Building Near-Real-Time MODIS Data Fusion Workflow to Support Agricultural Decision-making Applications

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***Abstract*—WaterSmart project is an NSF funded projected seeks water consumption reduction using satellite observations. In order to fit the fine temporal resolution requirement, satellites are required to have a high revisit cycle. MODIS is an ideal platform for monitoring the ground thanks to its daily coverage while the spatial resolution is too coarse. Research has demonstrated the possibility to improve the spatial resolution of MODIS using the Landsat 8 images. This research is aimed to establish a workflow to adapt the data fusion algorithm to achieve automatically processing at real-time in order to support short-term decision making.**

***Index Terms*—Agriculture, remote sensing, MODIS, data fusion, web service**

I. Introduction

Water is one of the most important resources for agricultural activities. Most farmlands were established near water sources such as rivers and lakes until irrigation system was invented [1]–[3]. With the development of the water grid and irrigation system, large scale farming became possible. However, the needs of water quantity varies for different soil type, plant conditions, and locations. To get accurate information on water consumption at field level, measurements need to be collected at field stations. To build many measuring stations could be economically inefficient, while data could be less accurate when there is no sufficient measurement across fields.

Remote sensing plays one of the most important roles in agricultural activities thanks to its large spatial coverage, frequent revisit cycle. and relative low cost [4]. Many research has demonstrate the feasibility of using remote sensing techniques to monitor agricultural activities [5]–[11]. However, remote sensing is not able to provide fine spatial and temporal observations at same time for large scale due to technology limitation [4]. Satellites are only capable to provide fine spatial resolution information when temporal resolution is coarse or footprint is small [4], [12]. For this reason, limited research was done to help farmer to make irrigation decision at field level for a large area.

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Image fusion was introduced to remote sensing community trying to get fine spatial and temporal resolution image at the same time by aggregating images from multiple satellites [13]. Many image fusion algorithms were developed; however, most of pervious research was mainly focus on the fusion algorithm which was not trying to bring the technology into real world applications [13]. This research tried to bring results from image fusion technology to real world application: 1) to test the feasibility of adopting image fusion in real world problem which needs to be addressed in near real time (NRT); 2) to build a workflow to facilitate automated data processing and dissemination using web services.

II. Background

To help the US Department of Agriculture reach its 2030 sustainable agriculture goals, the WaterSmart project was awarded by the National Science Foundation (NSF) to enhance food and energy security. The main goal of the project was focus on helping the farmer to save water during irrigation. Water plays an important role in energy used during crops production [14]. Irrigation during water shortage could help the growth of the crop, while over irrigation leads to energy and economic loss [6]. Farmers make irrigation decision every day based on the condition of crop and weather foresting. While weather foresting is usually accurate, the crop condition varies dramatically even at local level. The lack of understanding of such spatial variation brings difficult for farmers to irrigation decision, and could even reduce crop yield by over irrigating.

Nebraska was selected as the study area in this research thanks to its large scale of farmland and irrigation system. Center Pivot Irrigation System helped Nebraska became one of the top corn and soybean production states in the United States. To help farmers in Nebraska to reduce irrigation cost and increase crop productivity could be a good case study when promoting the solution to the entire nation.

III. Data and Algorithm

In this research, we try to combine existing image fusion algorithms from previous work and state-of-the-art GIS