Wireless sensor technology usage areas in livestock farming over the world and in Turkey

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Abstract

In our century the greatest and most important innovations occur at telecommunication industry. Lately, telecommunication is a vital incident for people, they need to communicate basicly by transmitting files or chatting at every place like farms, homes, warehouses, stores, hospitals, schools and cafes. To provide these needs of people, the easiest and cheapest technology is wireless network technology. With the help of the wireless technology, people can share data whenever they want and wherever they are, even they are mobile. The technology allows us to connect workstations, laptops, mobile phones, handheld PCs and even bar code scanners. Besides, agriculture and farming is the backbone of a country, thus the farmers should follow the recent developments about technology to provide the needs of ever increasing human population with decreasing lands for agriculture and farming. Today, the basic aim is to lower the costs and provide healthy products as seed, farm animals, vegetables and fruits. In the paper, latest improvements in agriculture and farming is examined briefly, in the way of technological developments which are a few years old and new implementations over the world and in Turkey. The investigations are basicly focused on wireless sensor network usage since the sensor technology is very suitable for health and environment monitoring of both people and animals. In America and Europe, sensor technology is used for more than ten years intensively but in Turkey only big livestock farms use such a delicate and advantageous technology for only a few years, in spite of the computer and network using number of people permanently increases in Turkey. In the paper, it is mentioned that the construction of sensor systems in the farms is very easy and useful for the farmers' budget and also for the economy of a country.

Keywords: *Wireless sensor technology; livestock farming; monitoring; farming in Turkey*

1. Introduction

Wireless sensor networks (WSNs) cover wide areas over the world depending on the technology, equipments and basic needs with consuming less power and cost than other presented communication technologies. Because of their crucial specialities, they are utilized at many different areas; at environment monitoring to collect data about the wildlife of animals, air conditions, pollution rates in air, water and soil and at disaster monitoring to collect, evaluate data and to take precautions such as at volcanic eruptions, earthquakes, flood disasters and hurricanes. Furthermore, it is used for health monitoring for patients and old people at hospitals and also at their homes with remote monitoring. Besides, another developing and growing technology and market is product monitoring at animal farms. It is very considerable in our century because

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of the ever growing healthy food demand of increasing human population. To provide the needs of people, many production methods become old fashioned and inadequate. For this reason, to increase the productivity, new technological methods; especially WSNs are used for big farms. A WSN based production monitoring systems at animal farms are composed of basic parts: a network structure which is composed of farm indoor and outdoor sensors, access devices like gateway and public communication networks and the management part of the farm with veterinary part (1).

Communication, computer and information technologies are ever growing and developing technologies with the recent advances produced by researchers. These technologies are combined and reached to millions of people with many devices basicly laptops, mobile phones and applications together with internet. Wireless networks enable people to reach network resources at every location in their home/office or in a primary networking environment. With the help of the increasing computer and mobile phone usage, many applications are based on these devices like e-agriculture, e-livestock and e-education. Here, the technology usage rates depend on gender, age and education level of people and many more factors. Mobile device usage rates at livestock management is examined in Turkey (2) according to many different factors like personal income, farm type and number of employee. Besides, the internet technology and computer usage over the world is examined in (3). We examined the technological developments used in livestock management over the world with the latest improvements. Then we presented the researches about the technological usage rates in Turkey because the aim of this study was to compare the technology utilization of Turkey in livestock management with other countries.

2. Materials and methods

2.1. Remote monitoring of hens

For the last twenty years, the hens are layed at cages but this system is out of date. Today, egg producers decided to raise the hens at non-cage environments. Because the in-cage environments cause stagnancy and stress over hens and eventually weak, unhealthy and diseased hens are produced. Consequently, these facts effect the egg production rates, quality of the eggs and other products gained from hens. Meanwhile, to monitor the hens at non-cage environments is very difficult. Also, researchers mostly focused on egg production rates, water, nutrition, medicine consumption rates of the hens and also the indoor environment temperature, moisture and oxygen rates. Contemporarily, many different factors and parameters are considered including every aspects in a daily routine of a hen. In (4) wearable sensors are attached to the hens and they are used to monitor the activities of the hens. With the offline machine learning methodology based system, six activities are trained to be able to monitor the hens, these are; raise, drink, dust-bathe, stand, walk or run, sit or sleep. Besides, there are many important illnesses that influence the health of the hens and the productivity rates. Thus, these illnesses should be monitored with sensors. One of the well known of these illnesses is avian influenza (HPAI) infection at birds and mammals. Infected chickens with HPAI viruses are examined widely but initial diagnosis is more important, because if there is an infected hen at the cage, the virus spreads very quickly from hen to hen at every 10 minutes, thus it is very important to be able to catch the first infected hens before infecting other hens in the cage.

