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파키스탄에서 IOT 에 기반한 스마트 동물 농장의 아키텍처 모델

Architecture Model of IOT Based Smart Animal Farms in Pakistan

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요 약 가축 생산은 파키스탄 농촌 인구의 2 번째로 큰 활동이며, 더욱이 농촌 지역에 사는 파키스탄 전체 인구의 67 %가 축산 활동에서 수입을 얻고 있다. 파키스탄 농촌에서 농업의 한 부분인 가축 생산은 파키스탄인에게 매우 중요하기 때문에, 비용 효과가 높은 비율과 실질적인 기술 도입으로 이 분야를 더욱 발전시키는 것이 특히 중요하다. 파키스탄 농업 분야에서 이러한 중요한 분야를 개선하기 위한 노력의 일환으로 파키스탄의 가축 생산 및 관리의 마이크로 프로세서 및 마이크로 컨트롤러 등 IoT 기술을 활용하는 능력과 가능성을 더 잘 이해하기 위한 연구가 진행되고 있다. 사물의 인터넷은 IoT 기술의 적용에 따른 비용절감과 효과적인 축산관리를 통해 소규모 농촌 축산물을 대규모 사업으로 확대할 수 있게 한다. 본 논문은 스마트 동물 농장에 기초한 IoT 농업 모델을 언급하였으며 그 분야에 IoT 기술을 적용하는 단점과 장점을 분석하였다. 본 연구에서 안전 센서를 탐색하여 가축의 무리 활동을 모니터링하고 시간 응답에 필요한 중요한 작업을 감지하기 위하여 시스템의 일부로 이러한 센서 사용에 목표를 두었다. 이 시스템은 필요 시에 사료와 물을 공급하고, 가축의 질병과 열을 방지하기 위하여 스마트 폰이나 컴퓨터와 이러한 기기를 인터넷으로 연결하여 온도와 습도를 제어해 한다. 본 논문에서는 IoT에 기반한 스마트 동물 농장 모델을 제안하였다.

Abstract Livestock production is the second largest economic activity of Pakistan's rural population, more specifically; sixty-seven percent of Pakistan's total population that live in rural areas sources their income from livestock activities. As this subsector of agriculture within rural Pakistan is so critical to Pakistan's economy it is especially important to further develop the sector through the introduction of cost effective, efficient, and practical technologies. In an effort to improve such an important sector within the agriculture sector in Pakistan research has been carried out to better understand the capabilities and feasibility of leveraging Internet of Things based technologies, such as, microprocessors and microcontrollers within Pakistan's livestock production and management. The internet of Things can potentially allow for the scaling of small-scale rural livestock production to larger operations through cost effective and efficient livestock management through the application of IoT technologies. This paper discusses the architecture models of IoT based smart animal farms and delves into the pitfalls and advantages of applying IoT technologies in this sector. In this work we will explore the cheap sensors to monitor the internal activities of cattle farm with the aim of using these sensors as part of system to detect the important operations that need on the time response. This system should provide the feed and water as required, and control the temperature in sheds to protect the cattle being ill and on heat, and humidity level .internet connection used to connect these devices with smartphones or computers. In this paper we proposed the architecture model of IoT based smart animal farm.

Key Words : Internet of Things (IoT), Architecture Model, Agriculture activities, Sensors, Smartphone Technologies

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I. Introduction

Pakistan is an agricultural country and enrich with large livestock population. It is pivotal subsector of whole Pakistan economy. 12.3% of total exports are earned from this sector. Moreover livestock also serve the mankind in several ways, they contribute a considerable amount to our daily protein requirements in the form of milk meat, hides and provide raw material for industry. Population growth results greater consumption of resources, Pakistan needs to increase its milk and meat production at the rate of 6 to 9% annually to keep up with increased demand and increase in income. The primary objective of this research is to increase the productivity of cows through streamlining processes and general betterment of their environments which will be achieved through the use of an IoT framework.

