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## **Calf Feeding Machine**

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## **Abstract**

This project aims to develop a calf feeding machine to streamline the process of feeding calves in agricultural settings. Calf rearing is a critical aspect of livestock farming, and efficient feeding plays a pivotal role in the health and growth of young animals. The significance of this project lies in addressing the challenges faced by farmers in ensuring consistent and timely feeding for their calves, thereby optimizing animal welfare and farm productivity.

The calf feeding machine project encompasses several critical aspects. Firstly, it focuses on automation to streamline the feeding process, reducing manual labor for farmers. By designing a machine capable of automatically dispensing milk at regular intervals, it aims to enhance efficiency and consistency in calf rearing practices. Additionally, the project emphasizes the development of a user-friendly interface for easy operation and monitoring of the feeding process. Integrating intuitive controls and monitoring systems, it aims to empower farm workers to efficiently manage calf feeding tasks.

The methodology for developing the calf feeding machine involves several key steps. Firstly, it includes the integration of a water tank equipped with a heater and sensor to monitor both the water level and temperature. A heat clock mechanism ensures that the water reaches and maintains a precise temperature crucial for calf health; the system will not operate unless this temperature threshold is met, thus remove the risk of stomach illness in the calves. Secondly, the milk tank incorporates plates driven by motors to facilitate the introduction of milk powder into a mixer. The amount of milk dispensed is regulated by the milk level sensor, which controls the flow of water entering the mixer, ensuring the correct milk concentration for the calf's nutritional requirements. The mixing component of the system includes a level sensor to monitor the milk level within the mixer. This ensures that the appropriate amount of milk is consistently available for dispensing to the calves. Additionally, a mixer and heater are integrated into the system to maintain the milk at precisely the right temperature.

# Chapter 1

## Introduction

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### 1.1 General background

Calf rearing is a vital component of livestock farming, with efficient feeding practices being crucial for the health and growth of young animals. Traditional manual feeding techniques can be inconsistent and labor-intensive, which may result in health problems and less-than-ideal growth. A solution is provided by automated calf feeding, which ensures precise, regular, and accurate feeding schedules. The goal of this project is to create a calf-feeding machine that uses cutting-edge technology and a user-friendly design to improve animal welfare, increase farm output, and speed up the feeding process.

### 1.2 Objectives

The primary objective of this project is to develop an automated calf-feeding machine that reduces the manual labor required by farmers, ensuring a consistent and efficient feeding process. To address problems associated with irregular feeding times and volumes, the system automates milk delivery at regular intervals to enhance calves' general health and growth rates.

The project also aims to provide a user-friendly interface for simple operation and monitoring. This includes implementing real-time monitoring systems and user-friendly interfaces to help farm workers efficiently handle feeding duties. The ultimate objective is to improve animal welfare and farm output by offering a precise and reliable feeding solution.

### 1.3 Significance or importance of your work.

This project lies in its ability to use automation to transform the methods used to raise calves completely. The calf feeding machine solves typical problems including inconsistent feeding times and improper milk concentrations, which can negatively impact calf development and health, by offering an effective and constant feeding plan. In addition to increasing animal comfort, this automation boosts farm productivity and enables farmers to better manage their time and resources. Moreover, the integration of a user-friendly interface and monitoring system empowers farm workers to manage feeding tasks with ease, reducing the likelihood of human error. Enhancing this further, the ability to control the machine through a remote website offers unprecedented convenience and flexibility. Farmers can monitor and adjust the feeding process from anywhere, ensuring timely interventions and better overall management. The project contributes to the advancement of precision farming technologies, promoting sustainable and productive livestock farming practices. Overall, this work aims to set a new standard in calf rearing, benefiting both the animals and the farmers who care for them.

### 1.4 Organization of the report

Our report is meticulously structured to guide you through the development and implementation of the Calf Feeding Machine project. We begin with an **Introduction** that highlights the significance of efficient calf rearing in agriculture and outlines the necessity for automation in feeding practices. Next, we present the **Objectives** of our project, detailing the goals of reducing manual labor, ensuring consistent feeding, and enhancing farm productivity and animal welfare. The **Technological Framework** section outlines the key technologies integrated into our machine, including automated dispensing mechanisms, sensors, heaters, and the user-friendly interface. In the **Implementation** section, we describe the step-by-step development process, from initial design to final assembly, emphasizing the integration of a water tank, milk mixing system, and temperature controls. The **Remote Control and Monitoring** segment introduces the capability to control the machine through a remote website, providing farmers with enhanced flexibility and oversight. We then outline the **Safety Measures** that ensure the system operates reliably and maintains the health and safety of the calves, such as temperature control and milk concentration regulation. In the **Results and System Efficiency** section, we analyze the performance of the calf feeding machine, discussing its impact on farm operations and calf health, supported by data and observations from field tests. Our **Conclusions and Future Work** summarize the achievements of the project and suggest potential improvements and innovations for future iterations of the machine. The report concludes with **References**, acknowledging the foundational research and technologies that informed our project.

