RFID IMPLEMENTATION ON DOMESTIC ANIMALS

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A thesis submitted in fulfilment of the requirements
for the award of the Bachelor of
Computer Science (Computer Systems & Networking)

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APRIL, 2010

ABSTRACT

Due to the adaption from media and television, we often have a perspective about farms where it is a place without advanced technologies. Works in the farm are carried out manually without the help of machines. For example, counting the animals, taking out which animal for medication and many more other jobs in a farm. As real as it is shown, our country, Malaysia, is slightly being left out from the advances of technology where animal breeding are still being done manually and without any computers that can help to increase the productivity and efficiency in breeding.

This project is actually to help breeders have an easier way in managing and monitoring their own animals. In this project, sheep breeding are taken as the case study. A RFID environment system will be implemented on a sheep farm to detect the correct amount of sheep present, monitoring each sheep and also to give breeders an automated way of managing its farm. Therefore, is it hoped that with the implementation of RFID on farms, would help breeders to increase the productivity and efficiency in breeding.

ABSTRAK

Disebabkan daripada pengaruh media massa dan televisyen, kita sering mempunyai perspektif terhadap kandang dimana ia merupakan suatu tempat yang tidak mempunyai apa-apa kemudahan teknologi. Kerja-kerja penternakan biasanya dilakukan secara manual tanpa bantuan daripada mesin. Contohnya, pengiraan ternakan, mengenal pasti ternakan yang memerlukan perubatan dan banyak lagi operasi dalam kandang. Seperti bagaimana yang kami dapat lihat, negara Malaysia agak ketinggalan dari segi teknologi dalam cara pengendalian penternakan di mana kami tidak menggunakan kemudahan teknologi yang wujud pada masa kini yang dapat meningkatan produktiviti ternakan dan mempercepatkan proses pengendalian penternakan.

Projek ini bertujuan untuk memudahkan kehidupan penternak dalam mengendalikan kandang mereka. Ia memudahkan penternak dalam mengendali dan memerhati ternakan mereka sendiri. Dalam projek ini, penternakan kambing berbiri dijadikan sebagai rujukan. Penggunaan RFID akan diimplementasikan di dalam kandang berbiri untuk membuat pengiraan kambing, memerhati keadaan kambing dan mengendalikan operasi perternakan secara automatik. Oleh itu, diharapkan dengan implementasi RFID pada pengendalian perternakan, ia dapat membantu perternak meningkatkan produktiviti dan urusan penternakan dapat dilakukan dengan lebih efisen.

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CHAPTER 1

INTRODUCTION

This chapter will provide a brief overview of the entire project including objective, scope and problem statement of the project.

1.1 Introduction

From what shown in media and movies, farms are normally being represented as a place without advanced technologies where everything is done manually without any help of machines and computers. As real as it is shown, animal breeding has always been well-known as the busiest and hardest job. Breeding requires a lot of hard work and experience and it is normally being passed down generation by generation. Normal people usually won't be able to do these kinds of jobs. If you asked an office boy to work in a farm for a month, it is sure that he will quit it in just a few weeks. This is because breeding animals is not easy as it says. One needs to understand everything about farming and being able to identify each animal that are present.

An example of breeding sheep shows how difficult the job is. Every day, breeders will release their sheep to the open land to graze the land. After that, the breeder brings back all the sheep back to the farm. While bringing them back, the breeder will count all the sheep and makes sure that the same amount that goes out comes back. This is not an easy task as the sheep will not sit stood for the breeder to count them. Therefore, the counting needs to be very fast and accurate. A mistake in counting will cause the breeder to recount all over again. Without an eye of an eagle, the breeder would face some difficulties in this part. Another situation, if the sheep that were brought back weren't the same as the amount that went out, the breeder needs to identify which sheep went missing. As each sheep looks alike, the breeder might not be able to identify the identity of the sheep. Therefore, if the breeder does not have a good memory and sensitivity, the lost sheep might just be unidentified. Not just when the sheep is missing, the problem occurs even when the breeder wants to take out the sheep for medication. Which sheep has taken medication and which is not? Being a breeder needs to be available all time. A breeder couldn't simply get someone to replace him/her for the job. There are no sick holidays or paid-leave for breeders.

