

Drone-based Thermal Imaging System

DRHR has developed a drone based thermal imaging system, to automate imaging of farm crops. The system captures thermal and colour images of crop with high-resolution thermal and visible-light imager. Drone navigates along pre defined path and capture thermal images autonomously. The thermal cue from captured images undergoes further analysis. Qualification trials have been conducted at NA&BTD farms near Gamma field. It has been found that thermal images captured by the imaging system are clearly showing special variations in canopy temperature. See field observations appended below. The system is easily deployable and has flight endurance of about 25 minutes which is adequate to cover large farm areas. System has capability to 'pause' the mission in between and resumes it after power cycles. This feature helps to overcome the 'limitations of single charge flying distance' in handling large survey missions. Features like flight planning, autonomous navigation, on the spot hovering and remote operation makes the system easy to use.



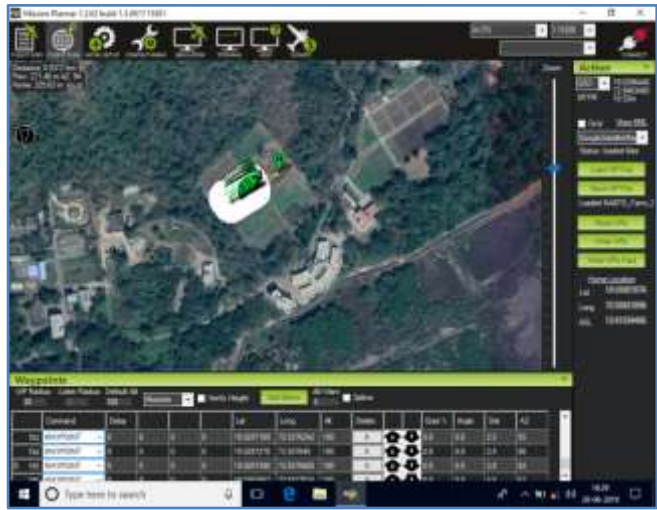
Imaging System about to takeoff



Qualification trials of survey mission



Crop image with thermal statistics



Mission planner & Navigation interface

Field observations

Some part of the farm at Gamma field had grownup chickpea planted in patches. Mutants showing different time spans for attaining maturity are segregated and planted in these patches. At the time of survey each patch had attained different maturity stages. NABTD personals marked four distinct patches that had attained clearly identifiable maturity levels. Less matured plants generally show low canopy temperature than that of the more matured plants. This ground truth is clearly visible in the corresponding thermal image obtained from the survey. Special fine variations in temperature help to distinguish patches in thermal image appended below. The thermal statistics tabulated shows an unambiguous correlation between canopy temperature and plant maturity stages. Relative temperature is important in segregating the plants and absolute value may not be that accurate.