To achieve this we need to deploy modern technology. Internet of Things (IoT) is the major technology which can be utilized in the betterment of livestock management. Modern technology for monitoring the animals in real time environment provides high productivity in diminishing resources [1] .Internet of things (IoT) is the name of daily used connected devices. In the era of advancement sensors are embedded in numerous things to handle their activities without human intervention [2]. Physical objects with internet connectivity can play remarkable role to improve the quality of life. There can be many IoT based applications , has high impact on daily life in several ways such as smart homes, health care, transport, emergency alert, or human generated hazards where human decision is difficult process [3]. IoT refers to technology that taking strong ground in wireless communication, IoT has visible impact on both domestic and business field. According to [4] in 2025 IoT will be in every node of daily life – food, paper document furniture etc.Remote Sensor Networks (WSNs), Internet of things (IoT) and cloud information are these days being significantly utilized as a part of our general public. This test requires another and brilliant remote system topology for imparting gadgets [15].

The large scale livestock production business contributes to the economy of country, at the same time it also requires robust diet care, prevention of cattle diseases and management. Economic loss due to poor management and cattle disease is terrible. According to [5] UK lost 4 million animals in 2001. For best potential each animal required individual monitoring and care for identification of abnormality in health. In the large farms it is impossible for human to visually monitor every animal frequently. People involvement makes this task costly and time consuming. IEEE802.15.4 based tags along IEEE 802.15.4 based router used for automatic data collection about feeding and drinking behavior of each animal. Animal robbery has been a principle issue in the farming segments in numerous countries, which destroyed the economy of those countries. Global positioning wireless node are used acquire the cow location information. AWSN node was design to sense the presence of thieves by the speed and movement of cow. The data of cow speed and movement is collected for investigation purpose. An irregular walk demonstrate is connected to the dairy animals′ position so as to decide the likelihood of the limit condition where we expect there is an expanded likelihood of a cow on the limit position being stolen. Continuous Time Markov Processes (CTMP) is connected to the development example of an individual cow with a specific end goal to discover the possibility that the dairy animals will be at the limit position [6].

IoT is such framework where sensor based objects connects to share their digital voice with external world. According to [7,15] sensor based strategy for temperature handling is optimal solution for environment. Most of the time it is used for monitoring data center environment, based on Arduino hardware and XBee RF modules.

그림 1. IoT의 기본 아키텍처
Fig. 1. Basic Architecture of IoT[14].

Number of IoT based projects specified their own architecture, according to their requirements. Architecture based in different subdomain of IoT depending to scope or requirement of project [8,17]. In this paper we design a savvy system which consists of temperature control system, humidity control system, and feed filling system. The collected data of the system is transmitted to graphical user interface through certain IP address with the help of Wi-Fi modem. The collected data is processed and analyzed for further analysis. The designed system can handle via GUI. This system can be handle automatically using some threshold values or manually. Our designed system considered all-important parameters of farms which are not available in already existing system.

II. Objective

Objectives of this research are to introduce sensor based model in Pakistan ,which control relate action to imperative occasions e.g. humidity and temperature, food supply management, in an effective manners via using sensor based frame work. The designed model is also affordable by small farmer along with the acceptability of large livestock farmers. To build up a model sensor framework fit for acquiring information about farm parameters. To create approach for more productiveness of dairy cows utilizing sensor based frame work.

III. Previous Work

A team [9] told method of bio-health monitoring revolves around the individual's visual observation, which weakens the nature of the inspection of the cattle's strength. In order to realize the early identification of each individual biological disease, in this enterprise, the remote sensor organization system (WSN) screens the biological encouragement behavior, drinking behavior through radio frequency identification (RFID), Zig-bee module and assistant sensors. Weakness, heartbeat and body temperature. This will ensure the continuous inspection of the cows and help predict health-related infections related to calves and expand the feasibility of different characteristics of the biological aquaculture (such as drainage system generation), reduce treatment costs, and reduce the cost of work.

