The Deployment of RFID Technology on Small Farms in Holopaw, FL: A Community-Centered Effort

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***Abstract*—This paper discusses a solution that deploys passive UHF RFID technology and wireless sensors on small farms to provide intelligence that will help mitigate some disparate socioeconomic conditions in farming communities. Starting with a collaborative effort with farmers in the community of Holopaw, Florida, in the United States, we first propose experiments to observe the feeding patterns of livestock on farms of less than 150 acres in order to improve pasture design. We hypothesize that intelligent pasture design will result in improved utilization, which has far-reaching implications such as improved growth and health of livestock, profitability, and ultimately mitigation of socioeconomic conditions of residents in a given city.**

I. Introduction

The proliferation of technology has brought much improvement to the agricultural sector. Many small farmers, however, do not have the resources to deploy technology on their farms. This phenomenon causes many people in rural and underrepresented communities to struggle financially. Furthermore, a lot of farmers lack knowledge in practices that could increase the growth, health, and reproduction of livestock on farms. There are also few educational resources and institutions that seek to collaborate with local farmers to provide assistance with deployment of technology on farms in rural communities.

The goal of this research is to promote economic development through the integration of agriculture and technology in the area of Holopaw, Florida, where a farm of approximately 100 acres will be initially used for deployment of a RFID-based solution designed to acquire knowledge about livestock feeding patterns. The intelligence acquired will help us replicate low-cost, profitable practices on other small farms in the area and eventually on other regional and national farms.

II. Livestock Tracking

Current technologies for livestock tracking include very high frequency (VHF) antennas, global positioning system (GPS), and radio frequency identification (RFID). The techniques mentioned vary in implementation, and use of resources, with some significant differences in performance.

In implementation of VHF antennas, transmitters that send out signals to field monitors are attached to the animals, the location of which is determined by triangulation. Such implementations require two people to operate the system for triangulation purposes, and there is a decrease in accuracy over longer distances.

GPS tracking methods are capable of calculating and transmitting the location information from the earth to a satellite, and then back to a receiving station. Although this technique is accurate, it is also expensive and energy inefficient [1].

RFID methods "comprise a reader, tag (or transponder) and software to convert tag data into meaningful information"[1]. These methods are currently the most widely used for tracking livestock. Active RFID devices require a power source, whereas for passive RFID device, a tag's lifetime is limited by the stored energy, balanced against the number of read operations the device must undergo [2].

III. Proposed Approach

The solution proposed in this work is the integration of passive UHF RFID technology coupled with wireless sensors to monitor the feeding patterns of livestock. Figure 1 shows a general framework of the proposed two-phase solution. Highlighted in yellow (Phase 1) is the area of focus for this research. As depicted in the figure, livestock on the farm will be tagged with RFID tags. Transponders and wireless sensors will be installed at strategic locations around a pasture that is specially organized according to grass species. As livestock move around the pasture to feed, transponders will report the location of the livestock in relation to grass species. An aggregation of sensor data and transponder readings will then be sent to an on-site central station. Data will in turn be transferred to a cloud server for storage and analysis. Pattern recognition techniques will be used to learn livestock feeding patterns. This intelligence will help farmers to better design pasture to improve pasture utilization and profitability. Experiments will first be conducted on a farm of approximately 100 acres. The results of the experiments will provide answers to the following research questions and knowledge to recommend and replicate certain processes and technology on other farms in Florida and ultimately other areas in the U.S.:

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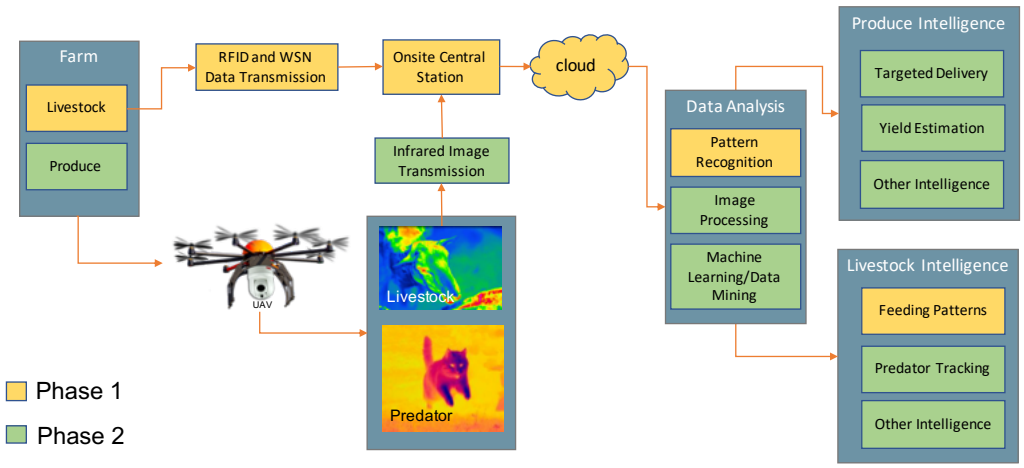

Fig. 1: General solution framework highlighting the focus of this research

1) To what degree can passive UHF RFID technology be coupled with wireless sensors to monitor feeding habits of livestock in a free-range pasture?
2) To what degree can knowledge of livestock feeding patterns be used in the design of pasture to increase the health and growth of livestock?
3) How applicable is passive UHF RFID on farms of approximately 100 acres?
4) To what extent can a farm of approximately 100 acres fitted with passive UHF RFID technology be used to alleviate farmers of financial struggles and manual farm monitoring?

1) Passive UHF RFID Coupled with Wireless Sensors: While low frequency (LF) RFID is traditionally used for animal tracking due to lower sensitivity to radio wave interference than high frequency (HF) RFID, recent advances in passive RAIN UHF RFID hold a lot of promise in livestock tracking with data reads of up to 12 meters and improvement in resistance to interference [3]. To the best of our knowledge, our controlled experiments will be the first community-based, collaborative effort within the United States to investigate the use of passive RFID on farms of less than 150 acres that are organized according to grass species with the goal of observing feeding patterns to provide intelligence to assist with pasture design which would lead to improved growth and health of livestock, and profitability.

IV. Research Impact

The ultimate goal of the project is to decrease the disproportionate level of poverty experienced by farmers in many areas across the globe. Since experiments will be first conducted in Holopaw, Florida, the estimated 5000-plus residents will be the first recipients of the benefits of this research. However, the intelligence acquired will be used to replicate processes regionally and nationally. The following are some of the benefits that demonstrate the impact of this research:

- **Jobs in agriculture for the community** - While current census data for Holopaw is unavailable, records show a prevailing issue of poverty and unemployment in the area [4]. Therefore, the availability of jobs is very important. This project will provide jobs in farm maintenance through the use of technology, harvesting of crops, livestock health monitoring, butchering of livestock and meat sale, to name a few.
- **Satellite research center for students to conduct research and innovate** - the collaboration with local farmers will provide the opportunity for students to conduct research on an actual farm equipped with modern technologies.
- **Opportunity for students to learn new skills in multi-agent systems** - this coupling of wireless sensors with RFID readers and tagged animals provide a multi-agent network that reports live information that can be analyzed using multi-agent approaches.
- **Provision of datasets** - tracking livestock feeding patterns provides a wealth of information that can be analyzed to provide intelligence on many levels including pattern recognition, data mining and machine learning.
- **Higher returns on investments due to livestock health and growth monitoring** - retrofitting an existing farm with livestock monitoring capabilities will result in higher profit margins that will ultimately alleviate the disparate socioeconomic conditions in the community of Holopaw and ultimately other areas where the solution proposed in this research is replicated.

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