

Backscatter Communication and RFID Transmission Optimization

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Background and Aims

Radio frequency identification technology which is also known as the RFID technology has become one of the most important parts in backscatter communication research. If the RFID transmission can be optimized, it can be used in more areas in the future.

Project Goals:

1. To increase the read range of a RFID system
2. To create a wireless control RFID system demo

This project will mainly focus on RFID range extension and demo construction. Based on the fundamentals of the RFID, the read range of a RFID system depends on several different factors. Mathematically, it can be formulated as

$$Range_{max} = \frac{\lambda}{4\pi} \sqrt{\frac{P_{tag} G_{tag_min} G_{receiving_tag_min} \tau}{P_{tag_min}}} \quad \tau = \frac{4P_a^2}{|Z_a + Z_c|^2} \quad [1]$$

where Z_a and Z_c is the impedance of the antenna and the tag. G_{tag} is the gain, P_{tag} is the power and λ is the wavelength. Besides, the read range also depends on the power of the antenna P_a . This relationship can be shown as the formula below

$$P_a = \left(\frac{P_t G_t}{4\pi r^2}\right) \left(\frac{\lambda^2}{4\pi}\right) G_{tag} \quad [2]$$

where r is the transmission range. Therefore, adjusting antenna gain and power will be the entry point for this project. Besides, for the wireless control demo, it is a new attempt and there is not an existing product in the market so far. It is going to achieve interaction between RFID chip, a controller and an online database.

Methodology

In this project, rc522 chip will be used as the signal transmitter and tag reader, then Arduino Uno will be used as the platform. The methodology for these two project goals can be shown below:

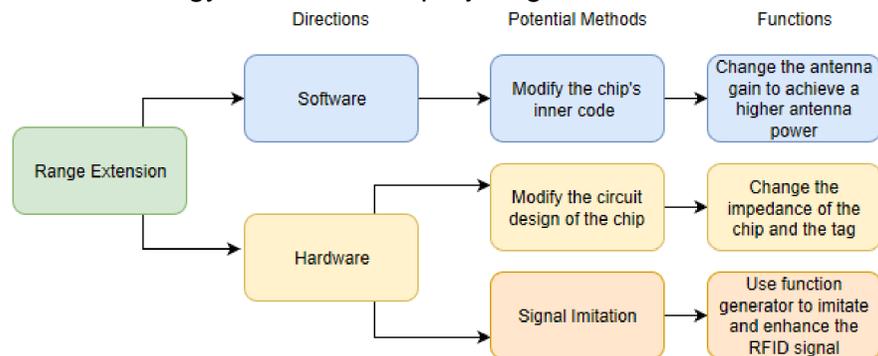


Fig. 1. Methodology for range extension

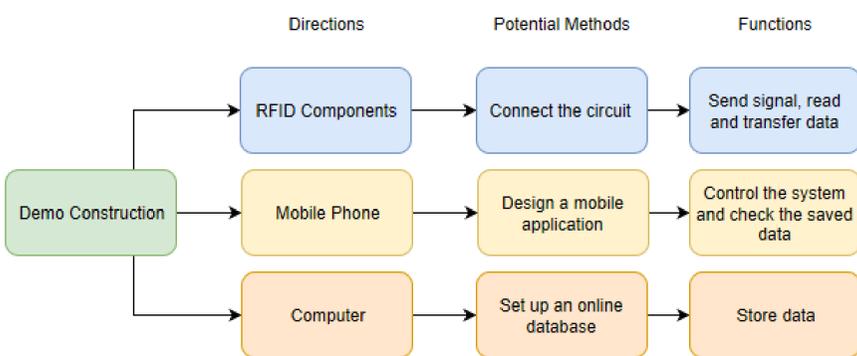


Fig. 2. Methodology for demo construction

Results

Primary Achievements / Outcomes:

- The read range of the RFID system has been extended
- The wireless control demo has been finished

The change of the read range can be seen from the figure below:



Fig. 3. Read range extended from 1cm to 4cm

Signal imitation via function generator can also be a solution for range extension and its schematic diagram is shown:

