2.2. Field Study

DJI Phantom 4, which is the low cost drone producing by Dji company (Table 1; Figure 2) (Dji, 2016), was used in the field studies. The flight altitude was defined as 120 m, and the ratio of side and forward overlaps were planned as 60% (forward) and 60% (side), respectively. Total of 45 geotagged images were taken in nadir perspective.

Model	DJI Phantom 4
Camera	PhantomVisionFC 2000
Resolution	12.4 MP
Sensor width & height (mm)	1/2.3" CMOS
Image width & height (pixels)	4000×3000
Geolocation	On-board GPS/GLONASS
Flight time (min)	28
Photo	JPEG, DNG (RAW)

Table 1. Specification of DJI Phantom 4

2.3. Image Process

The photogrammetric workflow of obtained images and automated flight were presented with respect to capabilities of available software. The flight plans were created by using Pix4DCapture software with android based cell phone (Figure 3) (Pix4D, 2016).

Image processing steps executed by PhotoScan can be listed as 1) identification of common points and creation of photo plane for block (alignment of photo), 2) point cloud generation, 3) image meshing, and 4) image texture (Agisoft, 2016). After image processing, several remote sensing data and digital layers can be produced such as orthophotos, contour maps, point clouds, and digital surface models (DSM).

Figure 2. DJI Phantom 4

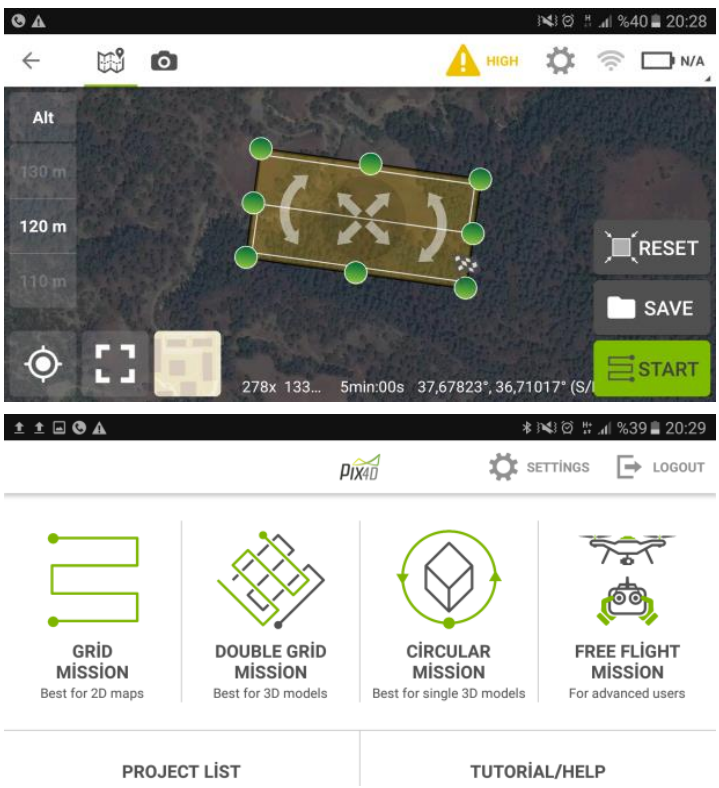

Figure 3. Interface overview of Pix4D Capture in the field (above) and planned flight path (below)

3. RESULTS AND DISCUSSION

In the study, photo alignment was completed by considering 34,654 tie points. Then, analysis of dense cloud point generation was carried out by totally 12,747,742 points (107.534 points/m^2). In the field, the estimated image acquisition height was about 136 meters. As a result, DSM with the resolution of 9.64 cm and orthophoto of 4.82 cm/pix resolution were generated as end products (Figure 4).

The results indicated that even low-level overlapping block, high-resolution imagery obtained by drone can provide significant data for assessment of forest stands, forest openings, stream channels and road, riparian buffer zones, biomass potential etc. in the study area. These results can be used to generate 3D modelling of forest structure and to delineate individual tree parameters. Drones, as very effective surveying tool, enable low-cost mapping opportunity for medium and large forested areas, and promise further evaluations and analysis, according to the specific research objectives.

REFERENCES

Agisoft, 2016. Agisoft PhotoScan User Manual. http://www.agisoft.com/pdf/photoscan-pro_1_2_en.pdf (Last visited: 10 June, 2017)

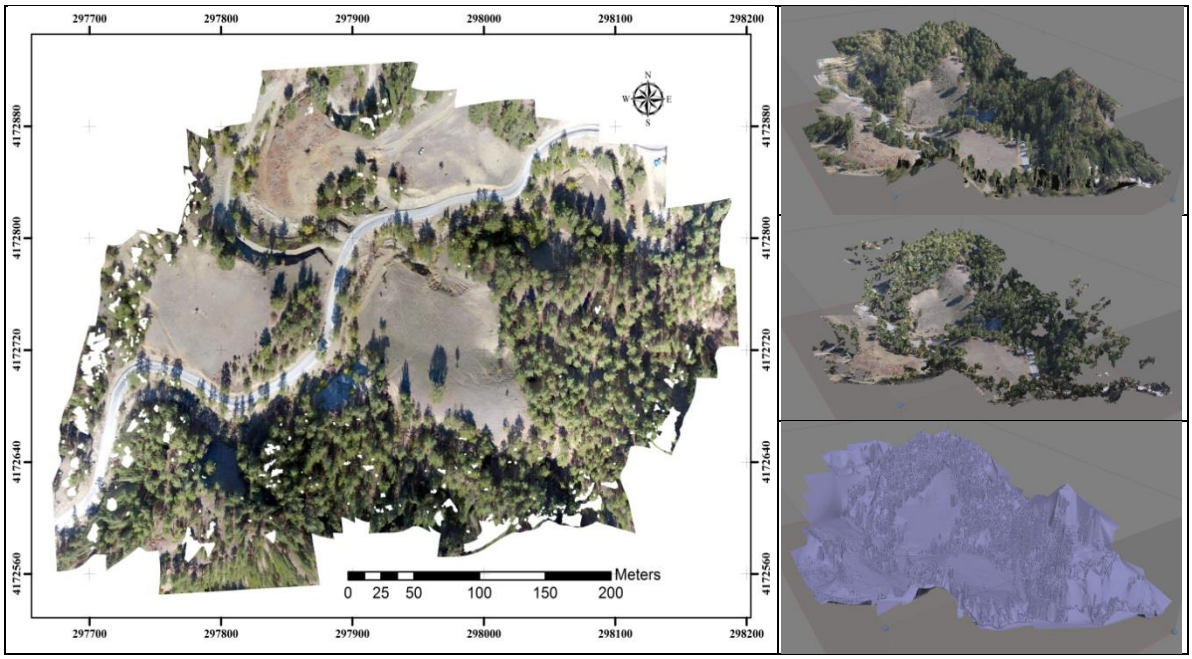

Figure 4. Generated point cloud data by using PhotoScan in forestland