Preliminary RFID Research

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Questions to be answered:

- How do antennas work to send power and communicate with the Iowa State cards?
- What class of RFID scanners are required in order to read Iowa State cards?
- How can this type of scanner be designed?

How do antennas work to send power and communicate with the Iowa State Cards?

- **Transmitters** - turns electrical signals into radio waves so they can travel to the receiver
- **Antenna/ Receiver** - Catches radio waves from the transmitter and turns them into electrical signals to feed some sort of system (i.e., radios, televisions, or telephones)
- The operation of a transmitter and receiver can be described in the following steps:
    a. A device such as a microphone creates electrical energy
    b. The electrical energy is then sent along a long antenna where the electrons move in such a fashion that they create an electromagnetic wave
    c. The receiver then is excited by the electromagnetic wave
    d. The electromagnetic wave creates an electrical current which is used in the receiver circuit as a signal
- The length of the antenna, generally speaking is supposed to be about half the wavelength of the signal you are trying to receive
- There are three important properties of an antenna:
    - Directionality
    - Gain
    - Bandwidth
- **Directionality** - antennas often pick up incoming signals which are at right angles to them.
    - The main purpose of this is to help reduce the interference of other signals that may create noise
- **Gain** - The gain is how much the incoming signal is amplified by the receiver. The bigger the gain - the better the reception is going to be
    - Often time signals are very faint and need to be amplified in some fashion in order to be of any use
- **Bandwidth**- The range of frequencies over which the antenna works properly.
    - For a design like our application we only care about a certain frequency thus a narrow bandwidth is ideal
- **Sources -**
    - https://www.explainthatstuff.com/antennas.html (used this the most)
    - http://www.antenna-theory.com/basics/main.php (really good)
    - https://en.wikipedia.org/wiki/Antenna_(radio) (additional)

What class of RFID scanners are required in order to read Iowa State cards?

- There are essentially three classes of RFID frequencies:
    - Low Frequency (LF) RFID
        - 30 kHz to 300 kHz
    - High Frequency (HF) RFID
        - 3 to 30 MHz

    - Ultra-high Frequency (UHF) RFID
        - 300 MHz to 3 GHz
- Passive versus Active RFID applications
    - Essentially all the information is conveyed in the chart below:

	Active RFID	Passive RFID	Battery-Assisted Passive (BAP)
Tag Power Source	Internal to tag	Energy transfer from the reader via RF	Tag uses internal power source to power on, and energy transferred from the reader via RF to backscatter
Tag Battery	Yes	No	Yes
Availability of Tag Power	Continuous	Only within field of reader	Only within field of reader
Required Signal Strength from Reader to Tag	Very Low	Very high (must power the tag)	Moderate (does not need to power tag, but must power backscatter)
Available Signal Strength from Tag to Reader	High	Very Low	Moderate
Communication Range	Long Range (100m or more)	Short range (up to 10m)	Moderate range (up to 100m)
Sensor Capability	Ability to continuously monitor and record sensor input	Ability to read and transfer sensor values only when tag is powered by reader	Ability to read and transfer sensor values only when tag receives RF signal from reader

- Given that Iowa State cards operate at 125 kHz, it is safe to assume that the cards most likely fall under the designation of Low Frequency RFID.
- Our cards are also passive RFID as they do not have a power source internal to them.
- **Sources-**
    - https://www.impinj.com/about-rfid/types-of-rfid-systems/ (used this the most)
    - http://www.ia.omron.com/support/guide/47/introduction.html (very good)

How can a low frequency type of scanner be designed?

- Good resources to view for this circuit design:
    - http://www.ti.com/lit/an/swra284/swra284.pdf (Texas Instruments has some circuit design for this type of thing)
    - https://www.autodesk.com/products/eagle/blog/rfid-works-antenna-design/ (good resource for designing a circuit)
    - https://www.digikey.com/en/articles/techzone/2013/may/a-designers-guide-to-rfid (also a lot of good information)