Researcher [10,23] expressed that steers wellbeing observing on the feedlot is a critical yet nontrivial errand. The customary method for checking depends intensely on the cowhand's visual reconnaissance, which makes the creature checking quality very subjective and related with the conspicuousness of the watched characteristics. Keeping in mind the end goal to accomplish early recognition of every individual creature's sickness, in this paper, a remote sensor arrange framework is produced to screen the creature's sustaining and drinking practices. A directional radio wire is utilized to enable one switch to screen numerous creatures all the while, and a vitality efficient work steering technique is proposed to total the observing information. The execution of the proposed framework has been assessed through numerical investigation and reproductions. The commitments of this paper lie in the curiosity and achievability of utilizing directional reception apparatus and remote sensor arrange advancements for feedlot creature wellbeing checking.

A group of researcher [11,19-20] explained a bespoke Wireless Sensor Network framework intended

to be mounted on touching creatures and gather development data which is then coded with reference to human perceptions. In doing this it has been conceivable to align the bespoke framework with the end goal that, in instantaneous, the framework can be utilized to derive creature conduct (e.g. resting, touching, rummaging, and so forth.) remotely. At the point when combined with future sans gps positional data, this framework will give significant data to the UK farming industry, notwithstanding conquering the difficulties looked by numerous business frameworks which depend on vitality serious GPS innovation. The innovation being produced and at present being used for the work depends on Wireless Sensor Network (WSN) innovation (Radio Frequency Identification [RFID]). This innovation was initially created at liverpool John Moore's University (lJMU) to track business products to be specific gas barrels, because of the vigor of the specially appointed systems administration approach accessible to WSN frameworks in cruel conditions.

A researcher expressed [12,22] framework's key goal is to have a smarter cattle infrastructure and to implement non-intrusive wearable services to track the physiological and organic movements of cows using the Internet of Things hypothetical name Internet of Things. Each cow is adorned with a wearable gadget. Wearable devices and receiver hubs are based on the engineering of cloud devices. Wearable devices are used for the early identification of diseases, from the identification of norms, crisis care, regional tracking, changes in the timing of calving, and the identification of diseases before the appearance of visual symptoms. The sink hinges are responsible for smart lighting, strong ventilation, bright sprinkler and smoke locations, and sprinkler activation to make the frame more accurate and safer. All sensor readings will be sent to the event cloud to authorize remote access. The fact that the cloud continues to be healthy is illustrated by the facts of the individual cows, the level of the flue gas in the cultivation, the daily water use and the electricity consumption will be displayed on the online map. All information other than time and date can be used as an extension of the interpretation of the expected list to conduct promotion checks. Therefore, the general dairy cow welfare and the creation of drains will improve welfare by reducing the cost of raising pigs, guaranteeing small scale, minimal effort, high consistency and reliability.

A researcher [13,16] expressed that idea of smart city can be seen in each field of life including brilliant stopping, saving money, sewerage, squander administration, keen transport, natural checking and human services focuses. Web of things (IoT) is a usage of keen hubs that sense the information, translate, process and give reaction inside a required time in a system. The capacity to implant detecting gadgets into genuine condition empowers the change of savvy condition. In any case, there is an almost no useful utilization of IoT foundation, in actuality compartment.

IV. Methodology and Experiment Design

In designing the smart framework of dairy farm first step is to design the flow chart of entire model to describe basic functionality of model and flow of work. Flow chart is modified and changed according to user requirements if needed. Flow chart shows in designing model first we work at the hardware level. And then move to software level after that we integrated both designed module. After successful integration data acquisition starts and all gathered information is show on ThingSpeak API [18,21].

We designed the system architecture that satisfied the all defined requirements. This model with little modification can be used at different farms. This model enables farmers to handle all activities remotely.

