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Applying machine learning in video monitoring of cattle

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ABSTRACT

Monitoring cattle behavior by using latest technologies such as GPS or Video camera is beneficial in understanding the behavioral patterns such as mating habits and early detection of diseases. The need for technologically assisted means becomes more important when a number of cattle become large. Commercial cow dairies, beef farms, sheep and goat farms etc normally have thousands of animals to be economically viable. Considering the volume of cattle and non-availability of sufficiently cheap trained labor to monitor the animals, often results into late detection of disease, which it might result into spreading of them in a larger cattle population, this might cause a large amount of cattle deaths or huge expenses on controlling the disease. I suggest a system for cattle behavioral monitoring by using multiple video cameras in whole grazing area and in animal sheds, where farm animals can be continuously monitored. I also suggest a low-intensity laser pointing system coupled with a monitoring system to easily and quickly identify the animals requiring attention.

Keywords: *Machine learning, Video monitoring, Cattle behavior monitoring, Cattle disease monitoring*.

1. INTRODUCTION

Behavioral monitoring of cattle via their motion tracking is an important research area with a specific focus on early detection of many infective diseases. While non-visual monitoring systems such as GPS can be used mainly for motion pattern analysis, often provide insight into limited characteristics. The video surveillance with machine learning algorithms can, however, be used for most of the monitoring tasks such as identifying pregnancies, births, disease, comparing the mating capability of males, comparing animal interest in specific forage in specific seasons, detecting hunting animal intrusion etc.

Video surveillance is a very cost-effective and reliable solution for cattle monitoring compared to other technologies such as RFID tags or GPS devices. This is purely non-invasive and requires the least amount of human intervention to get effective results.

Practical Considerations while Choosing cattle Monitoring System

- The initial cost of the system and overall cost of ownership.
- Reliability, accuracy, and maintainability of the system.
- Ease of identifying the specific animal having problem from a herd of thousands of animals on the farm.

UHF passive RFID tags do not need charging but require heavy antennas in multiple places, which means a lot of radiation exposure, which is generally not recommended for animals' health and their overall wellbeing. Centimeter accuracy GPS systems, only which will give good enough data to accurately capture the animal motion behavior are not economically viable, as each animal require one costly GPS device. And, each GPS device requires costly GPS service subscription along with data analyzing hardware. Also, availability of such accurate positioning services in remote hilly areas may not be possible. Even if the investment is not an issue, the bigger problem is recharging of batteries. The collars holding such devices might have solar chargers, but overall affordability and maintenance of such devices for a typical 10-15 thousand cattle farm is not going to be viable from any point of view. Currently, cost wise GPS is the costliest system, which may even cost more than the price of the whole animal herd in most places. Comparatively, manual monitoring could prove to be less of a hassle with zero upfront investment.

The second problem is how to locate the animal requiring immediate attention. In RFID and in GPS monitored systems, the system can tell you the identity of the animal and it's GPS location, but imagine the task of finding the animal yourself by using this much information. It will involve taking a GPS/RFID sensor and keep looking for the individual in a big animal herd. Worse if the number of affected animals is large.

Most of the problems discussed above with other technologies can, however, be managed easily with video monitoring coupled with low-intensity laser pointer system. Video cameras are cheap and easily available. Video monitoring is totally non-invasive and requires no tagging or device installation on each animal. Video monitoring being visual based can be used for much wider surveillances such as birthing, mating, and intrusion, which is not possible via other technologies like GPS/RFID. The identification of affected animals can be easily managed via system controlled low power laser pointers. These laser pointers are installed on camera posts and help quickly identify the animals requiring staff attention. Animal movement, behavior, and intruders are identified and tracked based on animal shape detection algorithms.

