Smart Farm: Extending Automation To The Farm Level

Drishti Kanjilal, Divyata Singh, Rakhi Reddy, Prof Jimmy Mathew

Abstract: With the advent of technology, the world around us is getting automated. Automatic systems are being favored over manual systems, as they are energy efficient and minimize the need for tedious manual labor. With agriculture being the primary economic sector of India and other developing countries, it is essential to automate it in order to increase efficiency. A typical farm requires a lot of labor. Automation can proficiently moderate the amount of manual labor, and make farming easier and faster, leading to more agricultural growth. The concept of automation is extended to the agricultural farms and farm houses. Numerous aspects of the farm are automated, which include auto-irrigation cycles and secure temperature controlled enclosures for livestock and farm products. In our paper, we implement automatic lighting system, auto-sprinkler system, in-house temperature control and security for farm houses. As temperature and motion sensitive devices will only work when required, such a system conserves energy effectively. The paper also presents features to enhance the security of the farm. Energy efficient farm automation is the need of the hour in an agro-based economy.

Index Terms: animal farming, embedded control system, farm house automation, farm security, mobile connectivity, remote monitoring, smart farm

1 INTRODUCTION

Automation is the use of machines, control systems and information technologies to optimize productivity in the production of goods and delivery of services. Automation is the answer to India's pursuit for being a world-class industrial competitor. The Indian farms are slowly beginning to feel the stimulus for the instrumentation, control and automation industry. Indian automation is advancing at a fast pace, yet it is one area that can never be achieved and admired – it is something that needs constant innovation and identification of trends in technology, and the innovations that thrust the implementation of automation in other countries. India, as one of the world's fastest growing economies based on agriculture and farming, has not taken to technology at a rather quick pace.

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India's growing foreign trade, rising internal consumer demands, infrastructural growth, as well as the revival from the economic slowdown, has only given the entire financial set up a new lease of life. India has now realized the importance of developing its own strength with automation, instead of being the smaller ally of the world. A large number of farmers in India depend on animal husbandry for their livelihood. India has the world's largest dairy herd, composed of cows and buffaloes, at over 304 million. It stands first in milk production, with 112.5 million tons of milk produced in 2009-2010 [2]. India is also the third largest egg-producer in the world, at over 180 million eggs being produced every day or 65.7 billion eggs for the year 2011-12, and the world's sixth largest producer of poultry meat [2]. India is the top global exporter of buffalo meat, and is also the fourth largest exporter of soybean meal, an important ingredient in commercial feed for farmed animals [2]. Present farming practices require a lot of redundant manual labor, which is tedious as well as strenuous. It is time consuming to manually look after the whole farm and livestock. Automation provides a solution to some of these problems. However, automation is still under developed in Indian farms, which constitute for a vast majority of the Indian economy. Automation is a single solution to achieve quality as well as the environmental balance. Apart from this, the growing interface, optimization, quality control and product tracking are a few advantages, that India has now estimated to receive from higher automation controls. A number of automation has been implemented in farms abroad. For example, automatic milking of cattle has been introduced in Europe. The aim has been to measure the effects of converting from conventional parlor milking to milking all cows by an automated milking system (AMS) [3]. Automatic hatcheries are also in use for incubating eggs and maintaining health of newborn chicks. It also includes counting and boxing of eggs, weighing of chicks and eggs and removal of bad eggs [4]. This paper aims to raise awareness that there are now alternative ways to support farming. Modern farming techniques seek to diminish human involvement, escalate yield, and improve animal health. Economics, quality and consumer safety, all play its role in how animals are raised in the farm. The paper attempts to extend automation to the farm house level, by incorporating sophisticated home automation techniques, and adjusting them to suit a modern day farm. We describe the proposed system in the next section, followed by

a short discussion and conclusion.