The figure shows the architecture we proposed. Message routing module is required for establishing

communication between ThingSpeak and IoT devices. At the same time, typical smart phones can use Wi-Fi and Bluetooth to communicate with IoT devices. Therefore, we designed an application framework to connect these communication routes and process messages according to the intentions of service providers and users. The framework we propose consists of following functions.

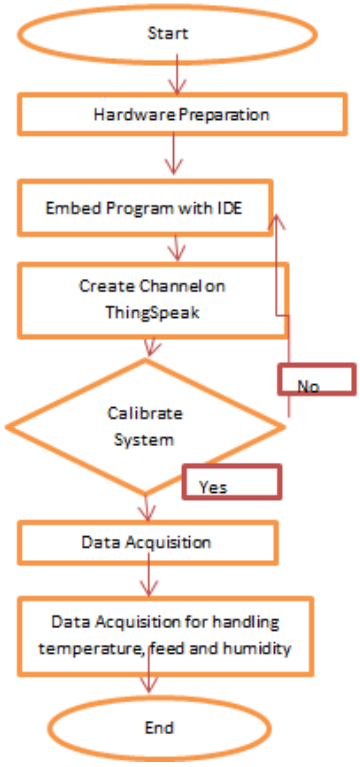

그림 2. 설계된 모델 기능의 플로우 차트
Fig. 2. Flow chart of designed model functionality

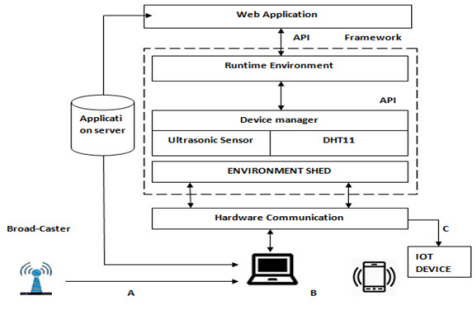

그림 3. 시스템 관리
Fig. 3. System Management

1. Physical System Design

The system designing module is divided following into two parts

1) hardware design

2) software design

2. Hardware Design

Hardware design is combination of two modules:

- Embedded module
- Ethernet communication module

The primary module comprises of the temperature and humidity sensor and ultrasonic sensor and two microcontrollers, which are placed in shed that detects the parameters of framework. WIFI connect is used to transmit the collected data via Ethernet using UDP protocol. System collects the information of connected dairy farm keep up the record and play out the point of view activity. The embedded module collects the information of animal farm and maintain the record for further processing and perform the relative function in real time environment.

It works in two modes

1) Automate mode

2) Manual mode.

If the framework in programmed mode, a threshold value is stored in the system, it operates the function according to that value and continuously giving feedback to GUI via Wi-Fi connection. If system is set in manual working mode, devices are controlled by using buttons in GUI. The sensor based creature cultivate comprise of subsystem, Bio gas controller, feed controller, IP cameras, Incubator and fire detection etc.

A. Feed control system

Feed control system consist of and feed storage tank .Ultrasonic sensor embedded into it, detect the level of feed in tank , when feed level goes down to predefined value it turn on the valves if it is in automatic mode or it sends back the feedback to user to turn on the valves if it works in manual mode. The

