INTELLIGENT POULTRY MANAGEMENT SYSTEM AND MONITORING THE HEALTH OF FARM ANIMALS USING INTERNET OF THINGS (IoT) AND DATA ANALYSIS

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ABSTRACT

The work aims to provide details on how to build an automated Environment Controlled Poultry Management System (ECPMS) and integrate it with Biosensors to predict diseases among farm animals using data analytics and low cost commodity. An all-inclusive system is proposed using RaspberryPI-3, used as a Linux Embedded processing unit and Arduino-Mega board for interfacing with arrays of sensors. The mentioned system has been systematically investigated for different physical parameters associated with effective poultry management which includes temperature, humidity, light intensity and air quality. Multiple body vitals such as sweat constituents, body temperature, behaviour and movement, stress, sound, pH, disease, analytes and presence of viruses and pathogens should also be considered along with the physical parameters to obtain a more objective output which is reliable for detection of diseases. It is observed that the system not only monitors these physical parameters but also regulates these parameters effectively. The framework was observed to be very useful for farmers as they could easily access and control the system remotely using their handheld mobile device. The system-human intervention, saves time, optimizes resource utilization and increase poultry production. Collecting the data from ECPMS and biosensors it is possible to predict and prevent future occurrences of diseases among farm animals by using Decision Tree algorithms for data analysis. Finally the system is expected to notify the poultry farmer about the possible animals being detected as ill before the naked eyes makes it possible to understand the symptoms.

INTRODUCTION

In terms of food production, India is agricultural well-off country. Poultry is one of the major sources food production as a mainstream population consume one source of meat or another. Eggs and chickens are rich sources of protein, vitamins and minerals that are found in richness throughout the country. Poultry gives rich natural manure and provides employment to a large number of farmers and different people across the country associated with the poultry business. Similarly, the health of cows, buffaloes and oxen depend on various farm conditions and various vaccinations given to them over a period. It is required that these animals are healthy and do not transmit their diseases to humans as milk is consumed at massive amounts throughout the country. The health of these animals depends on the environment in the poultry farm. If the environmental conditions are not suitable then there may be problem with the growth of farm animals and result in ailments. Humans contract a number of diseases from farm animals, some of the notable ones being: Newcastle Diseases, Avian Influenza (Bird Flu), Chlamydiosis, Ringworm, Tuberculosis, Anthrax and Swine Flu. This paper aims at reducing the risk of contracting such diseases from farm animals by monitoring the physical parameters as well as body vitals and analyzing this data to understand when a farm animal shows symptoms of diseases with respect to the parameters. This data will help us avoid certain parameters reaching thresholds by controlling them remotely and have a healthy farm environment.

The current day anomalies according to the KrishiSewa suggest that the primary concern for the problems is the lack of the technical knowledge faced by the poultry farmers failing to use the technology which could help the poultry standards and avoid majority of the health issues faced by the poultry animals. It is clearly noticeable that one of the primary concern of lack of space for all the animals is because larger the space the more difficult it gets to control the farm single handedly by the farmer. To tackle this situation the poultry farm has to be technology enabled and therefore the biggest problem hindering is the lack of technical knowledge faced by the poultry farmers to use these devices to control their farms. The second most important problem is that of the hygiene. All the poultry animals are confined to a shorted place than the required standards and therefore variable factors like excreta, dead animals, loss of feathers, etc. makes it extremely difficult to maintain the hygiene required for a better health condition for all the animals. There are several poultry farms which have enabled themselves with the technology to make sure the standards are increased but on the contrary with decreasing the manual power and relying on the technology the biggest problem faced is off the detection of the symptoms by the device. The devices being machines many a times interpret anomalies as normal conditions hence failing in detection of the symptoms which was previously done in an effective manner by the manual power available on the farm. Therefore there is a urgent need in the poultry industry to develop and make in use a software and hardware based technology which can eradicate previous problems of detection of diseases and treating them in an effectively and sharing this data.

