DATE: Jan 30, 2001

TO: Ziqin Guo and Dean Neikirk

FROM: Matthew Andringa and Allen Hall

SUBJECT: A proposal to build a radio-frequency identification system that will detect the structural integrity of welds.

PROJECT SUMMARY

The goal of this project is to develop a radio frequency identification (RFID) system capable of non-invasively detecting the condition of welds in a building. Currently, the only way to inspect a structural component of construction such as a weld is to remove any obstruction that exists between the weld and the inspector (such as a wall), visually inspect the weld, then rebuild the wall. Such a solution is obviously not cost effective. Ideally, a person should be able to inspect the weld without first tearing out the wall. With RFID, an inspector will be able to walk into a room with a device that will tell him exactly which welds in the room are intact. The device will emit low-frequency radio waves that power an integrated circuit attached to a weld. The circuit can detect whether the weld is broken, and transmits that information back to the device in the hands of the inspector. The inspection then proceeds much more quickly at a greatly reduced cost.

BACKGROUND

We are currently researching the possibility of using a passive RFID system for use in the weld inspection [1, 2]. The RFID system consists of a reader and a tag (Figure 1, page 2). The tag is magnetically coupled to the reader through the antennas. The reader performs three basic functions: energizing the tag, receiving the returned signal, and decoding the information sent by the tag. The reader uses a tuned antenna-capacitor circuit to transmit a low-frequency wave, which powers the tag. The tag then continuously transmits a signal back to the reader. The reader receives the transmitted signal, and an on-board microcontroller decodes the information embedded in the signal.

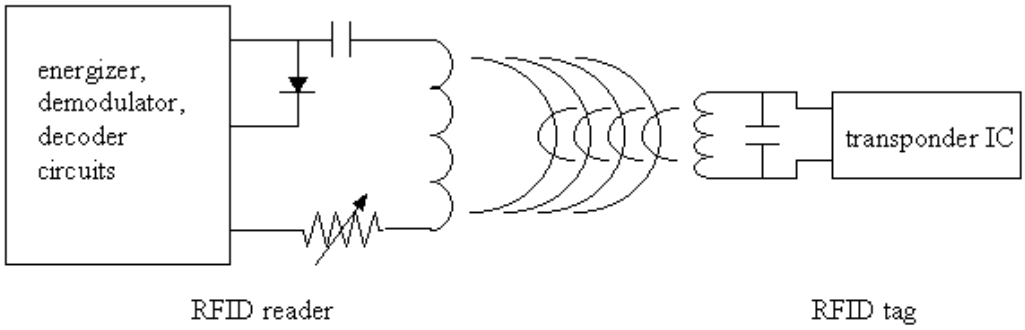


Figure 1: Block Diagram of RFID system [1].

Both Matthew's qualifications in electromagnetics and Allen's work in circuit design will be helpful in completing this project. The final design of the system will most likely include tuned antenna design as well as custom board layout for the reader and tag system. Our combined experience in programming C++ and assembly will also be useful in developing the software for interfacing with the system.

PROJECT DESCRIPTION

The usefulness of our system lies in the fact that we will be able to detect the status of the weld without destroying the wall covering that weld. Because the RFID system utilizes radio frequencies to convey information, line of site is not required. This makes the system ideal since the tag can be placed inside a wall, and its status can be checked at any time with an external reader.

We intend to design a sensor that can be attached to structural welds in order to make sure they are still intact. When powered up by the reader, the tag will check the status of the weld and convey this information via the returned signal. Using a portable reader and a map containing the location and ID numbers of tags installed in the building, an inspector would then be able to check the structural integrity of a building in a matter of hours rather than months.

Although the RFID ICs can be purchased off the shelf, it is left to the user to design the system in which they will be used. It will be our job to design the circuit and antenna

components to couple the RFID tag to an external transceiver and sensor switch. We will be experimenting to find an inexpensive design that offers good range while keeping power consumption low enough for use in a portable device. Once the circuits are working correctly, we will also design the printed circuit boards containing the loop antenna, IC socket, power supply and other external components. Our project will also include implementation of the software necessary to manage the signals received by the reader.

Because of his background in electromagnetics, Matthew will be in charge of the antenna design for the receiver and the tags. Allen will oversee the circuit design for these systems due to his experience in this area. Since we both have decent programming knowledge, we will work together on writing the computer code necessary to make our system user friendly. Although we have different specialties, we plan to work together on all aspects of this project and learn from each other as we progress.

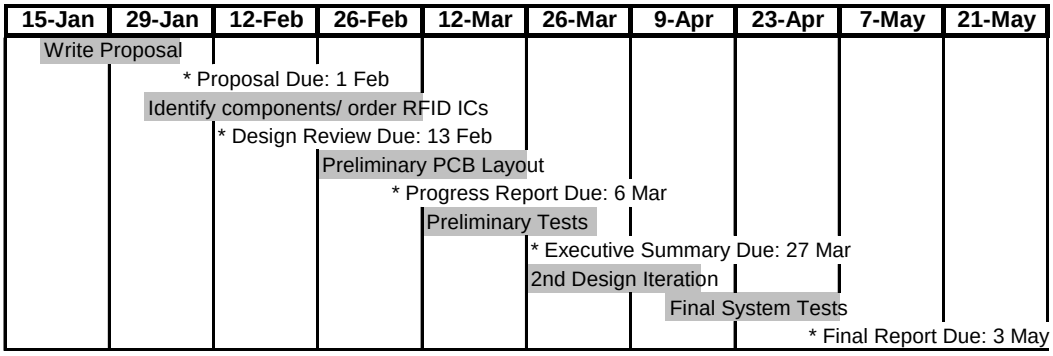
SPECIFICATIONS

In order to guide the design work that we are doing, we must have specifications that we are working towards. One of the main specifications of our project will be the range at which the reader can successfully acquire a tag. We feel that a distance of 25 cm will be adequate to reach through almost any type of wall surface. Tied into this are the FCC rules for the maximum allowable output power of the reader. Though we haven't gotten a response yet on an exact number, we feel that it will be somewhere in the range of one watt. For this system to be practical, we need the reader to be portable. Therefore it's weight and size, including the power supply, must be able to be carried around a building for several hours at a time.

PROJECT SCHEDULE

In order to ensure the timely completion of our project, we are proposing the following tentative timeline (Table 1, page 4). As we get more involved in the actual project, we will adjust this timeline as necessary to comply with the course deadlines.

Table 1: Proposed Project Timeline



RESOURCES AND COSTS

Dr. Dean Neikirk will provide most of the resources that we need for our project. He has already given us space to work in his lab at the Microelectronics and Engineering Research building (MER) as well as some preliminary equipment. The demo kit for the RFID system will run around $200 to $300 dollars depending on the actual model that we select. There will also be some minimal costs incurred to produce the PC boards for the final circuit layout including components, PC boards, and possibly a microcontroller and LCD display.

CONCLUSION

After reviewing our initial research we feel confident that we will be able to create a system capable of inspecting building welds without tearing down the overlaying wall. The final product should be relatively inexpensive and easy to install, and has the potential to save large amounts of money and time over the current methods used for weld inspection. Because we have the support of Dr. Neikirk, we should have adequate resources to complete our project, and by continually monitoring our progress against our proposed timeline we will be able to complete the work on time.

REFERENCES

[1] "Intersoft – Affordable RFID," <http://www.intersoft-us.com/> Accessed Jan. 16, 2000.

[2] "Microchip Technology Inc.: RFID," <http://www.microchip.com/10/lit/pline/rfid/index.htm> Accessed Jan. 16, 2000.