Here, a temperature sensor and an accelerometer including wireless sensor is mounted to the hen, to be able to monitor the movements, body temperature and also to detect the unusual states of hens caused by the infection of virus. As soon as the sensors catch fever at the body of a hen or weakness at the movements of the hen, it informs the manager by sending a report that includes health informations (5). Today, most of the studies are concentrated on the wearable sensors to be able to catch the changes immediately.

2.2. Remote monitoring of cattles

For cattles mostly static sensors are used in the farms,. The animals are monitored easily, if they are in the monitoring area of the static sensors that are mounted at definite places in the farms. But, if the animals are out of the monitoring area of the sensors, then the animals' activities can not be monitored. This fact is the basic disadvantage of the static sensors, since animals may become ill or injured out of the sensors' monitoring area.

Also leg or neck collars are used at big animals, mostly at cattles to collect data like body temperature, breath rates, heart rates, movement speed and periods. But these collars should be cheap for farmers and they should be light for animals. And also, they should not make animals uncomfortable or irritate their skin, because if the animals feel themselves uncomfortable, they try to get rid of the collars so extra cost and damage emerge or collars may cause extra stress for animals which effect the products gained from them. In the paper (6,7), mobile animals are monitored with the mounted antennas on the animals' necks for collecting real time data at every second and at every place. Basic animal monitoring system structure is composed of mobile sensors mounted on animals, static indoor sensors inside the farm, the static outdoor sensors outside the farm at the area around the farm houses and main sensor at the monitoring station for managers and veterineries. In (8), low cost animal health monitoring is given for examining the health of animals, providing treatment for them and providing initial diagnose for the illnesses to prevent the spreading of viruses (9). To be able to detect such a valuable data; a pulse oximeter, a GPS (Global Positioning System),an electrode belt, a body temperature sensor, a respiration transducer and also an environment temperature transducer including sensors are used (10).

2.3. Remote monitoring of other animals

In paper (11) the seperation anxiety at dogs is examined. This is an important disorder type and a kind of dog behavior problem which is difficult to treat, for this reason it should be realized as early as possible and this detection will be easier with sensors either mounted on the dog or positioned around the dog's environment to follow its anormal movements. Because, by monitoring the movements of a dog, many problems can be catched easily and rapidly. With the sensor technology, air and water changes, fish behaivours and reactions of fishes to innovations around them are monitored easily for instance with eco aquafarm system. Here, it is very simple to notice the effects of a disease in the farm with the environment monitoring system, state analysing simulation system and eventually with the disease diagnosing system which constructs the main eco aquafarm system. The fishes are so delicate animals, they are effected by the changes around them easily such as the temperature, oxygen rates and the salinity of their water influences their improvement, health and reproduction. Therefore, these parameters of an aquaculture farm should be

followed during the day to be able to protect the farm. In (12), these parameters are monitored and data is collected by sensors, then the collected data is sent to a server over a mobile terminal. If the system finds out a problem at the collected data, it informs related people. Besides, the system examines the collected data to follow the aquaculture environment changes, especially for providing early treatment for affected fishes before spreading of the viruses to the whole aquaculture farm. Also, at ZebraNet (13), the animals around a zebra is monitored by a sensor on the zebra. This is another type of monitoring technique. Here, the sensor mounted animal is not monitored but other animals and environment around it is monitored.