1. The Existing System

1.1.1. Environment Controlled Poultry Management System (ECPMS)

The Environment Controlled Poultry Management System is a suitable example of a smart green house indoor mechanism which has been in a concurrent usage in poultry farming. There are multiple governing and central factors which decide the growth of the farm

animals but the primary one amongst all of them is the climate change which drastically affects the health conditions. The mechanism discussed is built and curated in such a way that with the help of IOT and functioning of various tools like fans, ventilation system, air cleaners, etc the climate indirectly affecting the farm animals can be regulated in alignment to the owner's need. In the discussed paper the cooling fan and air cleansers are the core elements to control geographical aspects of the air like temperature, humidity, etc. A simple flow structure is established where all the geography based parameters which include temperature, gas levels, water level, etc. are regulated and then uploaded on to a database. The person controlling the farm then is made aware about these updates and any huge difference from the previous update is marked so that it can be brought to notice. The discussed database can be accessed either via a system's (laptop or personal computer) internet or via mobile based application which are developed keeping in mind the user friendly context.
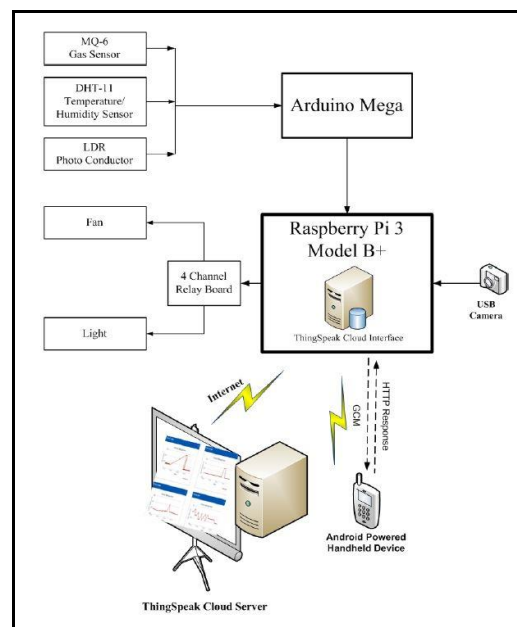

Figure 2.1: ECPMS Architecture Diagram

1.1.2. Biosensors

An emerging market that is quickly gaining recognition in the global market is Biosensors, as an application for animal health administration. Globally, a number of sensors being produced for animal health management are at various stages of commercialization. Some technologies for producing an accurate health status and disease diagnosis are applicable only for humans, with few modifications or testing in animal models. Cattle development and welfare are one of the few opportunities for ground-breaking technologies like these to be considered. Precision livestock agricultural techniques, which include a wide span of technologies, are being applied, along with advanced technologies like microfluidics, sound analysers, image-detection techniques, sweat and salivary sensing, serodiagnosis, and others. However, there is a need to integrate all the available sensors and create an efficient online monitoring system so that animal health status can be monitored in real time, without delay. Different wearable

technologies for animals, Nano biosensors and advanced molecular biology diagnostic techniques for the recognition of various transmittable diseases of cattle, along with the efforts to procure and compare these technologies with respect to their drawbacks and benefits in the domain of animal health administration are being developed.

1.1.3. Wearable Biosensors

The use of biosensors and wearable technologies is becoming increasingly important for animal health management. Such devices are particularly useful for dairy cattle and poultry farms. Due to the superior performance of wearable technologies and sensors, they can make a breakthrough in livestock development, and promises to become one the most impactful and practicable technology in the animal health market. New wearable technologies are being customized to meet the needs of animals, pets and livestock. Products such as medication patches, tracking collars, and electronic saddle optimization are being purchased at higher rates and harnessed for the healthier upbringing of farm animals. Sensors and wearable technologies can be implanted on animals to detect their sweat constituents, measure body temperature, observe behaviour and movement, detect stress, analyse sound, detect pH, prevent disease, detect analytes and detect presence of viruses and pathogens. Wearable sensors help farmers catch disease early, and thereby prevent deaths of animals. Farmers can also cull diseased animals in time to prevent the spread of disease in whole cattle herds through prediction.
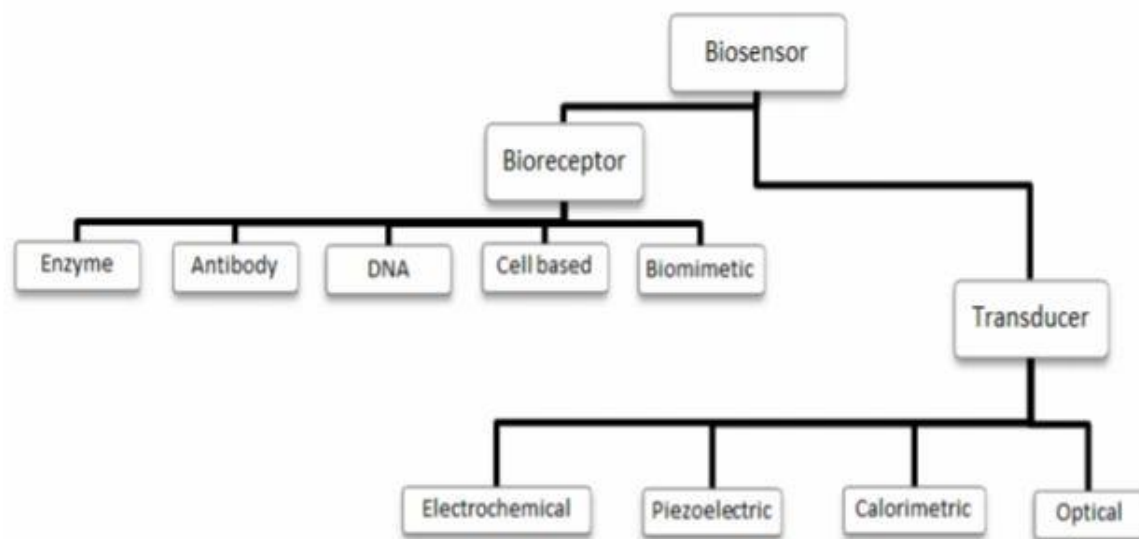

