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APPLICATION OF LIDAR TECHNOLOGY IN CATTLE GRAZING AREAS

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Abstract

Precision farming technologies increasingly appear in the livestock sector. The most precision animal husbandry innovations are in the precision breeding and nutrition, but nowadays, different robots (e.g. robotic milking systems, robotic barn cleaners, etc.) can help for effective animal production, mainly in barn. The number of such innovative solutions in field is less. In order to collect spatial information about the ethology of animals, grazing dairy cattle are survey by LiDAR sensor. The focus area is a pasture near Nyírbátor (BÁTORTRADE Trade and Services Ltd., North Trans Tisza Region, Hungary). Application of LiDAR terrain characteristic, topography, vegetation status (e.g. the qualitative and quantitative characteristic of vegetation) and grazing cattle in the pasture can be detected. The main goal of our study was to detect grazing cattle on field by ALS system. LiDAR data was useful for animal detection, and based on the spatial data lying and standing animals were identified distinguishing from each other. In order to examine the statically position of cattle, digital elevation model was created based on the high precision spatial data. Based on the distribution and behaviour of the animals, different problems (e.g. environmental stress) in animal husbandry could be concluded. Multispectral image pattern and monitoring the spatial distribution of cattle's movement, wet locations can be identified on the pasture. Using LiDAR data seems a promising opportunity to optimize land use and livestock size.

Key words: LiDAR, ethology, vegetation status, terrain characteristic

INTRODUCTION

Today, more and more areas require accurate, reliable and up-to-date characterization of Earth's surface and terrain. The currently rarely applied, but emerging airborne laser scanner (ALS, Airborne Laser Scanning, also known as LiDAR, Light Detection and Ranging) satisfies these needs with the speed of data extraction, the amount and accuracy of the information to be extracted. The LiDAR is an active remote sensing system with his own signal destination (Mutlu et al., 2008; Székely et al., 2007). It is similar to a sonar which uses sound waves or a radar which uses radio waves to map things. But a LiDAR system based on light-emitting and detection, which uses light sent out from a laser to measure the elevations of things, for example ground, forests or buildings. This remote sensing method is measure the distance between the emitting device and the reflecting surface with a laser light (Drosos and Farmakis, 2006; Liu, 2008; Lloyd and Atkinson, 2005).

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There are three different ways to collect LiDAR data: from the ground, from the airplane and even from the space. From these the most commonly applied data is the airborne LiDAR data, when a laser scanner – which attached to an airplane or helicopter, or drone (Neonic, 2014) – creates 3D point cloud model of the surface.

The emitted laser light reflects from the objects on the surface and the system records the time between transmitted and backscattered pulses. Since the speed of light is known the distance can be calculated (Csiha et al., 2017; Doneus et al., 2015; Drosos and Farmakis, 2006; Liu, 2008; Lloyd and Atkinson, 2005; Riczu et al., 2016). To image objects it uses ultraviolet, visible or near infrared light (Cracknell and Hayes, 2007).

The airborne laser scanning can be used in, such as forestry, including forest fire management (Fernandes et al., 2004; Lohr, 1998; Mutlu et al., 2008; Saye et al., 2005; Tamás et al., 2011; Tamás et al., 2013; Utkin et al., 2002), coastal surveys (Lohr, 1998; Saye et al., 2005), geomorphological research (Eeckhaut et al., 2007; Kasai et al., 2009), archaeological surveys (Bewley et al., 2005; Challis, 2006; Devereux et al., 2008) and infrastructural and environmental projects (Challis et al., 2008; Wehr and Lohr, 1999).

The reasons of this wide application area of this technology are the speed of surveying, relatively large surveyed area and acquiring of high resolution data.

In agriculture, for example in grazing, the application of remote sensing instruments provides an opportunity to examine the heterogeneity of the vegetation in the pasture (Tamás et al., 2014) and study the animal behaviour. In this study besides the terrain characteristic, vegetation status and topography, we also detected the grazing cattle on the pasture. The advantage of LiDAR as a remote sensing technology is that it doesn't have to be in direct contact with the tested object, so it doesn't disturb the natural behaviour of animals.

MATERIAL AND METHOD

The sample area was located near to Nyírbátor, easter part of Hungary (Fig. 1), which is owned by the Bátortrade Corporation and the grazing area was part of the LiDAR survey.

