Research on Adapting Sanitizing Robots in Stock Farms Hygiene

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Abstract: - This article describes a possible adaptation of sanitizing and other robots in stock farms to increase their hygiene conditions. The importance of the subject is analyzed, based on reviewing the main threads in terms of hygiene in stock farms. Existing sanitizing and other robots suitable for farm needs are described and reviewed. Conclusions about their implementation are made. Some improvements are suggested for optimizing the hygiene conditions in farms and reducing the risk of disease and infection spreading.

Key-Words: - automation, robot, sanitizing, cleaning, disinfection, farm.

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1 Introduction

Modern stock farming continues to grow to embrace the challenge of fulfilling the constantly growing need for food. As more stock is bred, the need for a safe and clean farm environment rises.

Life in agricultural areas is different than one in the city. The areas are more isolated and the demand for better health and sanitary conditions is compromised. The agricultural health problems even in the modern automated farms are more complicated than the industries in the urban sector since livestock farming is combined with much bio-waste. To avoid spreading infections, one of the most important issues is keeping good hygiene conditions, [1].

For running successful farm production an important factor is the sanitation and waste management practices that are carried out daily. Poor sanitation standards are considered as a risk factor. Sanitizing is the main measure needed to avoid disease occurrence in any farm with livestock. Large economic losses can occur in farms because of a disease outbreak. This is why biosecurity measures should be applied against most of the known disease-causing agents. A well-established practice for biosecurity is essential for ensuring the health and productivity of livestock within a farm and even a region and country This way the risk of human and animal health and economic losses can be avoided, [2].

With the growth of high sanitation standards, grows the need for more employees. Modern engineering develops new autonomous robots for sanitizing wide spaces to reduce the hiring of sanitation workers. It is now a necessity to support these workers with tools and techniques for maintaining the needed levels of efficiency. This way all areas of agricultural spaces and farms can be safe, [3].

By implementing well-known practices in stock farming, we can increase hygiene habits and ensure the safety of animals and humans.

In the next chapters, we will review the existing technologies and modern market solutions for maintaining hygiene conditions and their possible adaptation in stock farms. The first chapter reviews the main problems connected to sanitizing that can occur on a farm. The second chapter describes different cleaning robots that can be applied on-site in farming buildings. In conclusion, the connection between the different sanitizing robots for farms is presented and some possibilities for their improvement are proposed.

2Problems in Stock Farm Hygiene Conditions

In some regions where there are no special premises for cattle or poultry, the animals can be left in the open, if the climate conditions are suitable. Processes like milking and laying eggs need their buildings. To reduce disease risks, the large units for some animals should be separated. The living habits of all farm animals need to be taken into consideration. In some places, there are only two systems of buildings used. For example, poultry farms use large buildings of the same type other farms use differently situated buildings for their respective needs. The most used building shape is

the rectangular because other shapes have to be divided to avoid infection spreading, [4]. Special cleaning activities must be applied for all these covered shelters and barns.

Infectious diseases are a huge risk for the livestock health. They can be caused by viruses, bacteria, parasites, and fungi. Not all infectious diseases are contagious, but all contagious diseases are infectious and they can be transmitted from one animal to another. Some of the ways a disease can occur on a farm are

- Importation of animals that are infected or carry the virus;
- Polluted water;
- Contact with contaminated objects;
- Contact with not properly disposed dead animals;
- Other animals like birds, insects, and rodents;
- Contact with humans that walk around other farms;
- Polluted food and improper food storage;
- Storage premises with waste or soil;
- Airborne organisms.

Once a disease occurs the animal's body can fight it. Natural immunity is important, but with vaccination of the animals, the farmers stimulate acquired immunity. More safely, the vaccines stimulate the production of antibodies, which will defend the animals if a real disease occurs, [5].

For preventing the disease's spread and ensuring the health of the animals many precautions should be taken into consideration. These types of measures include the following:

Rodents prevention – Rodents carry all kinds of infections and diseases, so it is important to keep them away from the stock farms. Popular precautions in this matter include setting traps, filling any gaps, where they might be hiding, avoiding leaving food on the floor, etc.

Proper food storage – Different kinds of food for farm animals require adequate storage. If needed a cooling or refrigerator space should be built that provides the temperature needed to prevent the food from rotting. These premises should be clean, and the storage of food should be covered. To minimize colonization by pathogens the disposing of feed refusals if not eaten within 24 hours should be carried out. This is an important disease control measure, [5], [6].

Clean water – The water can be easily infected. That's why the water should be regularly disinfected and protected from all kinds of pollution. There are four main treatment processes: sedimentation, coagulation, filtration, and chlorination.

Manure disposal – Infections can survive in slurry and manure, this is why the in-time precautions for disposing of it are crucial. It is well known that most percent of infections occur because of poor sewage and disposal conditions. A good sanitary latrine will prevent many diseases, [6].

For all these measures sanitization a proper sanitation should be carried out which include:

- Solids removal
- Washing with water
- Rinsing
- Drying
- Disinfection

For better efficiency, these processes can be automated. In addition, many of the existing sanitizing robots can be adapted to the farm's needs.

