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A Development of a Reliable and Trusted Mobile RFID-based Asset Management System using Android Apps

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ABSTRACT

Physical asset management is very important to monitor the existence and functionality of the asset in organization. It including ensure the asset is locate at the recorded location and still can be used by the staff. Usually the monitoring exercise is done by checking the id number that stick to the assets and compare it with the record. The process of getting the id number can be done manually or by using a barcode. However this will take time because there are number of assets in one location and it takes time to locate the number sticker. We proposed the use of Radio Frequency Identification (RFID) technology to automatically detect the assets and provide reports on the mismatch of asset and location. The use of RFID required less time to perform the asset monitoring and increase efficiency in data management. It can connect with the database to match the records of assets and its location. By ensuring the safety of the assets, we can prolong its lifecycle where this will contributes to more sustainable and greener world.

1. Introduction

Effective organization needs a very efficient asset managements to ensure the smoothness in their business operation (Massawe et. al., 2010). Some of the organization were very big and need monitoring exercise to ensure the safety of their assets. Usually at the end of the year, assets monitoring exercise will be run. This is to ensure that the asset is still located at

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its intended location and be functional as expected. This is also to avoid the misused of the assets for the personal matters. However, assets monitoring is not easy to be done. It could be impossible to track the whole assets owns by the organization. The method used to track the assets is slow, where it uses barcode technology which needs a line of sight to be detected. Moreover it only can scan one item at a time. Imagine scanning one item at a time and also time to locate the barcode. It is a tedious and tiring job. We proposed the use RFID, a technology that uses radio waves to perform detection (Landt, 2005). It does not need line of sight to detect item, and it can detect more than one item at time. We integrate the use of RFID with Android apps, to perform the data management. The Android apps will received the reading from the reader via Bluetooth connection and compare the reading with the backend database. We organize this paper as follows: Section 2 is the system architecture, section 3 is the methodology, section 4 is the proposed application, section 5 is discussion, and last is the conclusion and future works.

2. System Architecture

A typical RFID system consists of a transponder (i.e., tag), which is attached to the objects to be identified, an interrogator (i.e., reader) that creates an RF field for detecting radio waves, and a backend database system for maintaining expanded information on the objects and other associated objects. Figure 1 shows RFID-enabled a generic system of interest. Generally RFID system architecture is made of four layers: tags, readers, middleware and database.

Figure 1: An RFID-enabled system architecture.

At the first layer, assets to be tracked and monitored are attached with an RFID tag. A tag contains memory to store the identifying information of the assets to which it is attached and an antenna that communicates the information via radio waves. Tags can be classified based on their power sources: passive, active and semi-active tags (Angeles, 2005). Active and semi-active tags have their own battery on-boards while passive tags not. Passive tag is the most commonly used tags in the market and has an indefinite operational life compare to other tags. Relative to both active and semi-active tags, passive tags are very cheap and they are widely used in very large quantities in many applications such as supply chain management.

At the second layer, we have the mobile reader. This reader is connected with the smart phone for the data processing. RFID data need to be process as it contains faulty and duplicate readings. We need a very algorithm to perform this because the processing power is limited in the smart phone. The mobile reader has the ability to read from few centimetres to a few meters. In our case, we use mobile readers that can read up to 2.5 meters to ease of use in detecting the assets. The third layer is the Internet, which connect the smartphones to the database. Data is requested from the database to match with the reading made. The smartphone also can send the data to the database for data storing purposes.