The laser surveys were carried out by Eurosense Ltd. in Feburary, 2017. The laser measurement was performed using the IGI LiteMapper system. The LM 6800 can perform up to 400.000 points per second (laser PRR: 400 kHz). The scanner and related processing software (RiAnALYZE 6.0.2, RiWORLD 4.3.7, TerraScan v16, TerraMatch) can also use waveform analysis.

The high-resolution survey covered 107.8 ha, which contains the arable and the grassland also. The area was built from 129.072.937 points. The resolution of the LiDAR data points is 14.58 points/m^2, which is appropriate for high resolution models.

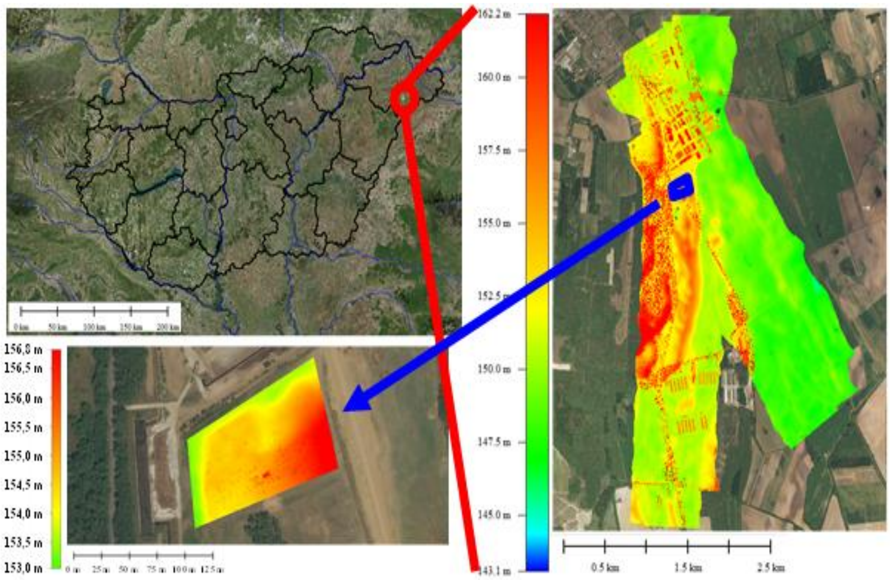

Fig. 1. The surveyed area in Nyírbátor

In this research, our evaluation was carried out in a small part of the grassland, which was 4.7 ha (and it contains more than 2.5 million points, 33.08 points/m^2). The airborne laser data allows the unique identification and monitoring of the cattle, so not only the status of the pasture were measured, but we also get information about the grazing cattle's ethology, the behaviour of animals. The processing of the data was made in ENVI LiDAR software environment.

As the figure 2 shows the Digital Surface Model (DSM) displays the land surface with all the objects (both natural and artificial also) on the area. The DSM shows where and how much vegetation is growing, so it is useful for the vegetation management. In other application areas the DSM is also useful for view obstruction and runway approach zone encroachment.

If we void the artificial (power lines, buildings and towers) and natural (trees, other types of vegetation) objects, we generate a Digital Elevation Model (DEM). The DEM is useful in soil mapping, hydrologic modelling, terrain stability and land use planning (GIS Geography, 2017). In contrast, in the DSM, all object covered by a mesh.

RESULTS AND DISCUSSION

The results of the surveying method are called point cloud, which is a set of data in a 3D coordinate system and these data represent the external surface of an object (Axelsson, 1999; Drosos and Farmakis, 2006). Laser data provides an opportunity to segment different surfaces, such a grazing animals or canopy coverage. In this case, the lying and standing animals were distinguished, since this method is suitable for segment the grazing and/or digesting cattle.