2 PROPOSED SYSTEM

Features of the farm house automation system are:

- Automatic lighting
- Climate control
- Fire and smoke detection
- Auto lock and release doors
- Humidity and moisture control
- Pre-set wash times
- Feeder control
- Remote mobile connectivity

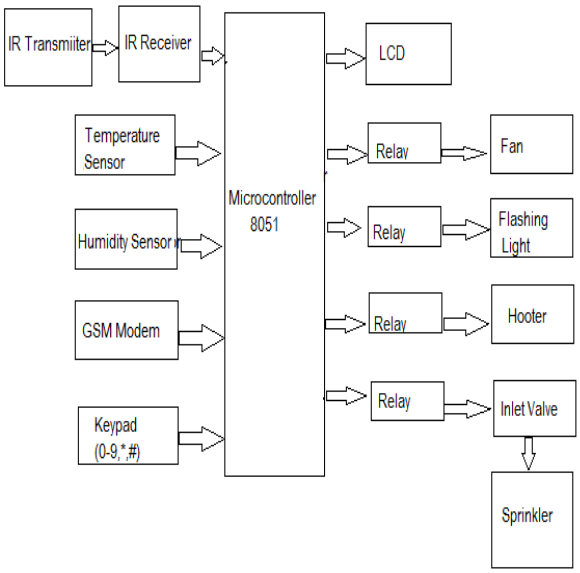

Fig.1. Block diagram for integrated system

2.1 Automatic light switching system

Bidirectional counters are used to count the number of people entering a room in the farm house. The lights are automatically switched off on count zero. The system can also be modified to be timer dependent. In this case, lights will only be switched on when animals are awake and in their enclosures. In the farmhouse, lights will switch off at a preset time. An up-down counter that can change its state in either direction is used to count the number of people entering and exiting the farmhouse rooms. The up mode is used to count number of people entering while the down mode is used to count the number of people exiting the room by decrementing the counter value. The IR sensor is used to detect motion. When a person exits or enters ,it detects the interruption and runs the counter in either up or down mode based on selector setting. The count is displayed on an LCD display. In this circuit, as showed in Fig.2, a pair of infrared (IR) sensor modules is used, for both up and down counting. The pair of IR sensors are horizontally placed at a distance such that, whenever an interruption is observed by the first IR sensor, it increments the counter value. Similarly, when the second sensor detects an obstacle, the count is decremented. When the count value is more than zero, the lights are switched on. When the value becomes zero, the lights are automatically switched off, thus conserving energy.

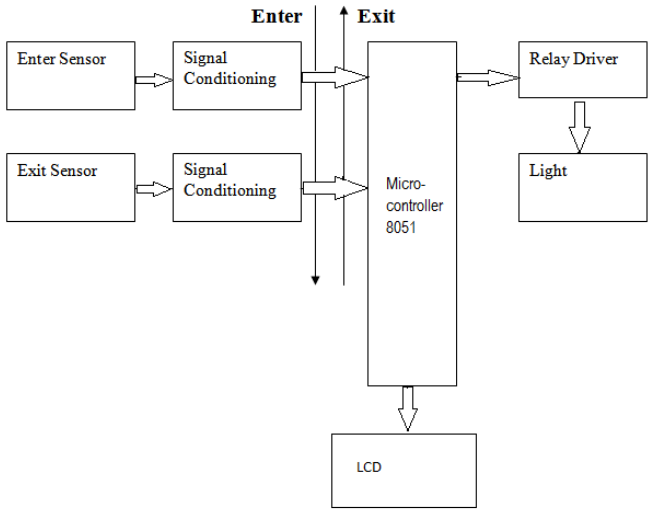

Fig.2. Block diagram for automatic light switching

2.2 Climate control system

An exhaust fan or a heater will get switched on automatically depending on real time readings from a temperature sensor. An 8-bit ADC is sufficient to provide required accuracy for in-house temperature readings. Depending on whether cooling down or heating up is required inside the farm house; the microcontroller decides to switch on the exhaust fan or the heater respectively. It has different configuration options, like temperature, humidity, auto-door open and close timings, etc. It provides comfortable conditions for livestock without tedious manual monitoring, along with energy conservation. The system can also be used for storage of farm products like milk and eggs, which require ambient temperature conditions to prevent spoilage. In addition, the system can also be used in hatcheries to store eggs at required temperature for artificial hatching to ensure quality control. The temperature output can be preset with a keyboard interface to the microcontroller based system. The system has also a humidity sensor to decide whether to humidify or dehumidify the hatchery.

