Performance Improvement of RFID System in Mass Races

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***Abstract*—Radio Frequency Identification (RFID) has been used widely to fairly judge the race time result. This paper proposes the method to increase the efficiency and accuracy of the detection system RDIF tags. We have carefully designed the important RFID system configuration parameters which include antenna placement, running speed, and tags density. We have evaluated our system in three race events that are 1) Siamrathani 2013, 2) Nakhon Phanom University – Khammouan International Marathon 2013, 3) The 16th Srinakarin Mini Marathon, and 4) The 11th Khon Kaen International Marathon. The implemented system is able to detect 100% of RFID tags passed through RFID checkpoints.**

***Keywords*—RFID, contact-less identification, mass races**

I. INTRODUCTION

Radio Frequency Identification (RFID) systems have been applied into many fields, such as commercial, industrial, warehouse and other areas. In the race events, RFID systems have been applied to identify and capture time for runners in the event. In using RFID systems for race events, each runner needs to have their RFID tags checked at the starting point and the finish point to get the net time. In the past, the RFID systems, including commercial expensive systems, often cannot get 100% of RFID tags read at the check points. This is due to an improper setting of layout and installation of RFID tags and readers. To the best of our knowledge, our RFID implementation system is the first one implemented by Thai people and that can prove 100% RFID tags read.

II. RELATED WORK

"The Optimization of the RFID System for the Identification of Sportsmen in Mass Races"[1] adapted the standard UHF RFID for the sportsmen in mass races but they used the patch antenna and did not test the system in real race events.

Another interesting work is "Tag Density Problem Solving at Marathon's Starting Point via UHF RFID Technology" [2] which presented a solution for tag density problem at the starting point via UHF RFID (Ultra High Frequency Radio Frequency Identification) technology. Their system was proved that 96-99% of total data could be read.

III. SYSTEM DESIGN AND IMPLEMENTATION

We design a tags as a band in 8 inches width and 1 inch height that is attached with the BIB number for runners to prevent tags form lost as shown in Figure 1.

Fig. 1. UHF RFID tags and a BIB number.

To improve the coverage of tags read, we shorten the distance between UHF RFID tags and antennas by having an UHF RFID tag as a band that attaches to the shoe ropes in a circle mark as shown in Figure 2

Fig. 2. UHF RFID tags attached to a shoe rope.

Figure 3 illustrates the antenna beam pattern. On the left hand side of this Figure, it shows the beam pattern of horizontal view with a radius of 3 meters.

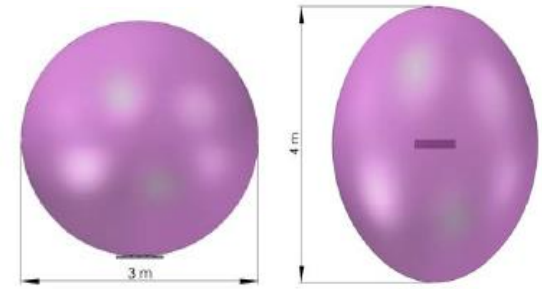

Fig. 3. UHF RFID antennas beam pattern [3]

On the right hand side of Figure 3, it shows another beam pattern in vertical with a radius of 4 meters.

Fig. 4. UHF RFID antennas and controllers

As shown in Figure 4, we have tried several settings of antennas and controllers to determine the optimized layout in order to avoid the interference of UHF antenna in the race events.

Based on our study and experiments, we have found out that we need to 1) set the position of antennas to cover the width of start lane so that it can read all RFID tags, and 2) set the space between each antenna as 43.6 cm. to avoid signal interferences.

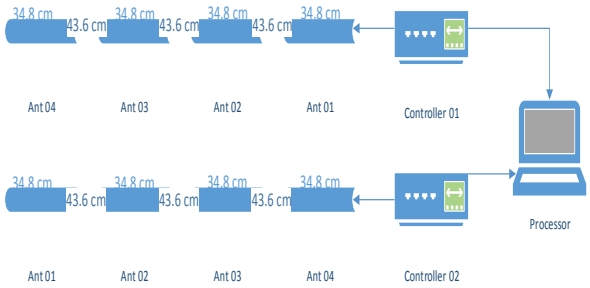

Fig. 5. An optimized layout

The optimized layout of our antennas and controllers is shown in Figure 5. A processor computes the tag read data sent from the controller 01 and controller 02 which are connected to child antennas.