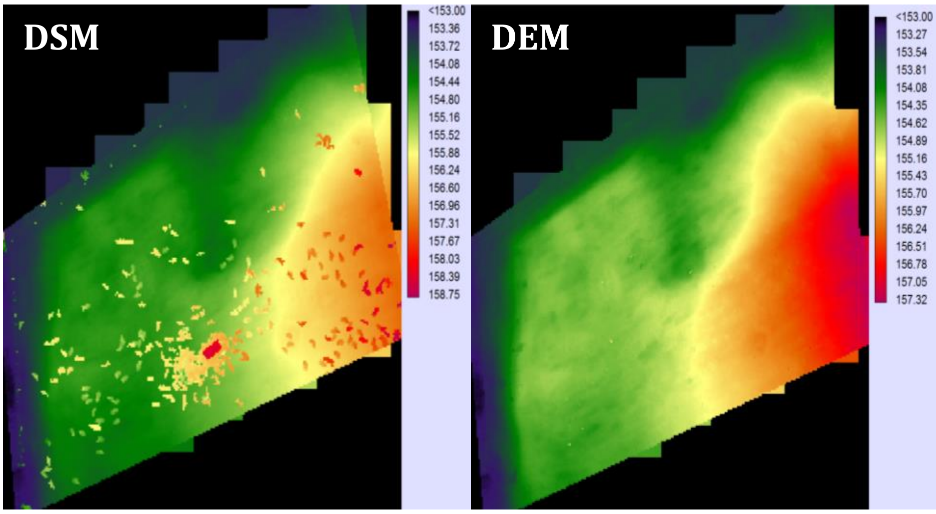

Fig. 2. The DSM and DEM of the grazing area

Objects above ground can be visualized by subtract DEM from DSM. That way watering facilities and other noise effects were separated from the animals.

Figure 3 shows the alignment of animals at the moment of the survey, where the animals group around the feeding place. Based on the pixels of cows, a height histogram was created as it shown in the figure 3. By this elevation histogram the standing and lying cows can be separated from each other. The separation threshold was on 1 m, so above 1 m, animals are standing, below 1 m, animals are lying.

By frequency of pixels, the average area of a cow can be calculated (2.54 m^2). According to our calculations the total area of standing cows is 406.25 m^2 and 278.25 m^2 the area of lying cows, which means that about 160 cows stands and 110 lies.

This surveying just was a one-time occasion, but with multiple LiDAR surveys the movement of livestock and the alignment of the animals could be monitored. A surveying method would be important before and during the grazing.

Previous to precision cattle grazing it is required to know the area, because the pasture should fulfil the feeding requirements of the animal. By analysis of multispectral images qualitative and quantitative characteristics of the vegetation (biodiversity, invasive plants etc.) can be concluded. The surveying also would be important during the grazing, because the grazing cattle modifies its environment. In other researches, this method could be extended to monitoring other animal species, for example it would also be possible to observe the wild population on different regions.

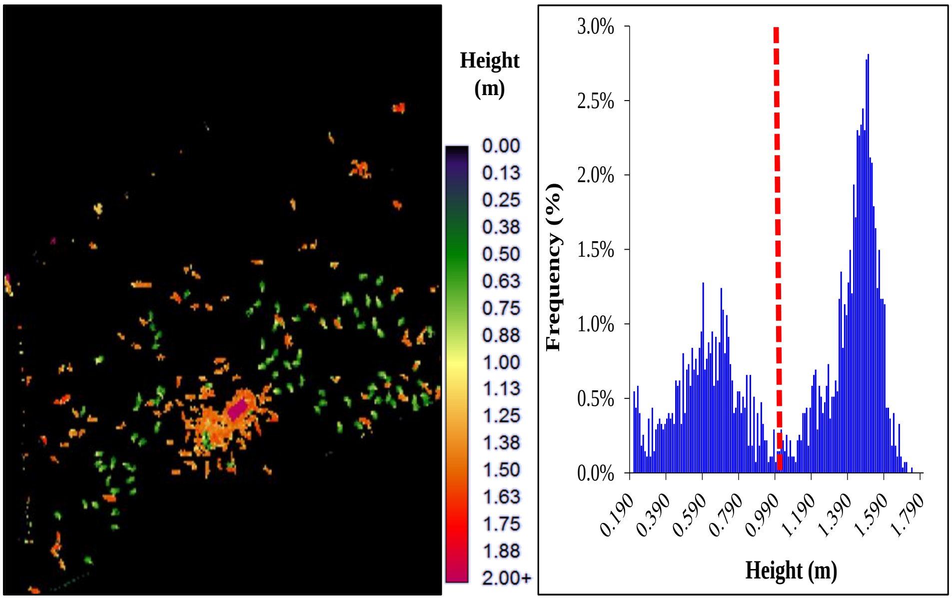

Fig. 3. Frequency of standing and lying animals

CONCLUSIONS

Summary the application of remote sensing technology in animal husbandry provides an opportunity to observe animal behavior and its changes, and also suitable to examine the welfare of cattle. By remote sensing the information about the temporal and spatial changes of the pasture (e.g. soil, vegetation, grazing ability etc.) also provided.

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