2.4. Remote monitoring of people

Contemporarily, to support and improve the ill and old people's life standards, sensor technology is the most attention attracting technology. The sensors are used for detecting emergency situations, monitoring daily activities and drug interactions on people. The occurance of abrupt and damaging changes at the body state of a person is named as emergency situations and they should be immediately detected and cured as soon as possible. Because these situations may cause big, affective and long term injuries at the body of a person. With the sensor technology, this type of care needing people can be monitored during the day and if an abnormal situation is detected at heartbeat, respiration, body temperature and blood pressure rates, then the hospital, nurse or the family can be informed instantly. By monitoring daily activities, social interactions, movement, sleeping, toilet and shower usage rates of people at indoor or outdoor, better security and health conditions can be provided for patients. Furthermore, monitoring is the best and cheapest way to prevent malnutrition, loss of consciousness and also for providing hygiene of old and healing people after a medical procedure. Besides, drugs may cause side effects; sleeping, nutrition, behaviour and mental disorders as a result of drug interactions for this reason, they should be followed by telemedicine and e-health systems (14).

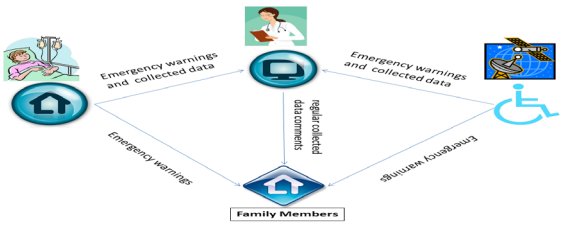

Figure 1: *Basic architecture of the health monitoring system*

Old people, neuromuscular disordered patients and paralysed patients need rather costly, special care and wheelchairs to be able to move. In (15) vital health conditions of people are monitored while they are mobile with their wheelchairs by the mounted sensor system which is working together with the GPS to provide outdoor localization and RFID to provide indoor localization as presented in figure 1. With the sensor system, remote healthcare assistance is provided for patients using wheelchairs together with monitoring their health status and current locations (16).

3. Results

The ever increasing population of people causes to enlarge the living areas of people over the habitat of natural animals, plants, forests and agricultural areas thus the consumption of natural resources will augment over the world. Therefore, the production amounts need to be increased at very limited areas with limited costs. Today, instead of utilizing human power, utilizing technological devices like computers, mobile phones, sensors and

wireless components, minimize cost, time loss and error factors. At current state, the increase of food demand and need for healthy products is a vital and big problem for human race. The gained protein from animals are more valuable for people than vegetal products, such as beef, chicken meat, fish, egg and milk.

In livestock management, providing well being of animals and increasing the productivity are the basic factors for farming. The positions of the farms, the enviromental conditions inside and outside the farms should be ensured with the structural design and technical equipments. In livestock management, to acquire highest efficiency, good maintenance, influential nutrition and convenient environment conditions should be provided to make a profit in production. To ensure the convenient environment conditions, farm area and the construction of farm structure should provide suitable and comfortable living space for animals. Afterwards, environment conditions and situations of animals need to be monitored to be able to ensure the health of animals together with the productivity and earn the best income.

Together with the adequate equipments, the design of the farm is the most important factor at livestock management. To provide the heat and humidity balance, air movements, gas and dust rate in the air are crucial factors effecting the indoor environment parameters in the farm. Besides, convenient ventilation and illumination systems should be designed according to the specifications of the farm because determining the light quality, the basic hours for light usage and air quality are very important since these are very vital variables. Furthermore, feeding and watering of the animals should be performed quickly, on time and with best quality fodder. Cleaning of the animals, farms and environment of the farms need to be considered. Additionally, here the basic aim is providing all of these factors with lowest cost and least labor usage but for big farms that are composed of many barns, ensuring the coordination is a big problem. Therefore, big farms and corporations try to use less labor but more technology; computers, wireless equipments and sensors for monitoring, sensing, evaluating and managing.