Join us as we explore the integration of automation technology in calf rearing, setting a new standard for efficiency and animal welfare in the agricultural industry.

# Chapter 2

## Theoretical Background

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### 2.1 Automation and Control Systems

Control systems engineering ideas are applied to farm automation, especially in livestock management, to improve accuracy and efficiency. The calf feeding system gathers data in real time on temperature, water level, and milk levels using a variety of sensors. The uniformity and quality of feed must be maintained, and this requires these sensors. The automated dispensing mechanism is governed by control theory, which guarantees accurate milk supply in terms of both timing and quantity. This combination of software and hardware is an example of embedded systems, in which devices are made to carry out particular control tasks on their own.

### 2.2 Thermal Dynamics and Mechanical Engineering

When developing the heating components of the calf feeding machines, thermal dynamics play a crucial role. To guarantee that the milk is continuously kept at the ideal temperature for calf health, it is imperative to comprehend the basics of heat transfer. The characteristics of the materials used to build milk and water tanks that maximize heat transfer and retention are also covered in this section. The mechanical parts—motors and actuators, for example—are also included. These parts are essential to the automated mixing and dispensing procedures since they depend on the exact control and dependability of electromechanical engineering concepts.

### 2.3 User Interface and Remote Monitoring

This section explores the design of user-friendly controls and real-time monitoring systems that enable farm workers to oversee the feeding process effectively. Special attention is paid to the remote website control capability that allows farmers to remotely

monitor and adjust the machine's operations from any location. This remote access is made possible by web-based technologies and secure communication protocols, guaranteeing dependable and easy-to-use management of the calf feeding system.

# Chapter 3

## Methodology

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### 3.1 Introduction

This chapter outlines the methodology adopted for the design and implementation of Calf Feeding Machine hardware project. The methodology encompasses adherence to engineering standards, consideration of design constraints, the design process followed, tools and technologies utilized, and project management strategies employed to ensure successful project completion.

### 3.2 Standards and Specifications (Codes)

We managed to follow Engineering standards in Calf Feeding Machine project, going with Agile Method with weekly meetings and discussion about each of the features, Starting with the machine mechanics ending by the factory testing and modifying, we built the machine step by step, each step as a feature.

### **3.3 Constraints**

#### **Economic and budget constraints:**

Financial constraints may have an impact on the project's size and the tools utilized in it. This is because the machine's size is determined by the volume of milk produced in a certain amount of time, which increases the need for electronic components like sensors and other parts and raises the project's overall cost.

## **Security and Accessibility Constraints:**

Because of the difficult conditions in Palestine. The continuous fighting in the area is one of the main obstacles since it endangers people's safety and interferes with daily life. Our ability to concentrate and work regularly on the project is hampered by the unstable environment created by the nearby war.

Our progress is further hampered by the bad road conditions and the ensuing transit issues. Our inability to commute to the university daily restricts our access to necessary materials, lab equipment, and possibilities for peer and faculty collaboration. To continue moving the project forward in this scenario, alternate strategies like remote collaboration and utilizing internet resources are required.

## **Project compilation limitations (Power):**

Due to differences in hardware components within the project and their varying power consumption, there was initial variation in power consumption. This led to challenges in power harvesting, especially since the components used operate across multiple power thresholds. This endeavor represents our inaugural experiment in building such a device, which involves simultaneous management of these distinct power requirements. To be clear, some components require a 220-volt source, including the water heater and mixer. Conversely, some elements operate at 5V, such as the display, while others operate at 3.3V, exemplified by the ESP. As a result, during the assembly phase, we used a versatile power supply capable of delivering diverse voltage outputs.