system block diagram is show in figure 1

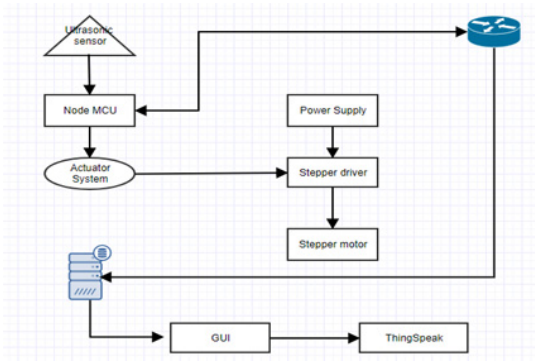

그림 4. 피드 제어 모듈
Fig. 4. Feed control module

B. Temperature Control System

Humidity and temperature are common parameters measured in many places such as farms, greenhouses, medical, industrial, home and office. We are using the Arduino for humidity and temperature measurements and displaying data on the ThingSpeak. In this Internet of Things project, we will use ThingSpeak to monitor humidity and temperature over the Internet, and we will use the ThinSpeak server to display current humidity and temperature data over the Internet. It is accomplished through data communication between Arduino, DHT11 sensor module, ESP8266 WIFI module. Celsius and Percent Hygrometers display ambient temperature and humidity and send it to the ThinSpeak server for real-time monitoring anywhere in the world.

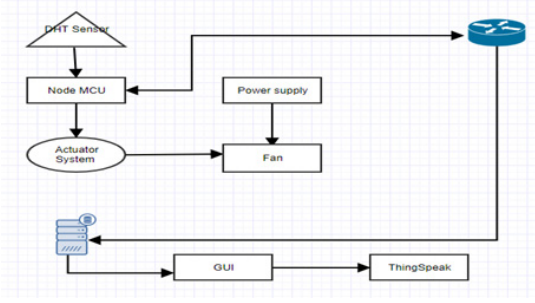

그림 5. 온도 및 습도 조절 모듈
Fig. 5. Temperature and humidity control module

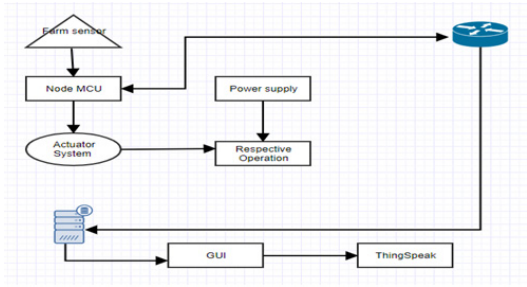

그림 6. 설계된 시스템의 완전한 모델
Fig. 6. complete model of designed system

2. Work and ThingSpeak settings

The IoT-based project is divided into four parts. The first is the humidity and temperature sensor DHT11, which is used to detect humidity and temperature data. Secondly, NodeMCU extracts the DHT11 sensor's data into appropriate percentages and degrees Celsius and sends it to the Wi-Fi module. Third, the Wi-Fi module ESP8266 sends data to ThingSpeak's servers. Finally, ThinSpeak analyzes the data and displays it in Graph format.

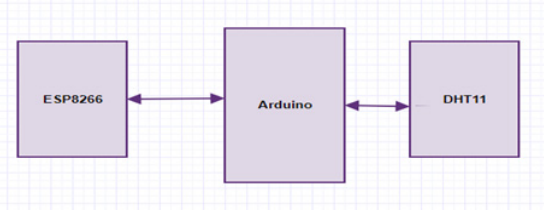

그림 7. ThingSpeak 설정
Fig. 7. ThingSpeak setting.

ThingSpeak provides very good tools for Sensor based IoT- projects. By using the ThingSpeak website, we can monitor our data from anywhere via the Internet, and we can use the channels and web pages provided by ThingSpeak to control our system over the Internet. ThingSpeak 'collects' data from sensors, 'trigger response' analyzes and visualizes 'data and 'behavior'.

Circuit description

NodeMCU with ESP8266 is connected with dth11

sensor for humidity and temperature and ultrasonic sensor for remaining feed directly on serial monitor and ThingSpeak site.

