Relating Strategic and Tactical Intelligence Image Quality Metrics

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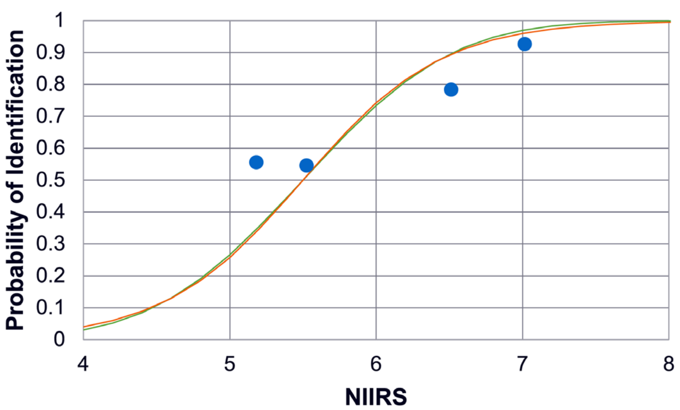
The quality of imagery used for intelligence purposes—be it of topography, hardscape, or individuals—affects intelligence analysts' ability to detect and identify an object. The higher the image quality, the more accurate the results. But image quality is a product of many complicated factors, and generalizations are made to produce useable metrics. The tactical and strategic components of the U.S. intelligence community have adopted different methods for defining image quality that are based on different philosophies and rely on mathematically incompatible frameworks.

The tactical intelligence community uses the Targeting Task Performance (TTP) metric, a method that defines quality in terms of the probability that an intelligence analyst will successfully accomplish an image interpretation task (e.g., identify a particular target). With the TTP metric, quality is indicated by the number of resolved line pairs (adjacent black and white lines of the smallest widths resolvable by the human eye at a given resolution) that span the target in an image, given the resolution of the imagery. The TTP calculation accounts for variation in the probability of successful task accomplishment as a function of image quality.

In contrast, the strategic intelligence community uses the National Imagery Interpretability Rating Scale (NIIRS) to measure image quality on a scale of 0–9, where each value represents a level of quality that permits a particular interpretation task (e.g., detect a particular object). For example, image analysts can detect the presence of a port given an image value of 1, while they can detect individual railroad spikes given an image value of 9. The level of quality is empirically determined but can be predicted from the image's scale and sharpness and the imaging system's signal-to-noise ratio.

Although mathematically different, both methods are widely used and well supported empirically (i.e., by observation and experimentation), which indicates that they can be combined effectively. **We developed a model for relating the tactical community's calculation of the effect of image quality on the probability of successful task accomplishment to the strategic community's image quality value.** The resulting cumulative probability distribution function calculates the probability of successful task accomplishment as a function of NIIRS value. Either one of two equations can be used for this purpose—one based on NIIRS value and the other on the TTP's Target Transfer Probability Function (TTPF). The slight differences in the fit of the curves for the two equations (left) pose no problem for all practical purposes.



The blue data points are 1999 data from the U.S. Army Night Vision and Electronic Sensors Directorate. Despite the limited data available, curve fits from our two equations are nearly the same. The green line indicates a ground resolved distance (GRD) TTPF curve with one fitted parameter. The orange line represents a normal cumulative distribution function with mean of 1 and standard deviation of 0.8. We assume that an NIIRS value of 5.5 would provide a 50-percent probability of task accomplishment.

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