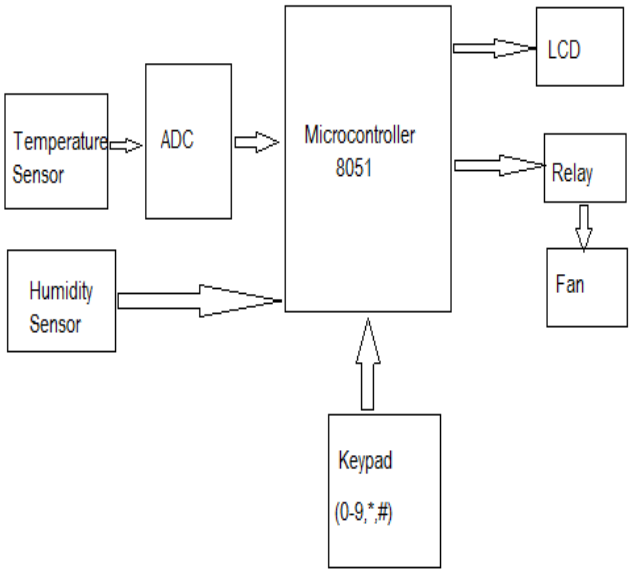

Fig. 3. Block diagram for climate control

2.3 Fire and smoke detection

It has a single independent input to detect any fire or smoke indication from the sensor unit, and sets an alarm or an indication to alert people. The sensor will detect presence of smoke and generate an interrupt to the microcontroller. This will switch on the exhaust fan and a sound alarm with flashing light. A GSM module is interfaced, so that the owner can be easily intimated about the fire in his mobile phone via an SMS. The alarm can be reset with the keypad interface.