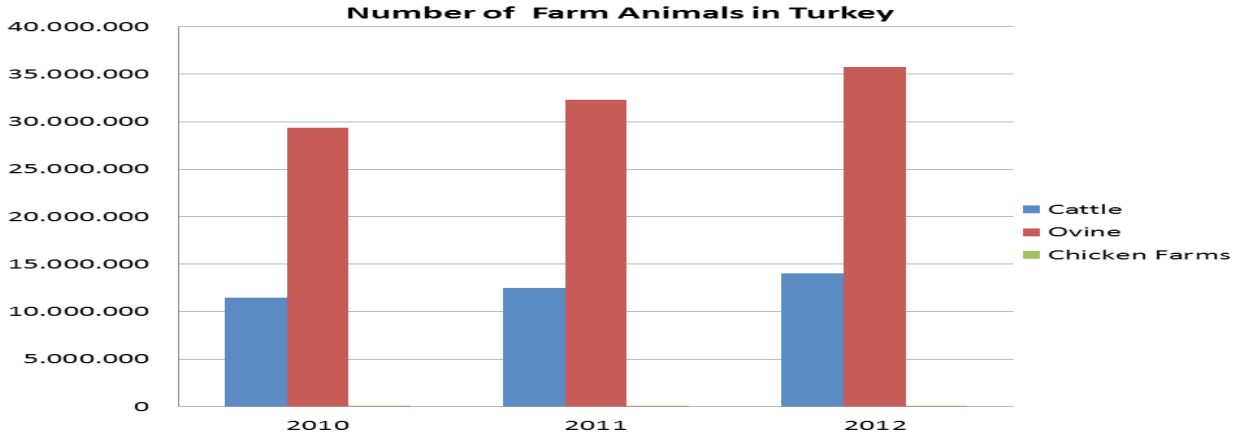

Figure 2: *The number of farm animals and chicken farms in Turkey between 2010-2012 (17)*

Eventually, it is easier and cheaper to control and manage the waterers, mangers, heaters and ventilation in the farms with the help of the sensor technology. In Turkey, especially at the chicken farms, sensors are mostly used for a few basic systems. For instance, to provide ventilation in the farm, delicate sensors are used to detect heat and humidity. Today, to provide the increasing demands of people in Turkey, animal nurturing in small farms turn into big production farms as given in figure 2 and figure 3. But, nurturing animals in big farms is very difficult and expensive thus the organization period as we mentioned above is very important.