Figure 2.1: Architecture Diagram of Biosensors

1.1.4. Collecting Data from Biosensors

The collection of data from biosensors eases numerous amount of tasks. It can also be considered a far better and reliable system of noting down the data in which these biosensors are allied with telephonic devices making them extremely less error prone in contrast to the conventionally accepted systems like pen and paper mechanism expecting everything to be in black and white. These handheld devices are automated to make sure

that the data collected and received by them is redirected directly to a server which is centrally accessible by everybody. To increase efficiency better optimised and higher specifications enabled sensors are used so that latency is reduced which also increases the efficiency of the entire data recording system. The data collected is sent over a network to the server which can be made accessible via a central management platform which acts like a unique dashboard making data visible in a user friendly notation.

1.1.5. Integration of Biosensors

Variable biosensors and their integration mechanism with the mainframe system are responsible for sharing and displaying the data. The mechanical device used for measuring the temperature of a animal body is attached to ears of the animals and the estimating cost for the same is about 10$ (~Rupees. 700/-) per cattle. The biosensors available in the market used to analyse and introspect estruses period are available for the cows. An extremely innovative mechanism to study the behavioural change of feeding and milking the animal is available in the market which consists of robot arms exactly like the prosthetic arms for humans which use electronically operated leg bands. With the growing demand of meat and understanding its importance it is very apt to provide high quality of the animal products in the market. Various devices like medical patches which are attached under the skin are used to monitor the vitals of the animals. There are also devices available which are attached in the interior of the skin of the animal and give more sound results in contrast to the one applied in the exterior. These devices are expected to work as per their development standards and help maintain the health condition of the animals making sure that the mortality rate is reduced and also increase the living standards.

### 1.2.   Limitations of the Current Work

To summarize the various limitations in the current functioning and operations of the poultry farming in a nutshell, the following would be the ones which have an adverse effect on the health of humans and the animals :

- The current technology takes in to consideration a small set of parameters for the detection of diseases which include temperature, humidity, light intensity, ammonia level in air, air quality, water level, etc. The restriction to such a small set of parameters leads to incorrect output as health is affected by a huge variety of parameters which include body vitals therefore current restriction to physical environmental parameters can lead to dubious outputs.

- Ongoing research suggests that recent trends implicate that the surrounding physical parameter are modified according to the threshold limits. This could be dangerous because with the gradual shift in atmospheric temperature sometimes the hardware could predict a abnormality even in normal situations like heavy rains. These atmospheric conditions being extreme in nature are important to poultry and subjecting the poultry to the same condition throughout the year would not be helpful.

- With the recent inventions in micro-controllers and sensors it is always useful to incorporate the recent advancements because it leads to better performance and economic viability. The suggested hardware is expensive and Indian Agriculture mostly being subjected to economic restrictions resist using such expensive hi-tech hardware devices. Therefore there a rigorous change required in traditionally adopted hardware devices.

- The tracking of physical parameters suggest that it can be resricted to specific set of geographical locations. Poultry across the globe are subjected to same diseases but stay in variation of physical parameters which drastically affect their vitals. Therefore prediction becomes difficult and hence a centralized system is required which can predict health conditions of poultry animals irrespective of their geographic location keeping the physical parameters of that area in consideration during the prediction.

- The output obtained is based on limited set of parameters to analyse and detect the diseases. Therefore with the lack of knowledge of data analytics it becomes extremely difficult to manage a huge amount of unstructured data and therefore the existing systems find it difficult over a period of time to detect and predict the diseased which have a possible chance of occurrence.