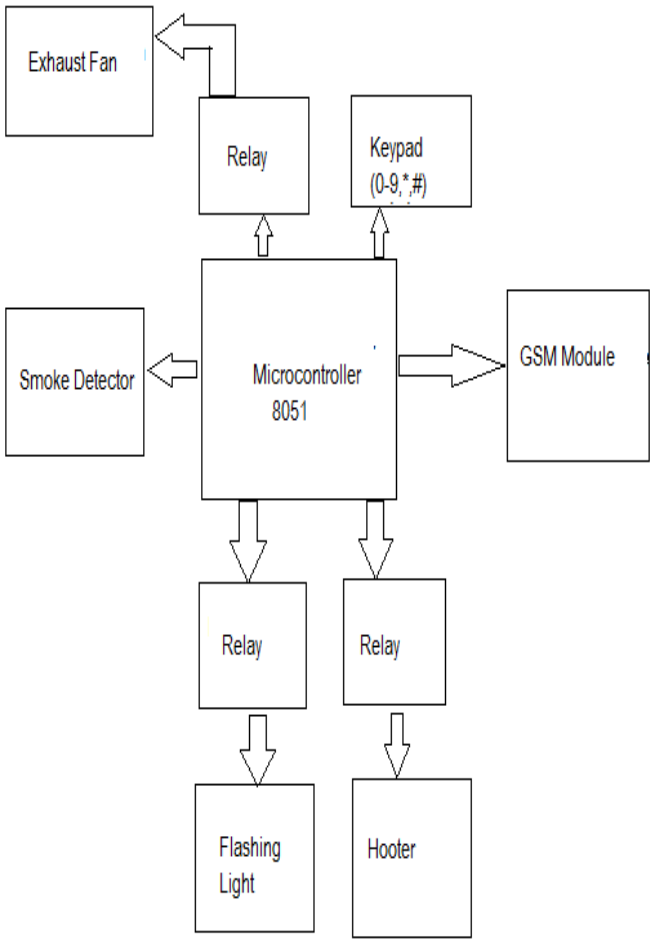

Fig. 4. Block diagram for fire and smoke detection

2.4 Auto lock and release doors

In this part, we have ensured a safe locking mechanism for the different animal enclosures of the farm. This lock can be opened and closed with the help of an alphanumeric password, which is stored and validated using a keypad. This ensures security of the farm animals, and prevents them from running loose. An auto door opening system, based on the time of the day is also incorporated. The doors to the animal enclosures are programmed to open at specific times in the morning. The opening time for each enclosure is ordered based on type of animal [4][5].

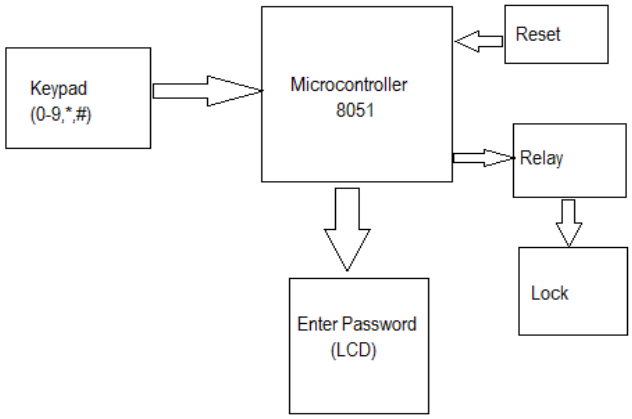

Fig. 5. Block diagram for auto door lock control

2.4 Humidity and moisture control

An additional humidity sensor circuit is used to detect a change in humidity of the surroundings and generate an interrupt signal to the micro-controller, at which the sprinklers are activated with the help of a digital solenoid valve [6]. In the present scenario of water shortage, this system is an efficient and simple way of conserving water used in the farm. Humidity sensor is also used in hatcheries to maintain ambient temperature for artificial hatching. New born chicks require specific humidity and temperature conditions for their survival and healthier growth.

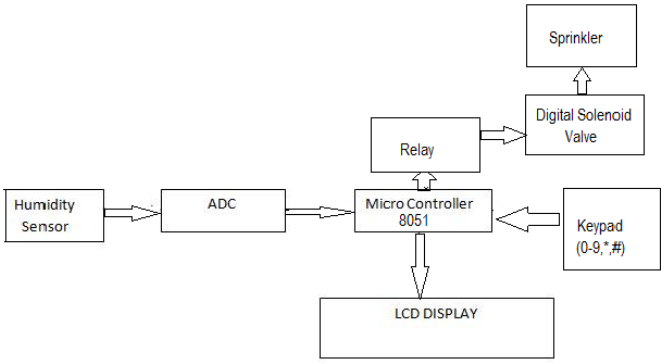

Fig.6. Block diagram for humidity control and sprinkler system

2.5 Preset wash times

A timer based sprinkler system will be installed in the pastures. The regular watering will ensure greener pastures. This will provide good quality food supply for the cattle. A similar system can be implemented inside to clean the farm house and animal enclosures at fixed times.