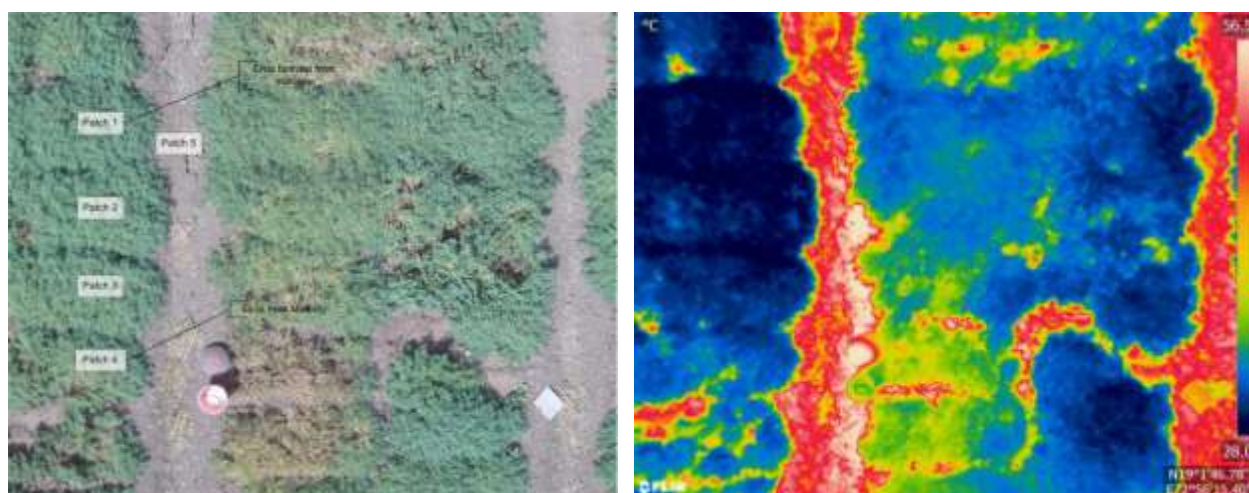


Fig 1 Colour & thermal images of patches of plants at different maturity stages

Area		Temperature			Remarks/Observation
		Minimum	Maximum	Average	
Figure 1	Patch 1	27.6°	30.1°	28.8°	Plants in this patch are far from maturity.
	Patch 2	28.4°	31.0°	29.6°	This patch is mature than that in patch-1.
	Patch 3	28.9°	32.9°	30.3°	Closer to maturity than that in patch-2
	Patch 4	30.6°	43.0	33.9°	Highest maturity among all the patches. Therefore showing highest temperature.
	Patch 5	30.0°	50.8°	43.5°	This indicates the temperature of a small patch of soil

One of the relatively low altitude flights had captured an image showing clearer view of plant canopy. This is an image of a wild verity chickpea surrounded with other normal verities. The wild verity matures over a long period. As this has not attained maturity, canopy shows relatively low temperature (zone 3, 7, 8). On the same plant, temperature is nearly same (0.3° difference) even at largely separated locations (zone 4, 5). On different verities of plants, temperature is widely different (1.5° difference) even at nearby locations (zone 2, 3). The image has been analysed and thermal statistics is appended below. System is able to clearly pickup low average temperature differences of the order of 0.2° - 0.5°.

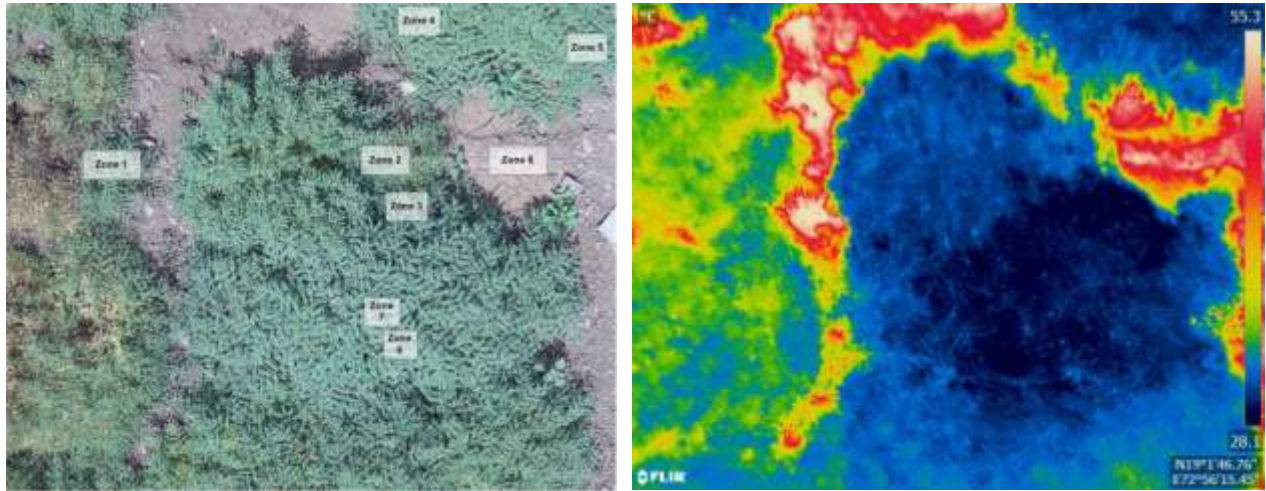


Fig 2 Colour & thermal images obtained from a low altitude flight

Area		Temperature			Remarks/Observation
		Minimum	Maximum	Average	
Figure 2	Zone 2	30.0°	33.6°	31.5°	On different verities of plants, temperature is widely different (1.5° difference) even at nearby locations.
	Zone 3	27.4°	30.7°	29.0°	
	Zone 4	29.6°	33.3°	31.1°	On the same plant, temperature is nearly same (0.3° difference) even at largely separated locations.
	Zone 5	29.5°	32.9°	30.8°	
	Zone 3	27.4°	30.7°	29.0°	Wild verity which mature over long period. As this has not attained maturity plant canopy shows relatively low temperature.
	Zone 7	28.1	29.8	28.8	
	Zone 8	28.0	29.9	29.0	