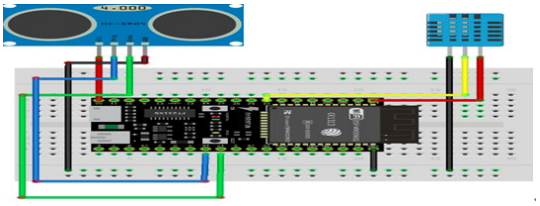

그림 8. 하드웨어 장치
Fig. 8. Hardware Device

V. Results

Intelligent systems for controlling temperature, humidity and feed are developed using two software platforms, ThingSpeak API. The Arduino IDE is used as an embedded program for microcontrollers. The display data collection on the PC works on the ThingSpeak API platform. This intelligent system is designed using ThingSpeak and simulation tools 4.7.2 IDE

Arduino's integrated development environment is a cross-platform application written in the Java language. It comes from the IDE for programming languages and wiring projects. Arduino programs are written in C or C++.

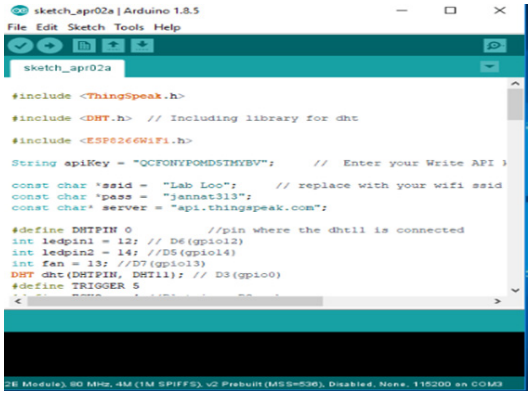

그림 9. 실험보기
Fig. 9. Lab View

Thingspeak API

The Thingspeak API is used as the integrating platform for acquiring, processing and transmitting data.It provides further Matlab analysis functionality on acquired data. Temperature results

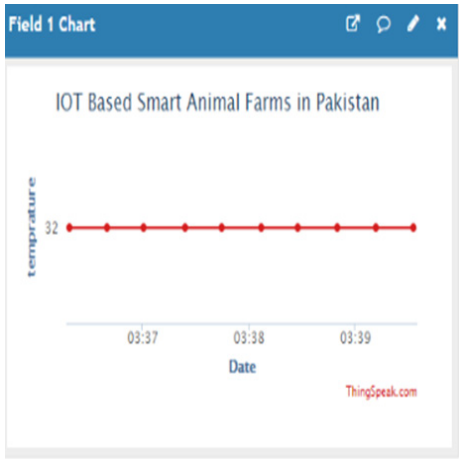

그림 10. 온도 조건
Fig. 10. Temperature Condition

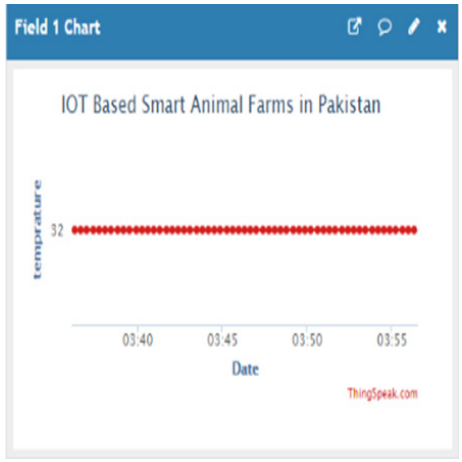

그림 11. 온도 결과
Fig. 11. Temperature result

In order to for proper condition of animals, the shed should be controlled for temprature on range 30-40C%.the mention. At this temperature their productivity like milk, meat etc, at maximum. After 40C cattles become heat stressed.