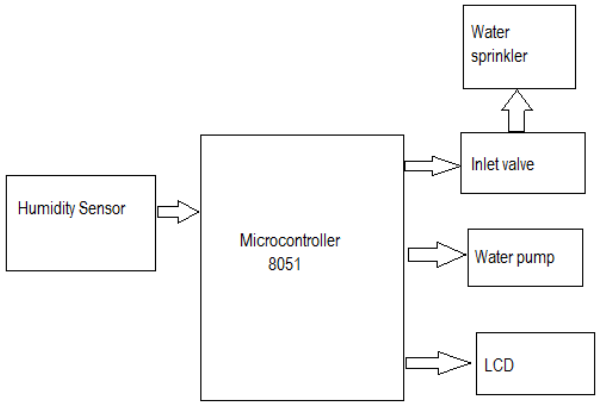

Fig. 7. Block diagram for in-house sprinkler system

2.6 Feeder control

It is hard to feed animals on schedule, yet livestock thrive when fed on time. Timed setups coupled with an automatic grain dispenser are used in this automated system. A galvanized steel, battery-operated feeder is engineered to deliver individual flakes of hay up to configured number of times [6]. This, plus its close-to-the-ground manger, is designed to simulate natural grazing activity. It can be stall-mounted or fence-mounted, and used to feed virtually any sort of livestock that eats hay. It can be programmed to dispense one to five cups of feeds, up to 12 times per 24-hour period. It is a watertight, rodent-proof, stainless steel unit which can be used indoors or outdoors [6].

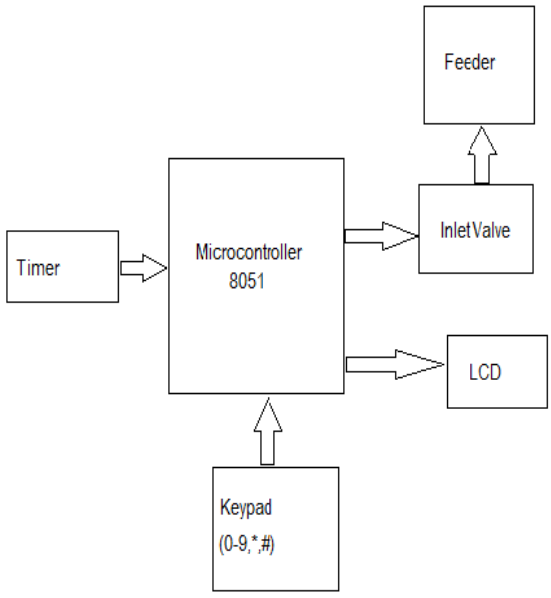

Fig. 8. Block diagram for feeder system

3 Discussion

This project will revolutionize farming in the country by automating the traditional farming practices through developing indigenous technologies and equipment. It aims at converting even small animal farms into high poultry and dairy yielding farms. This is achieved by automating the animal husbandry practices, and providing energy efficient habitable animal enclosures. Each enclosure also provides security. Remote monitoring can also be added to the farm with the help of GSM technology used in mobile phones. The system will notify the farm owners on their mobile phones, and allow them to control the automated system. The benefits include minimizing manual labor and improving the living standards of the livestock. This will improve the quality of the poultry, dairy and other farm products. Our control system requires no maintenance cost, if placed in a safe location. Also this system doesn't require much power to operate. The system becomes dysfunctional on power failure which can be overcome by incorporating alternative energy sources, or with a simple battery backup. The estimated cost of automation at basic level will be 1500 INR.

4 Conclusion

This project has attempted to introduce an efficient smart farm system. It has incorporated automation into various aspects of the farm. A new design for animal enclosures is put forward to improve the living conditions of livestock, as well as reduce manual labor. It includes an automated light, temperature, humidity and sprinkler system. The humidity and moisture control mechanisms make sure the animals are comfortable in the enclosures they are kept in, by adjusting the settings as per requirement. The system is made secure through a password protected digital lock which ensures the safety of animals in their enclosures. The auto lock and release doors can be used to facilitate the incoming and outgoing livestock. Smoke detectors are included to prevent fire hazards which if not detected on time could lead to loss of livestock and valuable resources. The feeder control system times the meals of the animals and reduces the human labor in the process. The system is energy efficient as it helps conserve resources like energy, water and reduces manual labor to a great extent. A GSM module is interfaced to connect all aspects of the modern automated farm. The farm owner has easy access to the system and can control it remotely through his mobile phone. This paper demonstrates that with the integration of information technology to the farm environment, systems and appliances will be able to communicate in an integrated manner. This will result in convenience, energy efficiency, and quality and safety benefits.

Acknowledgment

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