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3 Problem Solution

The use of robots in sanitizing has many benefits: they are fast, safe, efficient, and not to underestimate - avoid human interaction, especially in the field of livestock farming. Based on the order of the sanitation process, the robots can be divided into the following main groups (Dry clean, wet wash, and disinfect). We will review a representative for each group to better understand how the processes can be automated and optimized.

3.1 Floor-cleaning Robots

Floor-cleaning robots can mop, vacuum, and polish floors autonomously (Figure 1). The machine looks and operates like a home vacuum robot. The machine is specially designed for cattle barn floors and it can collect dirt. It has a compact design that allows it to travel easily from one place to another. With two ultrasonic sensors, the navigation is held independently without the need for a cable. The charging is at its charging station situated in a suitable position. The route of the device can be navigated on any mobile device via a special application, or it can be directly navigated. This makes the cleaning possible, even if the manager is not on-site, [7].

The cleaning performance of the robot is significant, if used regularly, the premises will be much cleaner. The use of a robot scraper could improve the cleanliness of any kind of animal

housing. Although wet-cleaning helps to remove or avoid incrustations, pure dry-cleaning is helpful, since the floor dries more easily. This might reduce the ammonia emissions in some animal shelters, [7].

The scope of operation includes mapping the farm and locating itself on the map, autonomous navigation following predefined paths, detection of collisions and wheel slippage, reporting problems, operation through the web interface, managing obstacles, battery monitoring, etc., [8].

Fig. 1. Floor cleaning robots, [8].

The main advantages of this type of robot are: that they perform some of the most unpleasant cleaning tasks, reduce manpower requirements and save time, tailored working schedules, and free movement of the animals, [9].

3.2 Water-cleaning Robots

Water-cleaning robots use high-pressure sprayed water for cleaning heavy-contaminated floors and side installations (Figure 2). These machines are simple in presentation but effective in their field. They have 4 wheels with approx. dimensions 65 cm by 100 cm, it weighs around 300 kg. The maximum water consumption is 40 l/hour with a water pressure maximum of 200 bar. The robot is controlled by a sidewheel, that can be adjusted. It runs up on side fixtures, ensuring the right direction. An ultrasound sensor ensures when the machine has to stop if there is a wall. The robot has an inbuilt battery, so the reach to every surface is improved. The robot has different washing programs including soaking. To operate, the machine has to be attached to a high-pressure system with high-pressure hoses requiring min. 25 liters per minute water volume. Specially-developed nozzles ensure that the water jet is highly effective at a distance of 5-6 meters, [10]

Fig. 2. Water cleaning robot in a farm, [11].

3.4 Disinfection Robots

During COVID-19 infection, many hospitals used disinfecting robots, for sanitizing the premises, not allowing the virus to spread. The disinfection robots can use disinfecting sprays (like hydrogen peroxide) or disperse UV light (Figure 3). Some can combine both. UV light is dangerous for living organisms, so it is best not to be used on farm animals or used only when they are out of the building, [12].

Fig. 3. Sanitizing robots in hospitals, [12].

Dispersing robots could be adapted for the disinfection of farm buildings, especially when an active tread is exciting. Some developments work in this direction, by adapting known technologies in farm disinfecting machines (Figure 4), [13].

Fig. 4. Dispersing robot, [13]

The robots are designed to effectively disinfect contaminated areas. They generate steam by transferring the special substances in the form of an aerosol. When it comes into contact with a surface with a lower temperature, the sanitizing compound precipitates.

This method is popular in the agricultural sectors because it is efficient and the disinfectant chemicals are cheap. The robot can work around 3-4 hours within 15 km. The compound can be sprayed up to 10 m depending on the air conditions. The covered area is automatically calculated by a specially installed sensor. Based on incoming data the robot adjusts its work. Of course for cattle shelters and barns, the sprayed chemicals should be appropriate and safe for the animals. All robot actions and parameters (battery life, amount of sprayed compound, coverage area, etc.) can be monitored true its application for mobile devices. After the distribution of the disinfecting aerosol, the robot returns to the charging station for refill. The biggest benefit of using this type of robot is that the technical staff is not exposed to highly concentrated chemicals, [13].

Studies that are researching cleaning robots with similar scope of work are limited. Some investigations have found that cleaning with UV-C light and hydrogen peroxide (or other chemicals) robots is useful in reducing microbial surface contamination. However, their full efficiency is completed in combination with manual cleaning, [14].

It is interesting that although the purpose of wet cleaning, floor cleaning, and disinfection robots is different, their movement operations and navigation are similar. All of them are operated by mobile device applications, have sensors determining their position and surrounding obstacles, and navigation programming. The operation and navigation in any of them are based on sensor readings, path-finding, mapping, data collection, and analysis. Their operation can be synchronized to achieve an efficient and undisrupted cleaning process. This can happen easily if their software is the same or compatible or if their functions are combined it one all-purpose robot for the sanitization of farms.

4 Conclusion

Nowadays the safety of the environment and the certified origin of all products are very important to the consumers. One step of the process for verification is the clean and safe production of the goods. This is especially applicable for the stock farms, where the good living conditions of the animals are a priority.