Camera Arrangement

Several cameras can be mounted on a single tower with appropriate lenses (tele, wide angle, normal) if entire grazing area is in the visible range. For wider areas, several camera posts can be installed, in open area as well as in animal sheds. Each camera has an overlapping field of view with its adjacent cameras so that each animal is always uniquely identified and tracked even if it moves from view field of one camera to another. Each animal is tracked by its enclosing shape detection rectangle. The first time, the whole animal habitat is divided into two-dimensional position coordinates and those coordinates mapped with camera pixels. Thus, later on, the animal position falling into those coordinate areas is derived via the image of the animal in particular camera pixels.

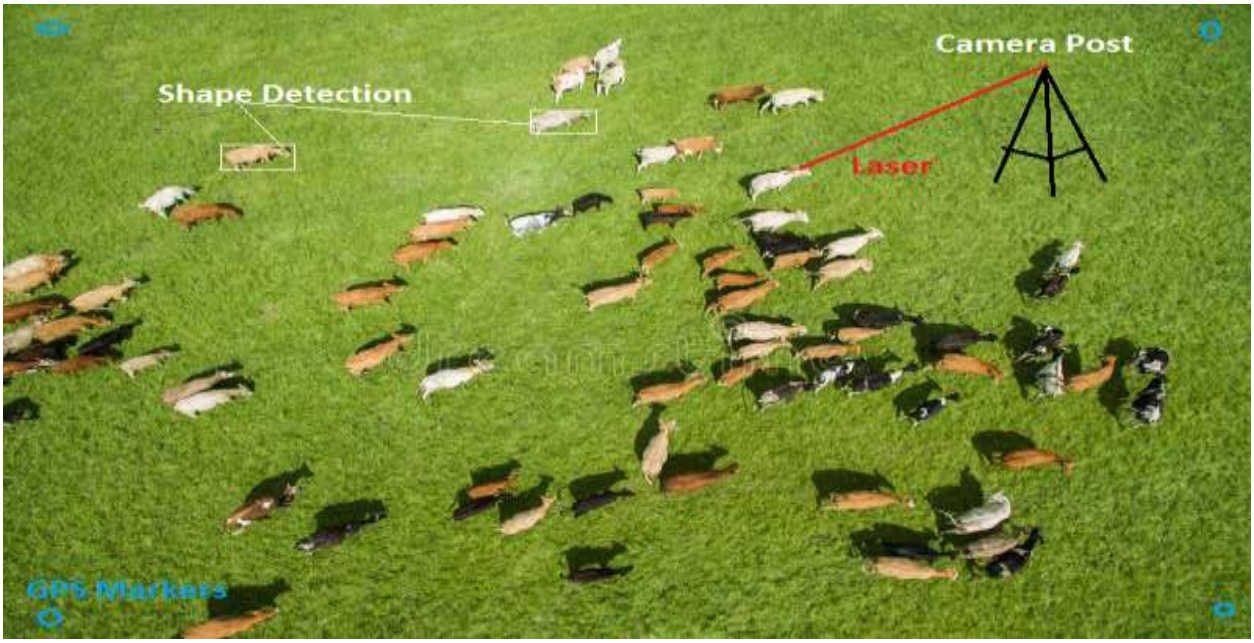

Fig-1

Learning and Analytics

The system will learn in supervised mode by taking farm animal and intruder images shot from various angles. Image classification algorithms such as Deep Learning (neural networks) are utilized for image classification of various animals. Individual animal images are mostly used for motion detection, while images showing mating, fighting, sitting etc. are used for other behavioral learning.

As animal motion patters vary due to breed, season, nature of the individual animal, geography, forage on the ground etc. Thus looking at the variables, getting reliable motion inputs to predict a distinct behavioral characteristic is difficult to get. A unsupervised learning will identify the distinct patterns. The outcomes of such unsupervised learning can, however, become input-output set for future supervised learning in the same and in numerous other animal farms.