## 3.4 Tools and Technologies

### Arduino Mega

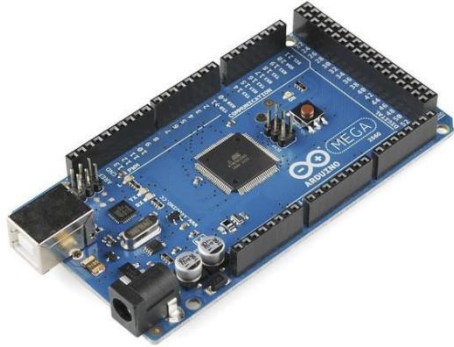


Figure 3.1: Arduino Mega.

In our project, we have chosen an Arduino Mega 2560, a microcontroller board from the Arduino family. It has more functionalities than the original Arduino board and makes use of the ATmega2560 chip. It features numerous communication interfaces like UART, SPI, and I2C, 54 digital I/O ports, 16 analog inputs, and may be powered by USB or an external source. It is frequently utilized in tasks like robotics and automation that call for more I/O connections and memory. We used the digital ports for writing and reading on some of the components, and we also used the serial ports to communicate with other components such as the ESP, i.e. we used 3 serial connections. We used SCL and SDA pins to connect the LCD driver, and the rest of the parts were connected to the digital ports.

## LCD 20X4

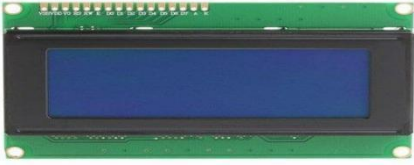


Figure 3.2: LCD 20x4.

It is a tool for visual output and information display. We used it to display writings on it so that the user can easily control the machine. It was controlled by an I2C driver.

## LCD Driver module with I2C interface



Figure 3.3: LCD Driver module with I2C interface

A specialized electronic component designed to make it easier to integrate a liquid crystal display (LCD) into electronic systems is an LCD driver module with an I2C interface. 4 wires GND, VCC, SCL, and SDA come out of it. VCC is connected with 5 volts and SCL, SDA from the driver with SCL, SDA from Arduino.

## Flow sensor



Figure 3.4: Flow sensor.

The integration of a flow rate sensor, which serves a dual purpose. Firstly, it ensures the continuous monitoring of water flow, which is essential for the operation of the machine. Secondly, and most importantly, it acts as a protective measure for the water heater element. The sensor confirms the presence of water flow before the heater is activated. This precaution is vital as operating the heater without water can lead to overheating and potential damage. Therefore, the inclusion of the flow rate sensor not only enhances the reliability of the system but also significantly extends the lifespan of the water heating component by preventing dry-running conditions.

## PT100

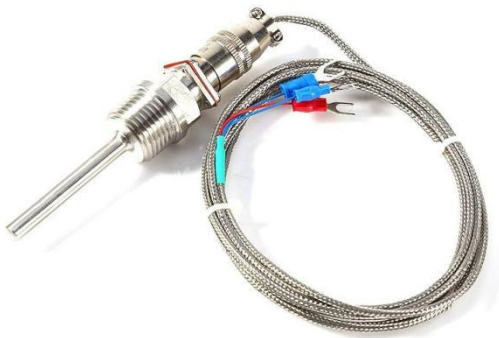


Figure 3.5: PT100.

The integration of a PT100 temperature sensor to precisely measure the temperature of the water before it is dispensed to the calves. The PT100 sensor, known for its high accuracy and stability, ensures that the water provided is within a safe and comfortable temperature range for the calves. This is essential for promoting optimal digestion and health.

## Power Supply



Figure 3.6: Power Supply.

A computer power supply converts electrical power from an outlet into usable energy for a computer's components. It typically provides DC voltage outputs to various components. Modern power supplies also incorporate efficiency features and safety mechanisms to ensure stable and reliable operation.

## IR Sensor

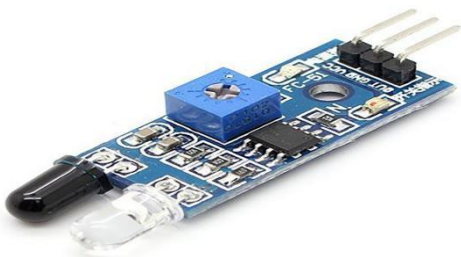


Figure 3.7: IR Sensor.

An IR (Infrared) sensor is a device that detects infrared radiation, often used for proximity sensing, object detection, or temperature measurement. It works by emitting and receiving infrared light, and changes in the received signal indicate the presence or absence of an object or variations in temperature. IR sensors are commonly employed in applications such as automatic faucets, remote controls, and security systems.