With today's modern technologies, the cleaning and sanitization of the premises can be handled with the help of cleaning robots. This way the workers can only monitor the action of the machines, without performing unpleasant activities. This will help them to focus on other important farm work.

Cleaning robots are specially designed to execute the main cleaning activities. They can wet-clean floors and surfaces, scrape and collect manures and other solids, and disinfect areas for viruses and bacteria. Not only they can perform this labor, but the degree of effectiveness is higher than with manual work. The technology behind all presented robots is based on IoT, intelligent control, data reading, and analysis. All these fields are constantly growing and improving, which will lead to further development and advancement of the abilities of cleaning robots.

Although their development is at an early stage, the robots are successfully replacing many steps of the cleaning process. This research demonstrates the abilities of the robots and reviews their main advantages. With further exploration and updating the cleaning robots can be synchronized for working independently. Also, a multi-function robot can be developed which includes all of the above functions for easy maintenance of different farm premises with minimal human interaction. Based on the research new and improved cleaning robots can be explored which will contribute to increasing the cleanness of the habitat of the animals and improve their well-being.

References:

[1] Guide to health and hygiene in agricultural work, International labor Office, Geneva, 1968, ISBN: 92-2-101974-8

[2] Fatema Tuz Jubyda, M. Showkat Hossain, Amit Kumar Dey, Sabbir Ahmed, M. Zamilur Rahman, Arfatun Nahar Chowdhury, M.

Moniruzzaman, M. Murshed Hasan Sarkar, 2021. Impact of Proper Sanitation, Hygiene Practices, Environmental Condition and Water Quality on Disease Incidence in Poultry, Bangladesh. Asian Journal of Poultry Science, 15: 13-23, DOI: 10.3923/ajpsaj.2021.13.23

[3] Effective Cleaning Precedes Effective Disinfecting: The Role of Robots in the New Normal, https://apac.softbankrobotics.com/apac/learn/effective-cleaning-precedes-effective-disinfecting/ (Accessed date: July 2023)

[4] V. Yosifova, D. Karastoyanov, "Implementing solar tiles in stock farms for increasing the energy efficiency," 2021 Big Data, Knowledge and Control Systems Engineering (BdKCSE), 2021, pp. 1-4, DOI: 10.1109/BdKCSE53180.2021.9627270

[5] Joe G. Berry, Livestock Disease: Cause and Control, Oklahoma Cooperative Extension Service, ANSI-3999, March 2017

[6] Disease prevention for livestock and poultry keepers, Department for Environment, Food & Rural Affairs and Animal and Plant Health Agency, 11 September 2012, https://www.gov.uk/guidance/disease-prevention-for-livestock-farmers (Accessed date: July 2023)

[7] Ebertz, P., Krommweh, M. S., Büscher, W. (2019). Feasibility Study: Improving Floor Cleanliness by Using a Robot Scraper in Group-Housed Pregnant Sows and Their Reactions on the New Device. Animals: an Open Access Journal from MDPI, 9(4). https://doi.org/10.3390/ani9040185

[8] R. Ruikkie, This Manure Robot Vacuum Cleans Your Barn Floors Like a Roomba, Odditymall.com, July 2021 https://odditymall.com/manure-robot-vacuum-cleans-barn-floors (Accessed date: September 2023)

[9] V. Mazzari, Robotised Cowshed Cleaning, June 2021, https://www.generationrobots.com/blog/en/robotised-cowshed-cleaning/ (Accessed date: September 2023)

[10] WashpowerPro Cleaner X100 Product overview, Mashpower A/S, https://pdf.agriexpo.online/pdf/washpower/wash-robot-pig-houses/184493-22429.html#open73673 (Accessed date: July 2023)

[11] Washpower product overview, Washing robot for efficient cleaning at pig farms, https://washpower.com/washing-robots/procleaner-x100/?lang=en (Accessed date: July 2023)

[12] Ackerman E., Autonomous Robots Are Helping Kill Coronavirus in Hospitals Robots that can efficiently disinfect hospitals using UV light could slow coronavirus infections, IEEE Spectrum, 11 March 2020, https://spectrum.ieee.org/autonomous-robots-are-helping-kill-coronavirus-in-hospitals (Accessed date: September 2023)

[13] SMP Robotics, Coronavirus Disinfection Robot S8.2, April 7, 2020, https://smprobotics.com/usa/coronavirus-disinfection-robot (Accessed date: July 2023)

[14] Cresswell K, Sheikh A, Can Disinfection Robots Reduce the Risk of Transmission of SARS-CoV-2 in Health Care and Educational Settings, J Med Internet Res 2020; 22(9):e20896, DOI: 10.2196/20896.

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- Veneta Yosifova carried out the problems in stock farm hygiene, and the analysis of the types of sanitizing robots, and contributed to the conclusion.
- Nikolay Stoimenov carried out the introduction, took part in the analysis of the floor-cleaning robots, and contributed to the conclusion.

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Conflict of Interest

The authors have no conflict of interest to declare.