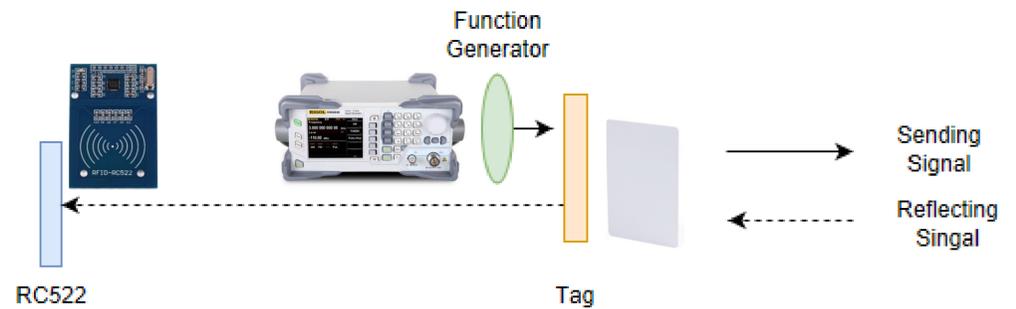


Fig. 4. Signal imitation via RF function generator

The wireless control demo worked well and the information was recorded correctly, it can be shown by the graphs below:

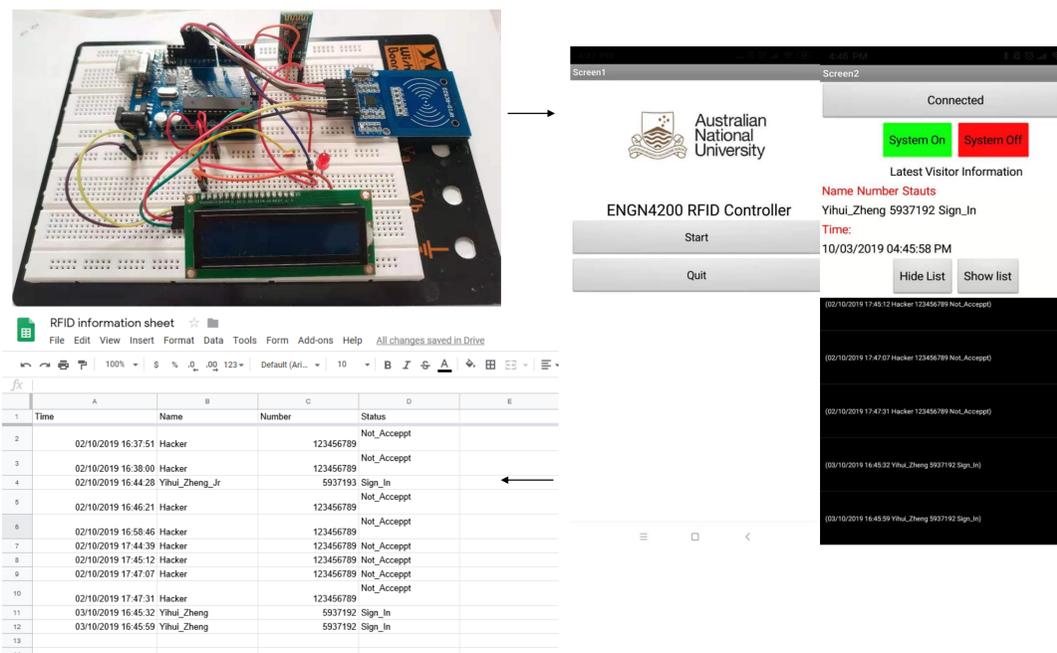


Fig. 5. Wireless Control Demo for RFID

- The mobile application can control the on and off of the system.
- After every tag scanning process, the data in the online database will be refreshed automatically.
- It is available to make changes to the database manually, and all the changed information can be checked on the phone.

Analysis/Discussion

- The extension of the read range can help to increase the convenience for RFID application
- With the wireless control demo, there are more potential working scenarios and opportunities for RFID technology. For example, it can be used as a smart locker or be used in an access control system for security purposes.
- There are still some limitations for this project, a better RF function generator is needed to generate a high-frequency RFID signal. Besides, more components can be added to the demo in the future to achieve more functions such as sending a text message when the Bluetooth is not connected.

Conclusions

The two project goals are achieved successfully. The read range of a RFID system can be extended by applying software modification and introducing signal imitation via function generator. The RFID demo can allow fully wireless data transmission and allow more potential working scenarios. Besides, more functions can be added in the future by upgrading these chips or adding more components.

References

- [1] Nikitin, P. V. and K. V. S. Rao, Theory and measurement of backscattering from RFID tags, IEEE Antennas and Propagation Magazine, vol. 48, no. 6, pp. 212-218, December 2006
- [2] Dobkin, Daniel M. "The RF in RFID," Elsevier Inc., 2008.