A Dual Sensor Machine Learning Approach to Sulfur Quantification of Lignite Coal
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Coal accounts for 38% of global power production. Sulfur appears in coal in two forms; elemental form and pyritic form. Pyrite is an iron sulfur compound (FeS2) which is not homogenous throughout coal. In combustion, coal forms sulfur dioxide (SO2) which is released into the air where it becomes sulfuric acid (H2SO4). This alters the pH of ecosystems. Mines use dry combustion analysis (expensive and time consuming lab analysis) to quantify sulfur. The goal of this study was to create different models to predict sulfur content in lignite coal, using optical color sensing and portable X-ray fluorescence (PXRF). For the study, 249 lignite samples were collected from four mines in North Dakota. Each sample was ground, dried, and subject to dry combustion analysis. Samples were scanned using color sensing and PXRF. Machine learning algorithms were used to create 15 different prediction models. 75% of samples were used to calibrate the model, while 25% of samples were used to validate it. The R squared values of models for individual mines A, B, C, and D using a combination sensor approach were 0.81, 0.19, 0.34, and 0.46 respectively. Comparatively, when all mines and sensors were used to generate a model, the R squared value was 0.85, meaning the model accurately predicted the sulfur content of the lignite with mg/kg resolution 85% of the time. This is preferable to traditional analysis because it is a faster, more cost efficient approach to sulfur quantification with minimal lab preparation.