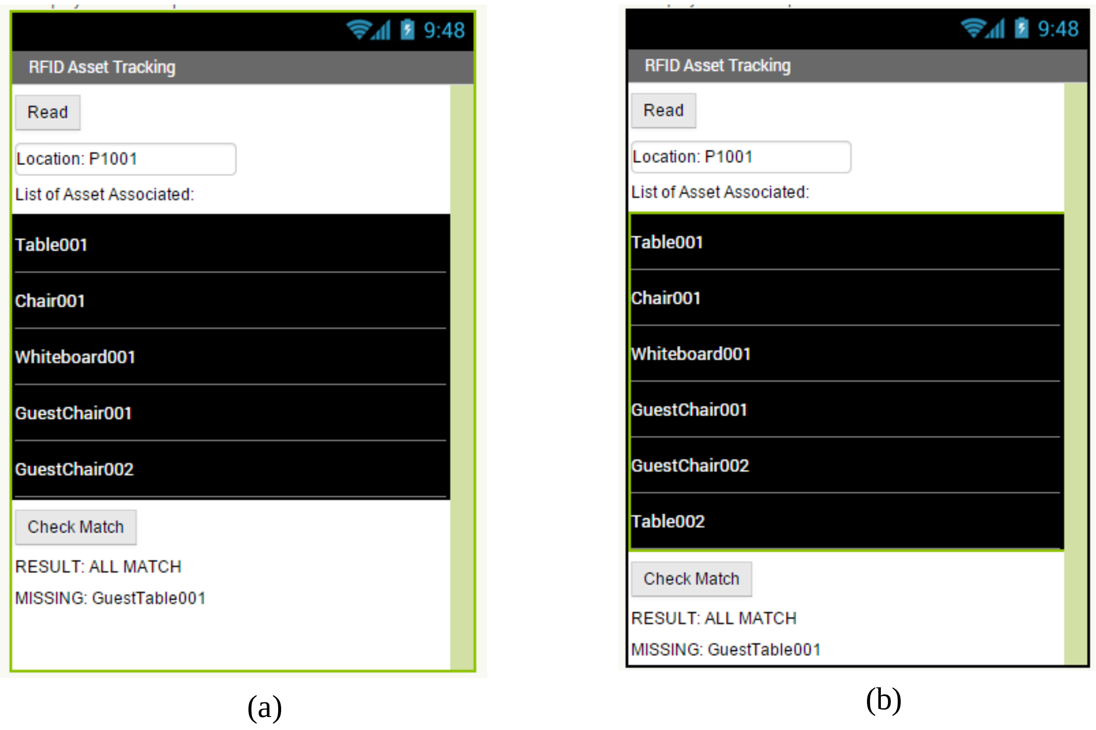

Figure 2: (a) screen design of the asset tracking apps (b) faulty reading (e.g. Table 002)

3. Proposed Application

The screenshot of the proposed apps is shown in Figure 2. In Figure 2, when the user press the button read, it will read the tag that represents the location of the place. In this example, the tag that represents the location starts with ‘P’. The other tags that the reader detects will be listed as the assets. Here we have five assets including Table001, Chair001, Whiteboard001, GuestChair001 and GuestChair002. However, we need to check whether all these assets are correctly belong to this location. By pressing button ‘Check Match’, it will connect the apps to the database, comparing the records with the one it reads. Here it finds that all the assets were belong to the location but according the database, there is one asset missing which is GuestTable001. GuestTable001 will be listed in the missing assets section until it was detected. When it has been detected, a message will appear so that the user will take further action such as returning the asset to its original place.

The challenge with the use of RFID technology is the false positive reads. It might read assets that reside in the neighbouring room. For example, in Figure 2(b), the reader read the same location in Figure 2(a) which is P1001. However, because of the location of the reader, it accidentally read asset from neighbouring reader too, let say P1002 which is Table 002. This is an example of false positive read. This kind of false readings needs to be filtered to avoid confusion to the user. Otherwise the user will think it is really one of the assets of particular room. When Check Match process is performed, the asset is not listed with the location. The user will need to find this asset in the room to move it while in reality it is not even there. Figure 3 depicts the scenario where the mobile reader in Room 1 can accidentally read object (chair) from the Room 2. However, as stated previously, the read rate for chair in Room 2 is only 5% because it is located in the minor region of the detection.