Therefore, an implementation of RFID (Radio Frequency Identification) in farms could make life easier for breeders. It helps to solve problems of breeders and makes breeding to move up to a higher level either in increasing the efficiency of breeding or increasing the productivity of animals.

1.2 Problem Statement

1. Counting the correct amount of sheep that returns together to the farm leads to confusion or miscalculation and it is difficult to categorize the sheep's breed.

The amount of sheep that a breeder breeds normally exceeds 500 per farm. When the sheep returns back to the farm, they will return in a flock. Imagine that a breeder needs to make sure the amount of sheep return are correct when all the sheep pushing back each other to get into the farm. Hénce, to calculate the total of 500 sheep in the short period will cause confusion or miscalculation and at the same time differentiating the type of breed will be an almost impossible task.

2. Breeders unable to identify the identity of the sheep that was not present in the farm.

If there are sheep that went missing after grazing the land, it is hard to identify which sheep went missing. This is because all the sheep look alike and it is hard to differentiate among them.

3. If breeder is not capable to work, there will be no one to replace for the job

Being a breeder needs to be available all the time and cannot afford to get sick or being unable to work. This is because to look after a sheep barn requires a lot of experience and it is a job where one must be trained from young. There is no way to pick somebody with no experience in breeding to take over the breeder's job.

1.3 Objective

1. To implement RFID in farms for detecting the amount of sheep present in the farm.

2. To keep a database of information of each sheep in the farm.

3. To provide an automated way of counting sheep and categorize sheep breed in the farm.

1.4 Scope

The application will be implemented in a sheep barn. The sheep will be tagged and information of each sheep will be stored in a database. Breeders will be the ones that will monitor and handle this application. A RFID reader will be placed at a specific area in the farm where it can sense the tag on the sheep.

The system implemented is a simulation of RFID implemented on the barn. The equipments and devices are not fully appropriate to be used on a farm. However, the concept can be used

CHAPTER 2

LITERATURE REVIEW

This chapter briefly explains the definition of RFID and farm management. The definition of RFID includes its components and current technologies.

2.1 RFID

Radio Frequency Identification (RFID) is the use of an object, known as tag, applied to or incorporated into a product, animal or person for the purpose of identification and tracking using radio waves. With RFID, electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum is used to transmit signals. A RFID system consists of an antenna and transceiver (also known as reader), which read the radio frequency and transfer information to a processing device, transponder or tag, which is an integrated circuit containing the radio frequency circuitry and information to be transmitted. The technology of RFID eliminates the need for line-for-sight reading that barcode depends on.

2.1.1 Components

RFID systems consist of the following principal components. The first is the transponder, which is affixed to the item that is to be tracked or identified within the supply chain by the RFID system [1]. A transponder (more commonly just called a tag) that is programmed with information that uniquely identifies itself [2]. The reader, which has a number of varied responsibilities including powering the transponder, identifying it, reading from it, writing to it, and communicating with a data collection application [1]. The reader, also known as the transceiver handles radio communication through the antennas and passes tag information to the outside world [2]. The antenna is attached to the reader to communicate with transponders [2]. The data collection application, which receives data from the reader, enters the data into a database, and provides access to the data in a number of forms that are useful to the sponsoring organization [1].

2.1.1.1 Tags

An RFID tag is a device that can store and transmit data to a reader in a contact less manner using radio waves. The tag holds the data that is transmitted to the reader when the tag is interrogated by the reader [4]. When the tag is interrogated, the data from its memory is retrieved and transmitted [4]. A tag can perform basic tasks (read/write from/to memory) or manipulate the data in its memory in other ways [4]. A tag's memory can be read-only (RO), write once-read many (WORM), or read-write (RW) [4]. There are 3 types of tags: passive, active and semi-active.