We have designed antennas for four points of the race track that are 1) the check in point to ensure the numbers of tags that come in to our system, 2) the start point to records runners start time, 3) the check point to ensure that runners race in track and 4) the finish point to records runners finish time. All of our antennas will send all read tags data to the server via Internet connection.

IV. EVALUATION

We have installed and implemented our RFID system in real race events that are 1). Siamrathani 2013 recorded 192 participants from 6:00AM to 10:00 AM in a light rain environment, 2). Nakhon Phanom University – Khammouan International Marathon 2013 recorded 605 participants from 06:00AM to 10:00AM in normal weather, 3). The 16th Srinakarin Minimarathon recorded 791 participants from 02:00AM to 12:00PM in normal weather and 4). The 11th Khon Kaen International Marathon recorded 4,487 participants from 04:00AM to 12:30PM in normal weather.

Fig. 6. The Siamrathani race 2013 event

Siamrathani 2013 race event was organized in Lumpini Park Bangkok. The system was running in a light rain environment for 192 runners as shown in Figure 6. Our system could read 100% of RFID tags.

We have evaluated the system in another race event at Nakhon Phanom Province. In this event, there were 605 runners with 226 marathon runners and 379 mini marathon runners. The system was running in fine weather. Our system could read all of the RFID tags.

Fig. 7. The Nakhon Phanom University – Khammouan International Marathon 2013 event

We set the antenna at the check in point as shown in the left hand side of Figure 8 and the check point as shown in right hand side of Figure 8.


Fig. 8. Antennas at the check in point and the check point of the Nakhon Phanom University – Khammouan International Marathon 2013 event

In the third evaluation of our system, we have tested the system in the 16th Srinakarin Minimarathon , which there were 791 runners who used our timing chips as shown in the Figure 9

Fig. 9. The 16th Srinakarin Minimarathon event

In Figure 10, the left hand side shows the antennas at the check in point while the right hand side shows the check point.

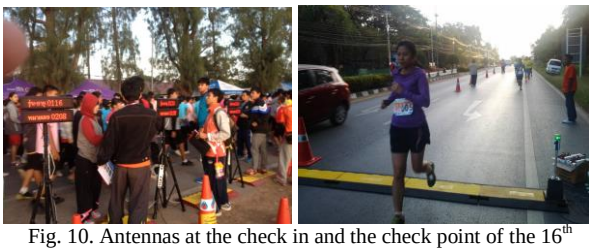
Fig. 10. Antennas at the check in and the check point of the 16th Srinakarin Minimarathon event

The last and the most important race event that we tested our system was the 11th Khon Kaen International Marathon. It is one of Thailand race event major with the total runners about 20,000.

Fig. 11. The 11th Khon Kaen International Marathon event

Figure 11 shows the start and the finish points of the 11th Khon Kaen International Marathon.

Fig. 12. Antennas at the check point

In Figure 12, antennas at the check in point are shown on the left hand side and ones at the check point are shown on the right hand side.

Fig. 13. Antennas at the start point and the finish point

Our RFID system could provide 100% of tags read in all three types of races that included 1) marathon with 712 runners, 2) half marathon with 948 runners, and 3) mini marathon with 4,065 runners. The system could help the race event organizers release the race result correctly within hours on the web site at http://timetrack.kku.ac.th/kkim/report/public

Fig. 14. The result of the 11th Khon Kaen International Marathon

Figure 14 illustrates the web site that shows the results of the 11th Khon Kaen International Marathon which runners can see and search their own time records.

V. CONCLUSIONS

We have designed and tested our RFID system for three real races events with the results as 100% of tags read. Many race event organizers are interested to employ our proposed RFID system instead of using imported RFID systems since it is economical and can read 100% of RFID tags. However, we still have some room for improvement such as we would like to find the method to determine whether runners use their own tags or others' tags.

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