There are number of ways to filter this kind of readings in RFID such as Comparison Bloom Filter (CBF) (Mahdin & Jemal, 2011), SMURF with Euclidean distance (HSMURFED) (Liu et. al, 2014) and many others. We simplified our proposed approach in (Mahdin & Jemal, 2011) due the different nature of system setting. CBF is more suitable to be used with permanent reader that continuously performs the readings. This is different with this problem where the problem of false positive readings is one-of case. We just it read on one place and then can decide which one is the unreliable reading(s).

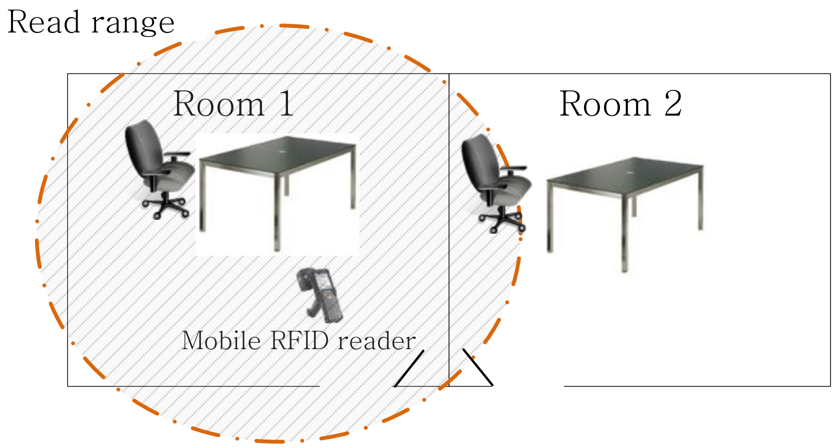

Figure 3: RFID mobile reader read range that made it reading object from neighbouring room

The unreliable readings can be filtered based on the number of readings. Object that located far from the reader will have less reading that the one that located near the reader (Jeffery et. al., 2006). It was pretty obvious because the objects that far from the reader only have 5% chances of readings compared to the others (Jeffery et. al., 2006). Moreover, the objects were separated by wall which is made it harder to be read by reader in other room. Based on this finding we put a threshold of 60% for a reading to qualify a correct reading. Correct reading here means that the tagged object really resides in the intended location. The algorithm to filter the faulty readings is shown in Figure 4.

In Figure 4 we show step by step how the filter is working. After reading has been taken, it will be filtered as shown in Figure 4. At step 1, each reading will be registered in a list. The number of reading will be count a as 1. If it has been registered in the list, its count will be increased by 1. Then we checked whether its count has passed the threshold (Step 7). The threshold is the minimum number of the reading need to be generated to qualify as correct reading. Reading that below the threshold indicates that it might represent object outside the room, where it should not be counted. If it passed the threshold, we marked the reading as TRUE, indicating the reading is valid (Step 10). After all reading has gone through this process, we produce the output (step 15) containing all the correct readings. The correct readings represent all the objects that are located in the intended room.

Algorithm BaselineFilter

```
INPUT: R-reading, threshold
BEGIN
 1: FOR each R DO
 2: IF R is not in the list THEN
 3: Store R in the list’s first available position
 4: Increment R count by 1
 5: ELSE
 6: Increment R count by 1
 7: IF (R count>=threshold) THEN
 8: IF R has not been output before THEN
 9: Output R
10: Set STATE-OF-OUTPUT as true
11: ENDIF
12: END IF
13: END IF
14: ENDFOR
15: Produce Output
16: END FILTER
```

Figure 4: Algorithm BaselineFilter to filter false positive readings in our apps

4. Discussion

Among the consideration to implement this system is the cost. The hardware costs include the mobile reader itself, processor, database and RFID tag. RFID tag is cheap and can be bought at RM 0.50 per piece. The mobile RFID reader would not cost you more if you buy only the reader, not with the processor. We can save money by using a smartphone as it processor. Smartphone that has Bluetooth and Internet connection is good enough to be the reading processor. The drawback of using RFID in asset management is the false positive read. However we provide the algorithm to filter the false read. Based on the simulation experiment it can give 100 percent clean readings. This is shown in Figure 5 where the result of filtering is presented.