2. Proposed System

The system that we propose comprises of 2 specific domains of computer science i.e. Data Analytics and Internet of Things. Data analytics is the key central element of our proposed system. The use of data analytics will help in analyzing and detecting the diseases in poultry animals and help save their lives with proper medication at the appropriate time. With the installation of RFID sensors on each animal in the farm we would start of by giving each animal a unique identity in the form of their RFID value. Multiple sensors like medication patches, electronic saddle and other bio sensors which can help us keep a k on animal's body vitals. The vitals that we will be mostly interested in studying are sweat contents, body temperature, detection of unwanted bacteria, pH body level, stress level and eating habits. Every poultry animal will be tracked on not only but definitely these parameters which will be stored in the centralized database.
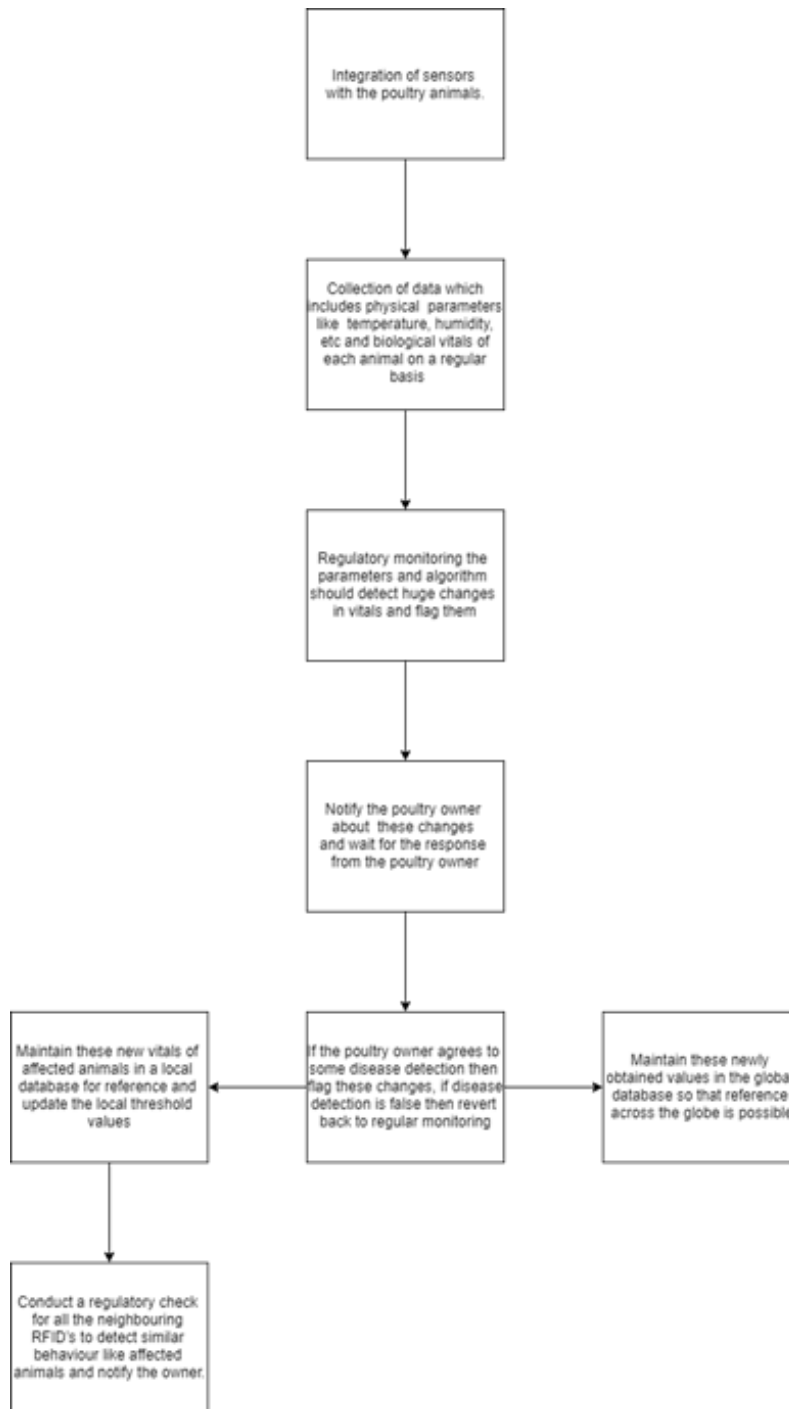
Figure 3.1: Block Diagram of Poultry and Health Management of Farm Animals