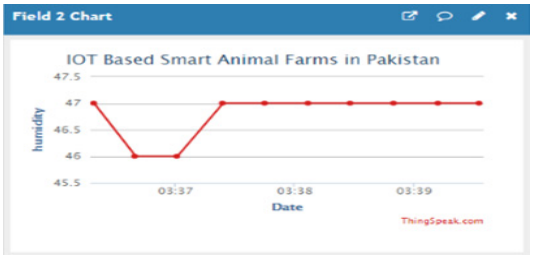

그림 12. 창고 내의 습도 조건
Fig. 12. Humidity Conditions within a Shed

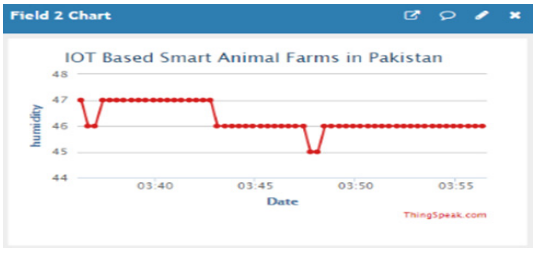

그림 13. 습도 조건
Fig. 13. humidity condition

The highest value of temperature humidity index is displayed. In order to get proper condition, the SHED should be controlled for humidity on range 80-90%.

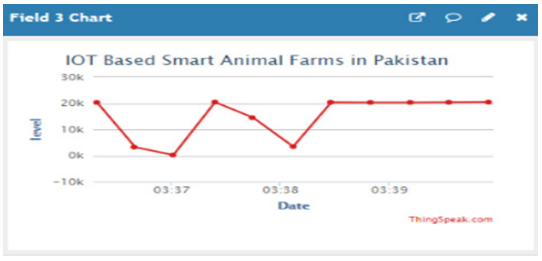

그림 14. 드럼의 급지 레벨
Fig. 14. Feed level in a drum

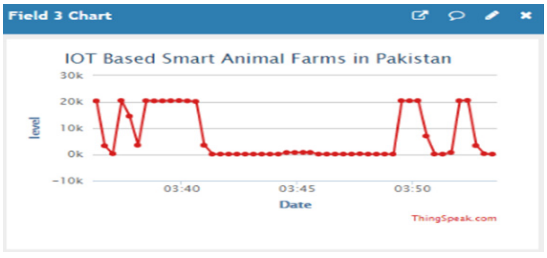

그림 15. 먹이 레벨
Fig. 15. Feed level

When the predefined level of feed goes down, the valve's turn on and supply of feed started.

All collected data of sensors is stored in excel sheet which can be utilize for further analysis and processing to evaluate the efficiency of system.it can also be used to take important decision about the condition of animals. Most situations, animal numbers and production will be controlled by feed supply.

All sensors data is stored in excel sheet. This collected data can be analyzed for further details and making important decision, and to know about the previous situation which required attention.

Automatic mode control system

In automatic mode thresh hold value is added in a system, when system reaches at that level it starts handle condition smartly.

표 1. 온도 대 습도 데이터
Table 1. Temperature verses Humidity Data

No	Measuring			Condition	
	temperature	humidity	feed	Fan	valve
1	>40	>90	>40	On	Off
2	>30	>80	<40	On	On
3	<30	<80	<30	Off	On

It does not need to wait for user response. This situation is suitable in emergency condition where on the time response is required to handle situation.

VI. Conclusion

The designed model handle all complex and on the time responsive activity of livestock. The purposed model is organized elements into components: identification, information sharing, management, handling of activities on the time. The designed system reduces economical loss and labor cost to maintain all the activities. More accurate data about the internal condition of farm is shared to take important decision and further processing done on collected data. In this paper we have designed IoT based smart livestock

farm. It's a cost effective system is its cost is 50000PKR.It continuously monitor the parameters of animals and minimize the change of mistake in management, and reduces the maintenance cost. It is best suitable for domestic to large farms. This can be handled both automatically and manually. With little modification this can be applicable to different farms. The "Farm Smart Framework" strives to demonstrate improvements in best practice in any livestock management work. Keep in mind the goal of ensuring the proposed model's capabilities and strengths.

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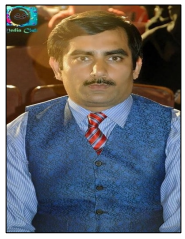

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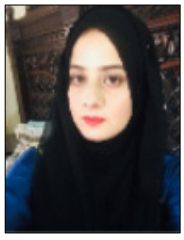

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