A COMPARATIVE ANALYSIS OF SPATIAL TEMPORAL FUSION METHODS

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ABSTRACT: Over the years, enormous amounts of remote sensed data with continuous improvements in the radiometric, spectral and spatial capabilities of system provided by the satellite remote-sensing missions. However, in current satellite sensor technology, improving a satellite sensor's spatial resolution may only be achieved at the cost of losing some other advantages of satellite remote sensing, such as spectral resolution, swath width, and radiometric resolution. The reduced swath width would also leads to a reduced temporal resolution since it may take more time to revisit the same place. Take the Landsat7 ETM+ sensor and the MODIS (Moderate-resolution Imaging Spectroradiometer) sensor as an example. The ETM+ data possesses high spatial resolution (30 meters), low temporal resolution (16 days revisit cycle); comparatively, the MODIS data possesses low spatial resolution (250 ~ 1000 meters), high temporal resolution (daily revisit cycle). On the other hand, an increase number of applications, such as feature detection, change monitoring and land cover classification often demand the highest resolution for the best accomplishment of their objectives.

One possible solution is data fusion, which could facilitate the monitoring of rapidly changing areas by offering an efficient integration of images of different spatial and temporal resolutions that are currently available (Spatial Temporal Fusion). There are so many STF methods making different assumptions, utilizing different sensors, and applied to different cases that researchers often fail to fully acknowledge previous contributions, with the potential to duplicate the previous techniques (Somers et al., 2011) and the hardness for new users to choose their own ones. This evolution requires a survey of the available knowledge comprehensively and analytically, which we aim to provide here. Starting from the relationship between image spatial features (texture and contexture) and spatial scale and temporal dynamics property of the processes observed, this paper presents a comprehensive framework for comparing, categorizing, and evaluating the exiting methods, and gives a guideline for users to choose their proper methods according to their demand. The current methods, including but not limited to Unmixing

based (Smith et al., 1994), regression based (Gao et al., 2010), STARFM (Gao et al., 2006), ESTARFM (Zhu et al., 2010), STAARCH (Hilker et al., 2009), SRFM (Wu et al., 2012), SRCM (Huang and Song, in press) and U-STFM (Huang and Zhang, submitted) are only different at how to merge the contexture and texture information from the fine resolution (difference) image(s) into coarse resolution (difference) image(s). The methods are categorized into three families, 1) only contexture information merged; 2) only texture information merged; 3) both texture and contexture information merged. To effectively choose the proper method for a specific application from all the benchmarks, one should consider what kinds of input images can be obtained for fusion, the spatial scale and temporal dynamics property of the observed environment, and the basic assumptions of the specific methods. Furthermore, one also should consider the implementation/execution complexity (like how many input parameters are involved and how they are adjusted, how many input images or prior knowledge the method need, how efficient of the technique). An experiment based fuse MODIS and TM images shows that this analysis could give some guidelines for choose among different methods.