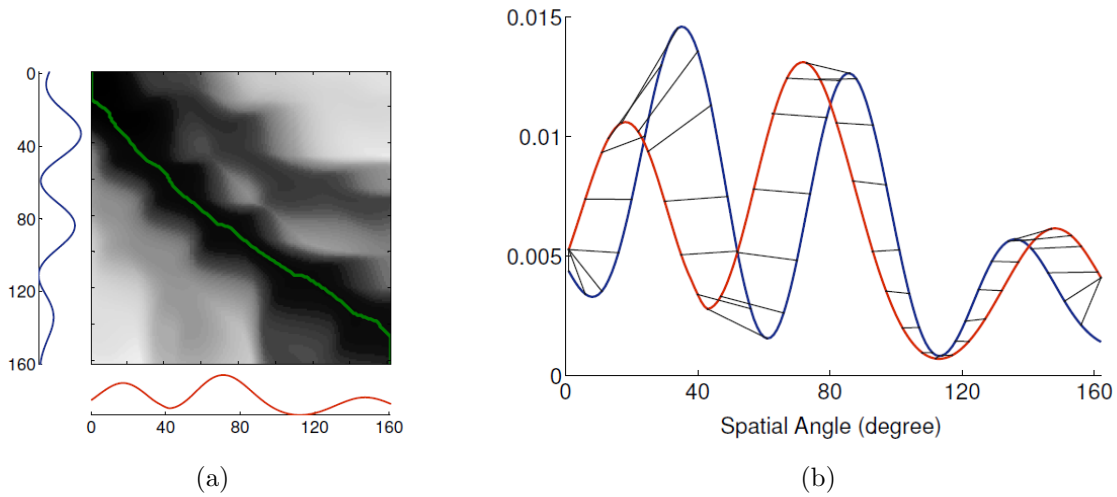


Figure 4: Dynamic time warping of multipath

### 3 Discussion of the PinIt

#### 3.1 Advantages

Their idea about using multipath information is novel. Compared with the single path, it is obvious that multipath can provide much more information. It can provide two-dimension profile while the single-path can only provide one dimension.

#### 3.2 disadvantage

Their algorithm need reference tag to support. Compared with most other RFID location method, this requirement is additional. So that, their system will be more complex than others. If some part of the system is broken, it will take more time to check it.

Another important part is that their paper only shows the feasibility in the library. The environment of the library is not too complicated because the electronic wave is only reflected once or less. And in this relatively simple environment, it seems not so necessary to consider so much information.