ECE4011/ECE 4012 Project Summary

Project Title	Drone Mounted RFID Cattle Inventory System
Team Members (names and majors)	Jesse Baker (EE) Neil Dahlqvist (EE) Ashley Hrebik (CmpE) Jorge Santiago Juarez (EE) George Tzintzarov (EE)
Advisor / Section	Dr. Manos Tentzeris (L7A)
Semester	2016/Fall Circle: Intermediate (ECE4011) or Final (ECE4012)
Project Abstract (250-300 words)	The purpose of this project is to design, build, and test a Radio-Frequency Identification (RFID) system for use in the cattle industry. The project is focused on improving the read distance and reading capabilities of the RFID technology through a system level optimized design. A system of this caliber will reduce the day to day labor of counting cattle in various herds from a multi-hour procedure down to sub-hour times. System components which were selected include a fully programmable RFID scanner marketed to developers, narrow-band circularly polarized antenna, a linearly polarized antenna, a Raspberry Pi and an external battery pack. Frequencies close to 915 [MHz] must be used due to FCC mandates and commercially available hardware. This project seeks to investigate the design of a mobile reader mounted on an UAV for inventory of cattle with the option for GPS coordinates of each bovine. Successful design of this system depended on (1) frequency of operation, (2) Antenna structure, positioning and power output, (3) power management. The sum of the hardware used for the prototype cost $2200. In addition to the primary design motivation, this system may be used for agricultural and environmental sensing. There exist RFID enabled sensors which monitor variables such as moisture, humidity, pH, pollution levels and many more. In theory, massive amount of these sensors could be deployed and read by the UAV system to increase land knowledge of farms and natural preserves.

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List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	- ISO 11784: The international standard defining frequencies, baud rate, bit coding and data structures of transponders used for animal identification. - Class 2/Class 3 RFID tag standards (for semi-passive tags) - Data content codes for 64-bit identification code (15 digits numeric) - Air interface protocol
List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	- Constrained by the use of passive tags which inherently give much smaller read ranges that semi-active tags. - The FCC limited us at 1 [W] of output power, significantly limiting the read range of the system. - Net weight of hardware had to be under 2 pounds to fly on drone - Hardware dimensions must be small in order to not interfere with aerial sensors.
Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen.	- A tradeoff existed where a linearly polarized antenna allows for a longer read range, whereas a circularly polarized antenna allows for freedom of antenna orientation on the UAV. Solution was to switch between the two options as required by the testing environment. - An active tag on the bovine would greatly increase the read range of the system, however it weighs too much and is too costly. It would also warp the bovines ear. Passive tags are cheap and light, but offer severely reduced read ranges. Solution chosen was to proceed with passive tags.
Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** tradeoffs, interfaces, and/or interactions. *Complete if applicable; required if team includes CmpE majors.*	The RFID reader (USBPro) had to be programmed to start up when the raspberry pi was powered on, and all appropriate operation states (power output, read frequency) had to be enabled. Furthermore, the CPU had to automatically create a *.CSV file on a thumb drive to store the tag reads. Next a GPS module was programmed to interact with the Raspberry Pi, with the option to time sync the tag reads with GPS locations to create map of bovine locations. GPIO pins were programmed to control the operation of the RFID reader, this was done by modifying the java source code provided with the RFID scanner.

ECE4011/ECE 4012: International Program

(Only groups with one or more International Program participants need to complete this page)

Project Title	
Global Issues (Less than one page)	(10 point font, single spaced)