Soaring Above: Providing Unique Insight into Turf Management

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With the fast changing world of technology, drone use within industries has seen a dramatic rise over the last few years. From using drones to monitor hot spots in forest fires to collecting the spray from whales' blow holes, the capabilities of drones are endless. One area that is up and coming is the use of drones to assist with golf course maintenance, such as monitoring turf and vegetation health, early disease or fungus detection, or identification of underlying drainage issues.

Using a method called the Normalized Difference Vegetation Index (NDVI), turf health can be assessed to identify issues or areas of concern that need to be field checked or monitored. Early detection of possible fungal invasion on greens can be identified so that a treatment can be started before the invasion becomes visible. Most modern golf courses have internal tile drainage under the fairways and greens. Blocked or partially blocked tiles can be detected using NDVI maps by identifying areas of low turf health.

History of NDVI

NDVI was developed by NASA in 1972 as a way to measure the health of vegetation from satellites on a large scale across the planet. The process of NDVI is still used today by capturing imagery in visible and non-visible light wavelengths and has become the standardized method of vegetation health assessment. The most popular use case of NDVI is in agriculture to detect crop health.

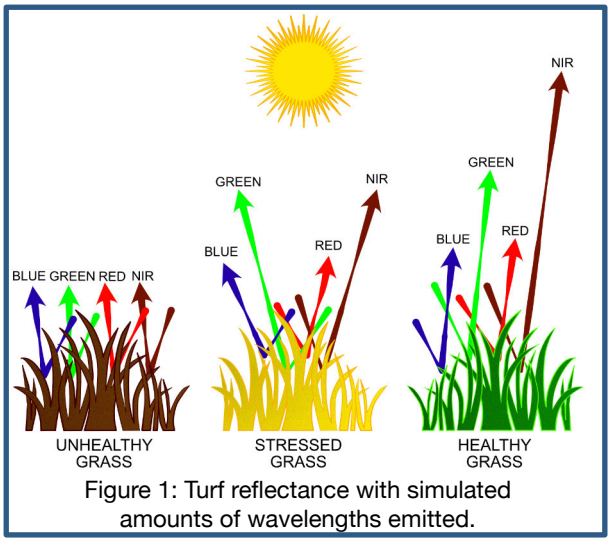

Figure 1: Turf reflectance with simulated amounts of wavelengths emitted.

What is NDVI

Traditionally, NDVI imagery is captured by satellites for large scale operations. Modern day imagery is now being captured by aircraft and drones which allow for higher quality data for smaller scale operations. NDVI maps are created from the reflectance difference between visible Red Light and non-visible Near Infrared(NIR) Light. Red Light is absorbed by plants for use with photosynthesis while NIR Light is reflected. Green Light is also reflected and is about 5-10 times less intense than NIR Light resulting in the plant's green appearance to the human eye (See Figure 1). When a plant becomes dehydrated, sick or afflicted with a disease, the spongey layer of the leaf or blade where the chlorophyll is stored, deteriorates and the plant absorbs more NIR Light. An equation involving the quantity of NIR Light and Red Light is used to calculate NDVI values to create an image where the values change depending on the health of the plant; higher values indicate a healthy plant and lower values indicate an unhealthy plant.

How is the data collected

A drone can fly over a golf course to capture the imagery required to produce an NDVI image. A drone is equipped with two sensors; a standard camera capturing the Red, Blue and Green Light wavelengths, and a specialized sensor that measures the NIR Light reflected from the turf below the drone (See Figure 2). As the drone flies over the entire course many photos are taken which are then 'stitched' together to make one large image. This image is then analyzed to determine areas within the turf with low health or other areas of concern.

Figure 2: A drone that can be used to conduct the surveys of the course to create NDVI images.

Why collect data using a drone?

Due to their size, drones can be transported quickly and mobilized faster. Other methods take longer: using an aircraft requires more planning and logistics; and satellites have a set return rate, when they orbit over the exact same spot on the Earth, which is usually an average of 24 days. Data can be collected faster and at more frequent intervals by using a drone. This results in updated information throughout the season which the grounds crew can use to manage turf health.