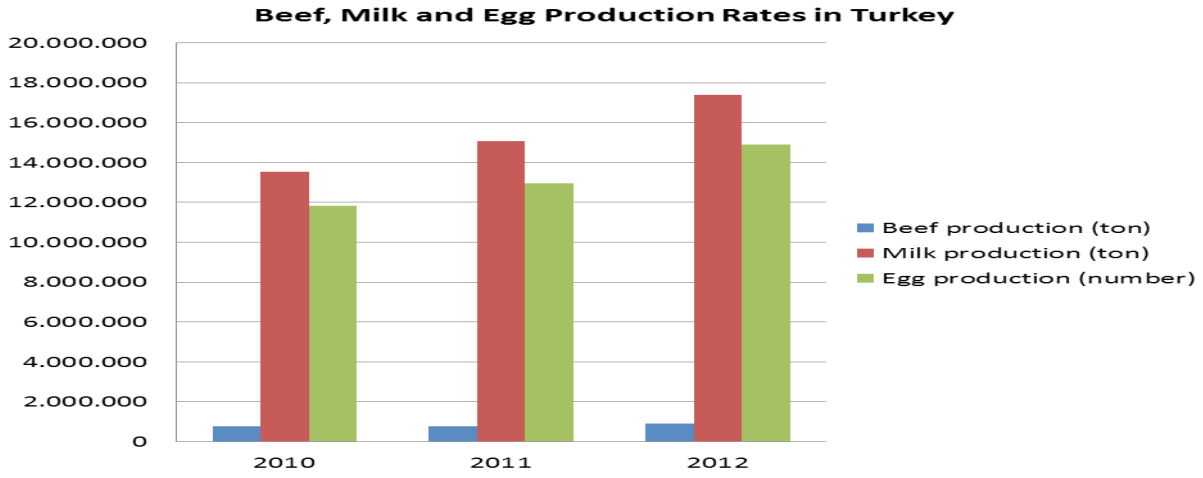

Figure 3: *Beef, milk and egg production rates in Turkey between 2010-2012 (17)*

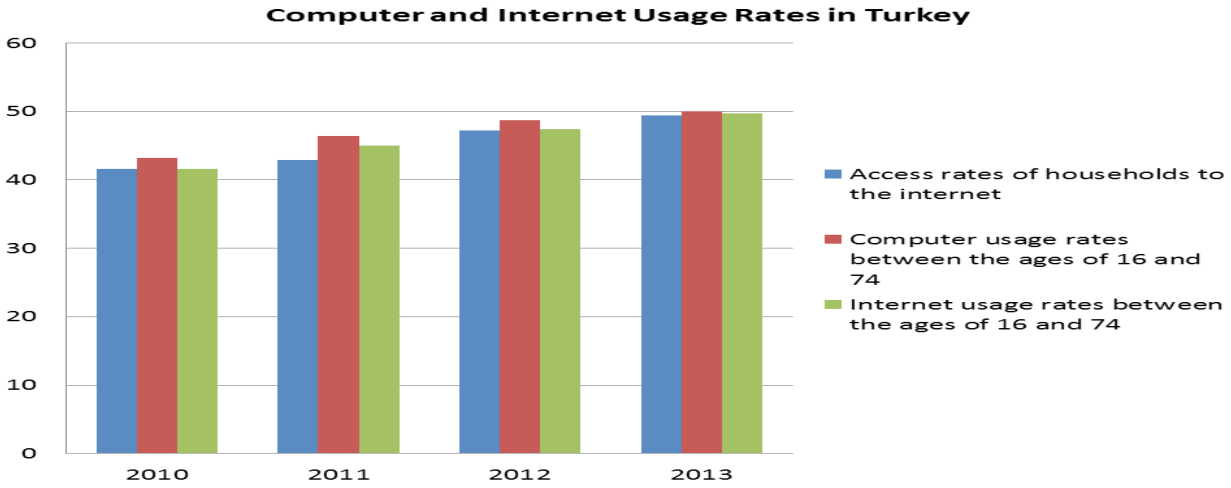

Figure 4: *Computer and internet usage rates in Turkey between 2010-2013 (20)*

The utilized technology at the farms is as important as the utilized equipments at the farms because labor and the production loss is the most costly part at production farms. Instead of utilizing labor, using technological devices decrease the cost, production loss and time loss. In Turkey, almost every home own a computer together with internet as given in figure 4, so it is getting easier to benefit from technological developments. Farmers monitor the farm, the animals, farm conditions and other necessary factors about the farm during 24 hours a day from their houses or outside by their computers and mobile phones with mounting some sensors in the farm according to the usage topics. Furthermore, owing to the sensor systems, the waterers, mangers, heaters and ventilation in the farms can be monitored, controlled and renewed if the rates diminishes to the specific values. Else, by monitoring animals, it will be easier and quicker to catch ill and dead animals in the big and crowded farms thus they can be send away from the farm immediately. Additionally, indoor and outdoor farm informations can be collected and can be stored, thus production cost is decreased, better and healthy products can be gained easily (18-21).

4. Conclusion

Contemporarily, livestock management is becoming a huge and still growing industry. With dense livestock farming, developing automation systems and technology, livestock management in smaller areas together with overcoming more work with less labor produce high production rates and makes the livestock management more profitable. But, badly designed dense livestock farming, restricts basic needs of animals like wandering, sunbathing and disintering around in the nature which disrupt animals' adaptation to their environment and other animals around them. Higher heat and humidity than needed amounts, bad lighting, ineffective feeding, uneducated farmers about animal behaviours and needs, using wrong equipments, sheltering more animals than appropriate numbers at a definite living area and not removing the dead and diseased animals from the farms as soon as possible influence animals badly, makes them stressful and uncomfortable. For this reason, when it is talked about the farms that possess the optimum conditions for animals, it means the farms that provide adequate environment for animals to be able to grow with best conditions they need, especially

without stress and with best care. Good planned and constructed farms present many benefits like acquiring most product with the least input; with decreasing the death rates, fodder consumption and energy usage; by improving the product quality and decreasing the labor need. Consequently, to increase the productivity; the construction of the buildings, the needed technology and devices, the place of the farm and the labor should meet the needs of the considered farming type (22). The construction stage of such a sensor sytem is a little bit tiresome and costly. Accordingly, in Turkey only big farms choose sensor technology instead of utilizing from old fashined methods. But, after constructing the system, the gained profit during a very short time is remarkable. Thus, in addition to big farms, middle sized farms should also utilize the WSN technology in Turkey.

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