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Figure 5 shows that when detection is made at every room, the number of items detected is more than the actual. After filtering has been made, the number of items detected is matched with the actual number. Therefore the filtering module is needed so that the application will give accurate result to the system.

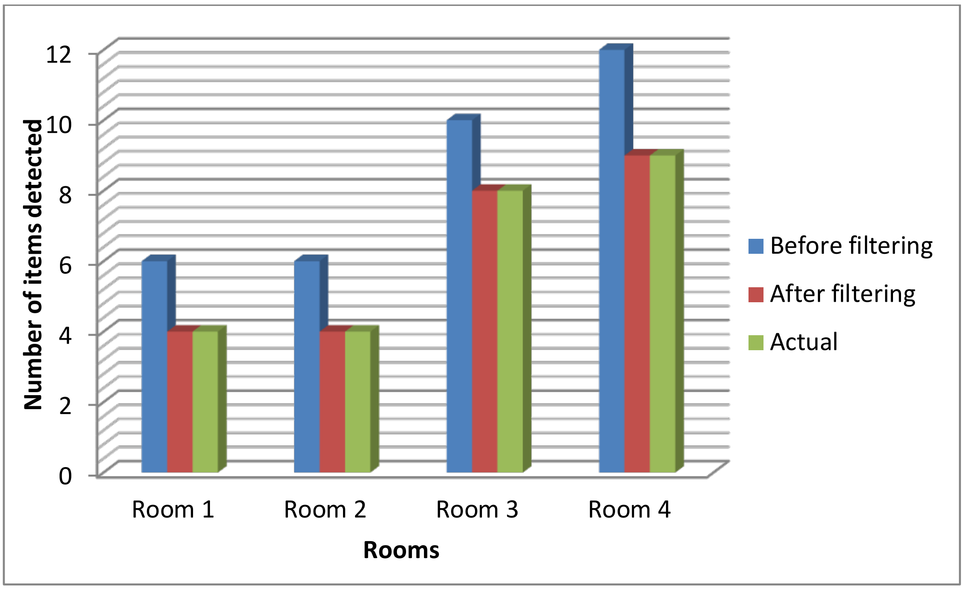

Figure 5: Number of items detected before and after filtering is being done

5. Conclusion

The use of RFID technology saves a lot of time because of its automatic identification feature. The user does not need to scan manually to identify the assets. In one reading it can identify all the assets and compare the record with the database using the proposed apps. Nowadays, apps is convenience as many people owns the smartphone. This application can be installed on Android smartphone and can be customize as needed. It connects with the mobile RFID reader using the Bluetooth. No papers are needed when using this apps and reports can be sent on the fly during the asset monitoring exercise. By using RFID, the use only need to stand inside the room and start the reading process. It will read all the objects automatically in the room and match the record with the database. This can be used to check any other assets to ensure the sustainable of the city and growth.

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7. References

Angeles, R. (2005). RFID technologies: supply-chain applications and implementation issues. Information Systems Management, 22(1), 51-65.

Liu, L. L., Yuan, Z. L., Liu, X. W., Chen, C., & Wang, K. S. (2014). RFID unreliable data filtering by integrating adaptive sliding window and Euclidean distance. Advances in Manufacturing, 1-9.

Mahdin, H., & Abawajy, J. (2011). An approach for removing redundant data from RFID data streams. Sensors, 11(10), 9863-9877.

Landt, J. (2005). The history of RFID. Potentials, IEEE, 24(4), 8-11.

Massawe, L. V., Kinyua, J., & Aghdasi, F. (2010, May). An implementation of a multi-agent based RFID middleware for asset management system using the JADE platform. In IST-Africa, 2010 (pp. 1-8). IEEE.

Ma, Jiangang, et al. "Efficiently managing uncertain data in RFID sensor networks." World Wide Web (2014): 1-26.

Jeffery, S. R., Garofalakis, M., & Franklin, M. J. (2006, September). Adaptive cleaning for RFID data streams. In Proceedings of the 32nd international conference on Very large data bases (pp. 163-174). VLDB Endowment.

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