2. BLOCK DIAGRAM OF A SYSTEM

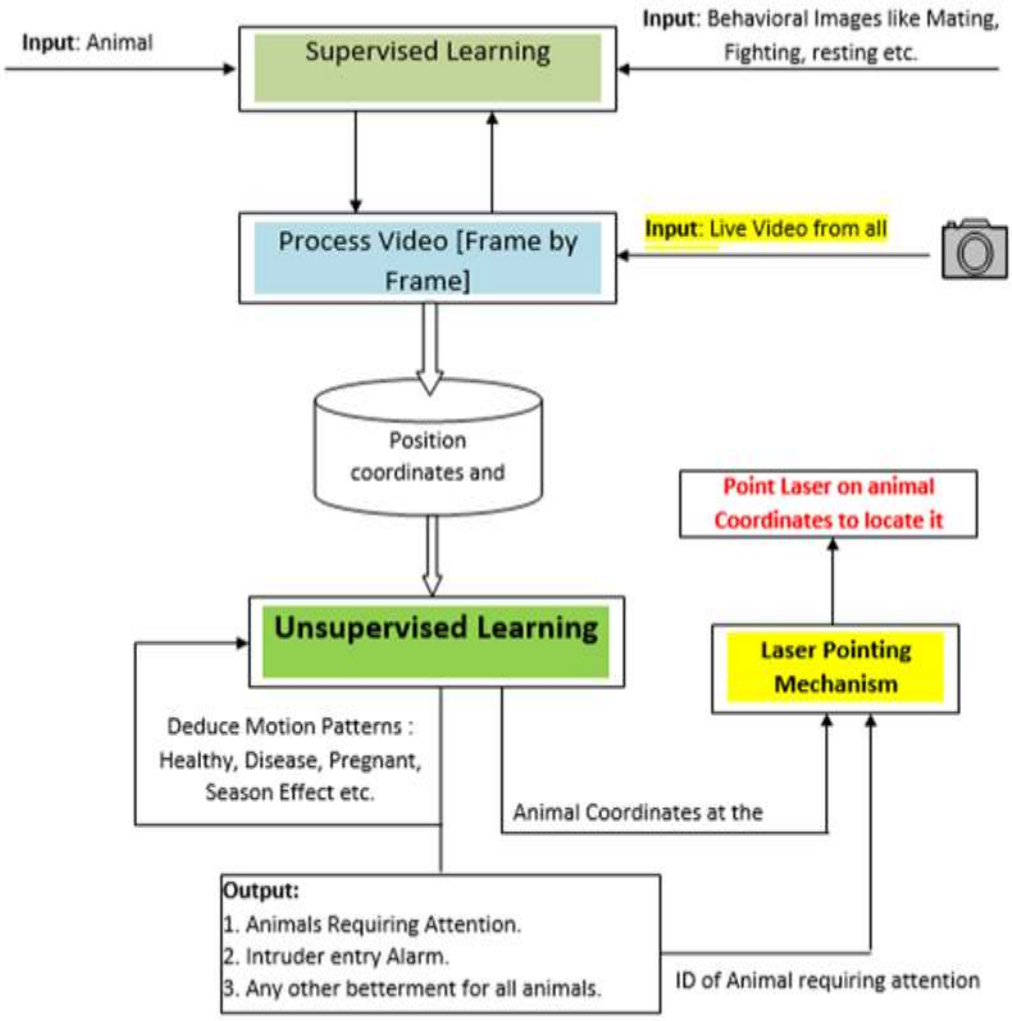

Fig-2

3. CONCLUSION

Machine learning is gaining a lot of momentum with many researchers supporting the knowledge base to handle a large amount of complex data. Video surveillance itself is also very old technology with a variety of cameras commercially available at an affordable cost. The reliability of video capturing system is also very good. Video capturing along with machine learning can open new dimensions to effective monitoring of the large number of animals in commercial farms. The video and Machine Learning combination is not only easier and commercially more viable than other similar technologies such as GPS tracking but also more capable of detecting several other behavioral characteristics. This coupled with system guided laser pointers to instantly identify the animals requiring attention can highly increase the usability and effectiveness of the monitoring system.

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