2.1.1.1.1 Passive Tags

This type of RFID tag does not have an on-board power source (for example, a battery), and instead uses the power emitted from the reader to energize itself and transmit its stored data to the reader [3]. Passive tags do not have a dedicated power supply [1]. Instead, they derive their operating power from the electrical field generated by the reader [1]. A passive tag is simple in its construction and has no moving parts [3]. As a result, such tag has a long life and is generally resistant to harsh environmental conditions [3]. A passive tag is typically smaller and cheaper compared to an active or semi-active tag [3]. Many solutions are currently in place that employs passive tag technology, such as animal tracking, asset management, industrial automation, electronic article surveillance, and access control applications [4].A passive tag consists of 2 main components:

(a) An integrated circuit of chip: This chip stores data and executes specific commands [2]. Most of the passive tags today carry 96 bits of memory, although some can carry as little as 2 bits or as much as 1000 bits [2]. The chip design determines whether the tag has read-only or read-write properties [2]. Three of four manufacturers, including Philips, Texas Instruments, Fairchild, and ST Micro, are the primary makers of these chips [2].

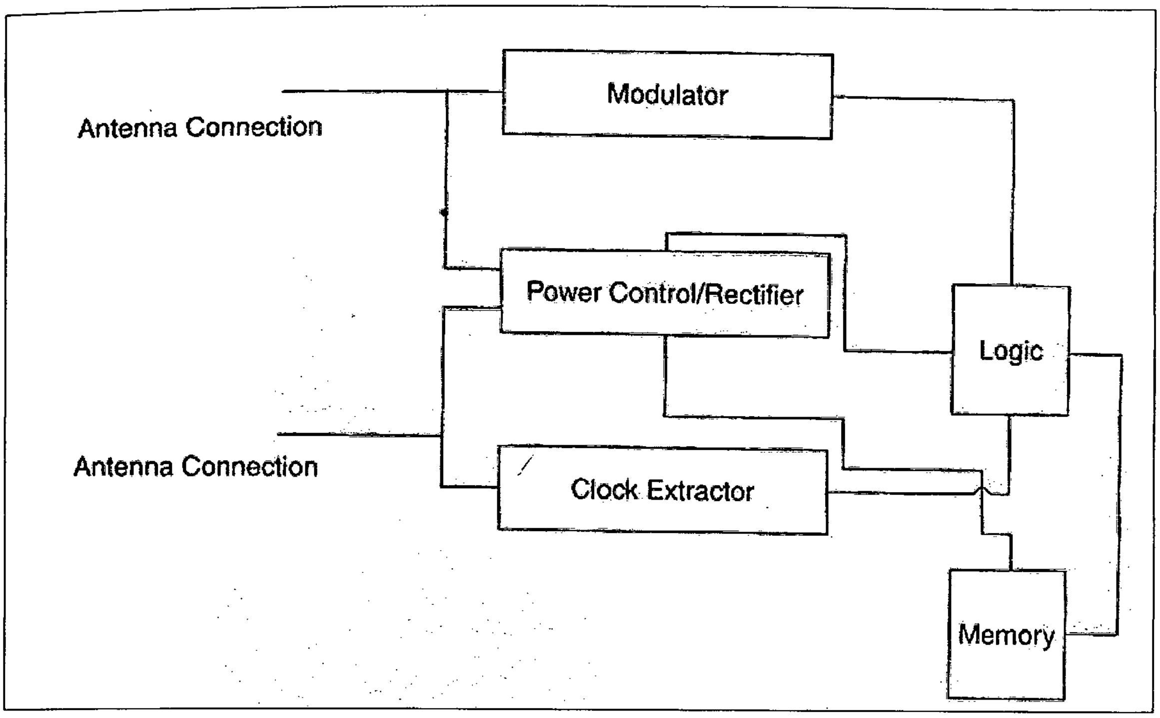

Figure 2.1: Basic components of a microchip [3]