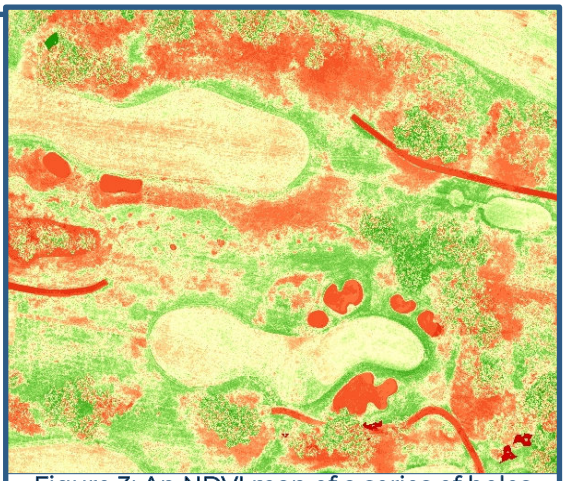

Figure 3: An NDVI map of a series of holes showing turf health. Areas in solid red are bunkers and cart paths.

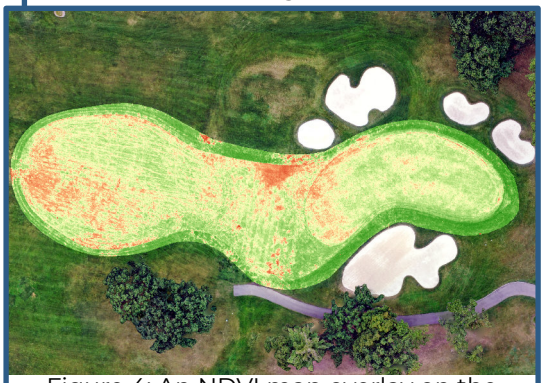

Figure 4: An NDVI map overlay on the fairway and green showing areas of high (green) and low (red) turf health.

The use and benefits of NDVI

On an NDVI map, green areas or high NDVI values represent healthy plants which require less maintenance. Areas in red or low NDVI values represent unhealthy plants which would benefit from more care by the grounds crew to improve the quality of the turf (See Figure 3). This will allow for grounds crews to work more efficiently where more maintenance is required, so that they don't spend time on areas that may not need it. The data is fully GPS-Calibrated so maps can be uploaded to tablet devices and carried into the field to constantly show your location in respect to any turf management issues that have been identified by the use of NDVI. This allows for maintenance teams to conduct spot checks to ensure that the right areas are being targeted.

By identifying vegetation health and stresses before they are seen by the naked eye, a drone can help target areas needing more attention throughout the golf season. Using drone technology for golf course maintenance does not make maintenance staff redundant, rather it is an extra tool to make their efforts more efficient and cost effective.

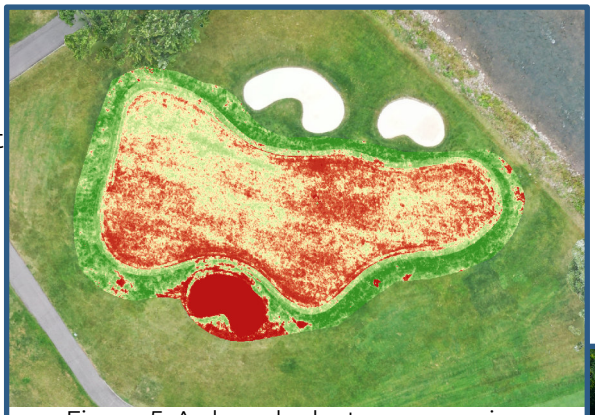

Figure 5: A closer look at a green using NDVI shows areas where there has been more foot traffic due to pin placements.

Figure 6: An aerial view of a hole can give a different perspective of how things look.

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Prepared for

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