**Fog Assisted Application Support for Animal Behavior Analysis and Health Monitoring in Dairy Farming**

**Abstract**

With the exponential growth rate of technology, the future of all activities, including dairy farming involves an omnipresence of widely connected devices. Internet of things (IoT), fog computing, cloud computing and data analytics together offer a great opportunity to increase productivity in the dairy industry. In this paper, we present a fog computing assisted application system for animal behavior analysis and health monitoring in a dairy farming scenario. The sensed data from sensors is sent to a fog based platform for data classification and analysis, which includes decision making capabilities. The solution aims towards keeping track of the animals’ well-being by delivering early warning alerts generated through behavioral analytics, thus aiding the farmer to monitor the health of their livestock and the capability to identify potential diseases at an early stage, thereby also helping in increasing milk yield and productivity. The proposed system follows a service based model, avoids vendor lock-in, and is also scalable to add new features such as the detection of calving, heat, and issues like lameness.

**INTRODUCTION**

The Internet of Things (IoT) has reformed the future of connectivity and reachability. While the traditional methods of farming have been more intuitive, the growing demand and supply of agricultural products have made the manual tracking of well-being of the livestock cumbersome and time consuming, and this becomes a major issue with the increase in size and scale of the farm. Over time, the agricultural sector has recognized the need to leverage information and communication technologies (ICT) to improve practice efficiencies, yield, and animal welfare. A smart dairy farm scenario involves a large number of sensors spread across the farm, either in the form of devices worn by the livestock which are used to monitor their health and mobility, or other miscellaneous sensors for measuring farm variables such as soil composition, grass growth, and other environmental scenarios. To ensure proper management for the various processes on the farm, analysis of the data generated by these sensing devices in such a setup becomes of prime importance. Currently, the data collected by these devices is subjected to a cloud based analytics system to gather value in terms of insights and useful information. But this leads to a huge amount of heterogeneous and unstructured data being uploaded to the cloud. Our work is motivated by the prevalent communication delays [1] observed in primarily cloud based application systems (especially in scenarios with intermittent or no Internet connectivity), thereby affecting responsiveness [2] due to increased latency in getting timely insights in critical use cases; and the fact that the present state of computing systems, applications and architectures inhibit innovation due to the lack of multi-vendor interoperability [3]. In consequence, the alternate directive is to design the systems for pre-processing, with an aim of reducing raw data prior to uploading it to the cloud, and shifting intelligence/analytics closer to the data source. Fog Computing is a relatively new networking paradigm that provides compute, storage and networking resources at the edge of the network. It utilizes the available in-network computing resources and shows the capability of reducing the dependency on the cloud by facilitating data analytics on the network edge [4], thus capable of assisting latency sensitive applications. This improves the responsiveness of the system, reduces resource requirements on the remote cloud infrastructure, and in turn increases the efficiency of the system in terms of energy consumption and network usage [5]. Several interpretations [6] have been proposed for the implementation of fog nodes and their configuration, either via servers, networking devices, cloudlets, base stations, or vehicles. To our understanding, fog node is any compatible device that can be used to deploy applications or a component of an application on it— for example, depending on the specific use-case, it could be a gateway, set-top-box, switch, router, PC, etc. The most suitable configurations to serve as a fog node for such deployments in the particular case of a smart farm scenario include PC, fog servers and compatible networking devices such as gateways. In this paper, we present a fog computing assisted application system for animal behavior analysis and health monitoring in a dairy farming scenario. The main contributions of the work are as follows:

* Identification of the farm activities and thus services that demand real-time or near-real time response and decision support.
* Design, creation and development of services following micro services based application design principles to tackle the problem of vendor lock-in, or multi-vendor interoperability.
* Granular service specification such as lameness detection, heat detection, etc. for the farmer/user to choose from, depending upon the individual requirements and size of the farm.
* Scalability and agility to add new services, and provide solutions and features that a user/farmer may demand in future with the usage of the system.
* An added benefits to dairy farmer in case of his/her physical absence from the farm, as the application serves as a medium for other workers to get insights and understand the animals.

The paper is further structured as follows: §II contains motivation, background information and related work, will contains the architecture and the workflow of the smart dairy farm setup as a part of our real world test bed deployment presents the animal behavior analysis and health monitoring informatics from the data thus generated, and presents the concluding remarks and future work.

**EXISTING SYSTEM**

With the recent advancements in IoT, the use of computing systems utilizing wireless sensor networks (WSN) has been widely proposed in the agriculture sector in order to facilitate real-time monitoring of farm processes. IoT is an active enabler of smart farming, whereby various entities on the farm can be connected for collecting and exchanging data, thus allowing joint or independent operations. As technology grows to be an integral part of the agricultural and dairy industry, it is important to generate timely insights from the data collected, and enable effective data management. The authors in [8] provide an implementation of a smart farm setting using a range of environmental sensors and livestock monitoring technologies, while another such implementation of a system for detecting mastitis in dairy cattle and managing their milking processes in the parlor has been presented by the authors in [9]. A study by authors in [10], [11] gives an overview of the sensor systems available for health monitoring of animals in dairy farms. A wireless sensor and actuator based virtual fencing system based on acoustic signals and electric stimuli has been implemented in dairy farms as a replacement of physical barriers to regulate and control mobility of cows within a given boundary.

**PROPOSED SYSTEM**

We position our work as an answer to the issues mentioned above, thus bridging the gap, and providing an innovative way that integrates edge, fog and cloud computing to provide a solution specifically in case of smart dairy farming IoT settings. For the reasons mentioned above, we follow a micro services [18] based approach for design, creation and deployment of the application in our setting. This provides many benefits such as better adaptability to technological changes, and more importantly avoids vendor lock-in, i.e. it gives the flexibility to allow simultaneous deployment of software from different vendors implemented using different technologies. We position our work as an answer to the issues mentioned above, thus bridging the gap, and providing an innovative way that integrates edge, fog and cloud computing to provide a solution specifically in case of smart dairy farming IoT settings. For the reasons mentioned above, we follow a micro services [18] based approach for design, creation and deployment of the application in our setting. This provides many benefits such as better adaptability to technological changes, and more importantly avoids vendor lock-in, i.e. it gives the flexibility to allow simultaneous deployment of software from different vendors implemented using different technologies.

**PROPOSED SYSTEM ADVANTGE**

* It can measure the step the cow walks throughout the day.
* It can measure the temperature and Heart beat for the cow.
* Automatically the data send to server.
* It can send the alert to server based on heart beat rate.
* It improves the health of cow.

**BLOCK DIAGRAM**

HEARTBEAT SENSOR

GYROSCOPE

POWER SUPPLY

PIC

TEMPERATURE SENSOR

GSM/GPRS

**HARDWARE COMPONENTS**

* PIC16F877A Microcontroller
* GSM/GPRS
* Gyroscope
* LM35
* Heartbeat sensor
* Transformer
* Power supply board

**SOFTWARE DESCRIPTION**

* MPLAB IDE SOFTWARE
* EMBEDDED C LANGUAGE