The power control/rectifier converts AC power from the reader antenna signal to DC power [3]. It supplies power to the other components of the microchip [3]. The modulator modulates the received reader signal [3]. The tag's response is embedded in the modulated signal, which is then transmitted back to the reader [3]. The logic unit is responsible for implementing the communication protocol between the tag and the reader [3]. The microchip memory is used for storing data [3]. This memory is generally segmented (that is, consists of several blocks or fields) [3]. Addressability means the ability to address different (that is, read or write) the individual memory of a tag's microchip [3]. A tag memory block can hold different data types, such as a portion of the tagged object identifier data, checksum (for example, cyclic redundancy check [CRC]) bits for checking the accuracy of the transmitted data, and so on [3]. However, a tag's physical dimensions are not determined by the size of its microchip but the length of its antenna [3].

(b) An antenna (or coupling element): A tag's antenna is used for drawing energy from the reader's signal to energize the tag and for sending and receiving data from the reader [3]. This antenna is physically attached to the microchip [3]. The antenna's function is to absorb RF waves and then broadcast a signal back out [2]. The antenna powers up the tag by collecting the energy from the RF field and exciting the onboard chip into action [2]. This process is called coupling because the tag antenna must "couple" with the electromagnetic fields that the RFID reader emits [2]. In more technical terms, coupling describes the extent to which power is transferred from one system component to another – in this case, from air to the antenna [2]. The size of the antenna is critical to the performance of the tag because the antenna's size usually determines a tag's read range [2]. The antenna length is directly proportional to the tag's operating wavelength [3]. A dipole antenna consists of a straight electric conductor (for example, copper) that is interrupted at the center [3]. The total length of a dipole antenna is half the wavelength of the used frequency to optimize the energy transfer from the reader antenna signal to the tag [3]. A dual dipole antenna consists of two dipoles, which can greatly reduce the tag's alignment sensitivity [3]. As a result, a reader can read this tag at different tag orientations [3]. A folded dipole consists of two or more straight electric conductors connected in parallel and each half the wavelength (of the frequency) long [3]. When two conductors are involved, the resulting folded dipole is called 2-wire folded dipole [3].

2.1.1.1.2 Active Tags

Active RFID tags have an on-board power source (for example, a battery; other sources of power, such as solar, are also possible) and electronics for performing specialized tasks [3]. Due to the battery, they have a finite lifetime [4]. They are, however significantly larger than their passive counterparts and therefore lend themselves to a different set of applications [1]. For example, they are often used for automated toll-paying applications (Touch N Go or Smart Tag) or for tracking large items in a warehouse. An active tag uses its on-board power supply to transmit its data to a reader [3]. The on-board electronics can contain microprocessors, sensors, and input/output ports powered by the on-board power source [3]. Therefore, the components can detect various kind of information. Active tags do have an internal battery and therefore have significantly greater read range [1]. An active tag is almost similar to a wireless computer with additional properties. In tag-to-reader communication for this type of tag, a tag always communicates first, followed by the reader [3]. Because the presence of a reader is not necessary for data transmission, an active tag can broadcast its data to its surroundings even in the absence of a reader [3]. The reading distance of an active tag can be 100 feet (30.5 meters approximately) or more [3]. An active tag also consists of the two same components as a passive tag, a microchip and an antenna [3]. One of the more common uses for active tags is for tracking high-value objects over long ranges such as tagging and tracking of military supplies shipped around the world [4].

2.1.1.1.3 Semi-Active (Semi-Passive) Tags

Semi-active tags have an on-board power supply source (for example, battery) and electronics for performing specialized tasks. This type of tag draws power from the onboard battery to "energize" and operate the tag's IC and perform simple tasks [4]. The on-board power supply provides energy to the tag for its operation [3]. However, for transmitting data, it uses the reader's emitted power. Batteries used in these types of tag typically last several years because power is only consumed when the tag is activated and is in the reader's field [4]. In a tag-to-reader communication, a reader communicates first, followed by the tag [3]. A semi-active tag does not use the reader's signal (unlike a passive tag) to excite itself it can be read from a longer distance as compared to a passive tag [3]. Because no time is needed for energizing a semi-active tag, such tag could be in the read zone of a reader for substantially less time for its proper reader [3]. Therefore, even if the tagged object is moving at a high speed, its tag data can still be read. A semi-active tag offers better readability for tagging of RF-opaque and RF-absorbent materials [3]. The reading distance of a semi-active tag can be 100 feet under ideal conditions using a modulated backscatter scheme (in UHF and microwave) [3]. A very common example of this tag is electronic toll collection, in use since the 80s [4].