Upon storing of the information IOT enabled devices will bring in 2 different aspects. First aspect of using IOT is to make sure that the physical devices can be connected to the real world and can help us derive information flow easily over the mobile apps that would intricate the poultry animal about any changes. Second aspect for IOT usage is to bring in the automation, once the vitals or geographical physical parameters have crossed a threshold limit it would notify the poultry owner which automatically take immediate

actions on changing physical parameters remotely. Data analytics being the key ingredient of this proposed system has more work than just storing the vitals information. Keeping in consideration of geographic physical parameters like temperature, humidity, etc. research has shown that animals sharing these aspects are most likely to depict same body vitals in the same health conditions. Therefore using this inference to its best we would like to suggest a flag mechanism where whenever the poultry owner observes some particular change in the animal's behaviour or detects the illness of any animal it should immediately update the same on the portal for the specific RFID value. Once it is done a tracking mechanism will set those body vitals of the ill RFID value as the threshold value and well before when a poultry animal is set to reach those vitals which in other term would mean its illness it can be detected and hence necessary precautions could be taken. Similarly with the increased amount of data it can also help eradicate several diseases from the poultry because a live track on vitals when combined with analytics can easily predict illness with specific set of symptoms which are easily ignored with naked human eyes. The Data Analysis approach to predict diseases occurring in farm animals in advance can be done with the help of certain machine learning and data analysis algorithms. The model most suitable for our problem statement would be Decision Trees. Diseases being the dependent parameter on the independent parameters such as environment parameters and internal health parameters. Most of these parameters return a numeric value which can be classified into certain categories or classes. These classes can take decisions depending on the output of the parameters to predict the health of the farm animals. The leaf nodes of the decision tree will determine the health of the farm animals. Using this data and analysing them farm administrators can prevent a parameter(environment or internal health of animals) from reaching the particular class in advance using already existing data. XG Boost is one of the popular algorithms which can be used to implement decision trees. XGBoost is an algorithm that has recently been dominating applied machine learning and Kaggle competitions for structured or tabular data. XGBoost is an implementation of gradient boosted decision trees designed for speed and performance. XGBoost stands for eXtreme Gradient Boosting. XGBoost is used for supervised learning problems, where we use the training data (with multiple features) x_i to predict a target variable y_i.

We would also like to discuss about the incorporation of various other domains of computer science for futuristic work which can help improve our results. Digital Image Processing can be used to keep a track on the physical behaviour of the animals and hence predict the changes along with already suggested body vitals mechanism. Altogether a combination of Machine Learning with all the technologies discussed above

can help us teach a machine about the health monitoring and therefore with a huge and appropriate amount of data it would provide the poultry owners a fair chance to get notified about the disease well before in hand and doing so can reduce death toll and increase life expectancy in poultry animals.

2.1.   Advantages of Proposed System

- The proposed system will effectively give out more stable outputs in contrast to the previously existing systems because a wide variety of parameters now have been taken into consideration because of which a more reliable and effective output can be expected.

- The mortality rate will also be decreased because now since a more reliable output can be given out much prior to the disease actually causing harm the animal, the poultry owner can take precautions and also fight the diseases in much more informed state. With comparison to the previous methodologies the disease detection was not accurate and subjected to smaller geographic regions making the detection extremely arduous. Therefore the current system will also help to decrease mortality rate.

- With more sophisticated Artificial Intelligence and Machine Learning tools, over the period of time it will be possible to eradicate diseases completely from not only the locality but across the globe. Therefore overall health will also be increased of all sorts of animals in the poultry farm.

- The proposed system has an indirect advantage on the human beings too, with the decrease in the possible health disorders in the poultry animals major influenza's like swine flu, etc. can be detected prior to their development and will save a lot of human lives too.

- The currently existing systems are expensive because of the industry trying to monetize the IOT aspect, most of the Indian Poultry owners are below poverty line and would not like to invest such a big amount in the technology therefore the proposed system talks about medical patches and RFID sensors attached to collars making it extremely economical.

- The existing system is purely tech enabled causing it difficult for the non technical people to handle it or even solve some minor issues, with enabling data analytics and IOT it becomes extremely easy to connect the technical world with the physical world and therefore the system becomes easier to use and easier to repair therefore the proposed system talks about how lay man usage can be increased of technology.

- Reduction in man power, in the previous times it took manual work to check every animal on a daily basis making it difficult to concentrate on other work, now with the automation the poultry owner can scale the farm to a large number and handle the same single handedly with a better surveillance.

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