2.1.1.2 Tag Classes

To distinguish tag types from each other, EPCglobal has established five tag classes to indicate capabilities a tag can perform as indicated at the table below:

Table 2.1: Tag Classes. (Source: Hardware Program Configuration, EPCglobal, 2004, at www.epcglobalinc.com) [5].

EPC tag class	Tag class capabilities
Class 0	Read only (i.e., the EPC number is encoded onto the tag during manufacture and can be read by a reader)
Class 1	Read, write once (i.e., tags are manufactured without the EPC number which can be encoded onto the tag later in the field)
Class 2	Read, write many times
Class 3	Class 2 capabilities plus a power source to provide increased range or advanced functionality
Class 4	Class 3 capabilities plus active communication and the ability to communicate with other active tags
Class 5	Class 4 capabilities plus the ability to communicate with passive tags as well

Not mentioned in the table are the Class 1, Gen. 2 tags which take into account the interoperability issues between Class 0 and Class 1 tags. It is not possible for the retailer or supplier to duplicate the EPC number in Class 0 tags in Class 1 tags; that is, the EPC number in Class 0 is not transferable to Class 1 tags [4]. Generation 2 consolidates multiple protocols specified in Generation 1 as a single protocol [4].

Class 0 through Class 2 tags are passive communication types and Class 3 are semi-passive. The Class 4 and Class 5 are active communication types.

2.1.1.3 Reader

The reader is responsible for orchestrating the communication with any tags in its read range and then presenting the tags' data to an application that can make use of the data [6]. It is also referred to as the interrogator, a device that captures and processes tag data [4]. It is responsible for interfacing with a host computer. The frequency ranges at which a system operated is defined by the reader because it is the reader's antennas that emit the energy used by the tags in a passive tag implementation [6]. The reader's antennas must generate the carrier wave at the correct frequency so that the tag in its range will be able to absorb the RF energy [6]. One of the more important aspects of a tag and reader communication (coupling) is the frequency at which it operates [4]. The most common RFID frequency ranges are Low Frequency (LF) at 135kHz or less, High Frequency (HF) at 13.56MHz, Ultra High Frequency (UHF) starting at 433MHz, Microwave Frequency at 2.45GHz and 5.8GHz [4]. The frequency determines the data transfer rate (speed) between the tag and the reader. The lower the frequency, the slower the transfer rate. A reader's task is to read data stored on the tag, which requires a sophisticated software algorithm to ensure reliability, security and speed [4].

Table 2.2: Summary of characteristics and applications of most popular RFID frequency ranges [4].

Frequency	Key Characteristics	Typical Applications
Low Frequency (LF) Less than 135KHz	• In use since 1980s and widely deployed • Works best around metal and liquid • Lowest data transfer rate • Read range measured in inches	• Animal identification • Industrial automation • Access control

High Frequency (HF) 13.56MHz	• In use since mid 1990s and widely deployed • Common worldwide standards • Longer read range than LF tags (3+ feet)	• Payment and loyalty cards (Smart Cards) • Access control • Anti-counterfeiting • Various item level tracking applications such as for books, luggage, garments, etc. • Smart shelf • People identification and monitoring
Ultra High Frequency (UHF) 433MHz and 860 to 930MHz	• In use since late 1990s • Longer read range from HF tags (10+ feet) • Very long transmit ranges for active 433MHz system (up to several hundred feet) • Gaining momentum due to worldwide retail supply chain mandates • Potential to offer lowest cost tags • Incompatibility issues related to regional regulations • Susceptible to interference from liquid and metal	• Supply chain as logistics such as: - Inventory control - Warehouse management - Asset tracking