## **RTD (Resistance Temperature Detector) transmitter**



Figure 3.8: RTD transmitter.

In the automated calf feeding machine, a PT100 temperature sensor is interfaced with an RTD (Resistance Temperature Detector) transmitter to accurately gauge the water temperature. This setup enables the transmission of precise temperature readings in a format that the Arduino Mega can easily process. The RTD transmitter converts the resistance measurements from the PT100 sensor into a standardized output signal, ensuring reliable and accurate temperature data. This data is crucial for the control system, which relies on it to adjust the heating elements, ensuring the water is at a safe and optimal temperature before being dispensed to the calves. By using this combination of PT100 sensor and RTD transmitter, the project achieves a high level of precision in temperature management, enhancing the effectiveness and safety of the calf feeding process.

## Fuse



Figure 3.9: Fuse.

Safety and equipment protection are prioritized through the strategic use of two fuses. The first fuse is placed in the circuit supplying power to the Arduino Mega, safeguarding it against potential over-current that could arise from faults in the connected input devices. This fuse acts as a critical protective barrier, ensuring that any excessive current does not reach the micro-controller, thus preventing damage and maintaining system stability.

The second fuse is integrated into the power line of the output devices connected to the Arduino. This setup protects the micro-controller from any anomalies such as short circuits or overloads originating from the output side, including motors, heaters, and sensors. By isolating the Arduino from these potential issues, the second fuse plays a vital role in maintaining the overall operational integrity and longevity of the system.

## ESP32

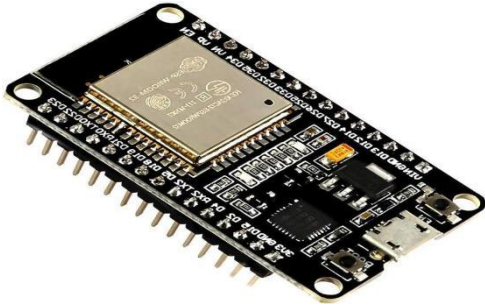


Figure 3.10: ESP32.

The ESP32 is a versatile micro-controller developed by Espressif Systems, known for its dual-core processor, built-in Wi-Fi and Bluetooth capabilities, making it ideal for IoT projects. With a rich set of peripherals, low power consumption, and a cost-effective design, the ESP32 has gained popularity for a wide range of applications, from home automation to industrial IoT solutions.

## 3.5 Final Design of The Project

### 3.5.1 Design Process

As shown in the picture, the final design of the “Calf Feeding” project appears, where all components are shown: the control panel, water valves, temperature control clock, manual operation switch, mixer, milk tank, water heater, IR sensor to calculate the height of the water inside the mixer, and the white box. In the middle of the machine is a secondary heater for the milk powder to keep the milk at the optimum temperature for the calves.



Figure 3.11: Calf Feeding Final Design.

To ensure the main heater operates safely and avoids damage, it should not function without water flow, as this could cause it to burn out. To address this, a start mode was created to check for water availability before the system runs. The start mode involves adding a small amount of water to confirm its presence, allowing the system to proceed with operation only under safe conditions.

**Two conditions must be met for the system to run:**

- 1- The temperature must be above the selected threshold (default is 35°C).
- 2- The infrared (IR) sensor must detect more than 18 cm, indicating an empty mixture tank.

**When these conditions are satisfied:**

- The milk motor will activate, moving the blades to push milk.
- The water valve will open, allowing water to flow based on the pressure difference until the IR sensor detects 14 cm of liquid.
- The mixing mechanism will operate for 20 seconds every 120 seconds to ensure proper mixing.



Figure 3.12: Control Unit Design.

**The system includes the following buttons for operation and adjustment:**

**Start Button:** Initiates the system.

**Stop Button:** Halts the system.

**Auto Button:** Returns the system to automatic mode from adjust mode.

**Adjust Button:** Enters adjust mode to modify settings such as water temperature and milk volume.

**Select Button:** Navigates through adjustable parameters.

**Increase Button:** Increases the selected parameter value.

**Decrease Button:** Decreases the selected parameter value.

**The control unit features an LCD to display various system parameters, including:**

- Water temperature
- IR sensor readings
- Mixer operation time
- Milk motor operation time
- Status of output devices (mixer, milk motor, valve, heater)
- Relay status





Figure 3.13: mixer and secondary milk heater design.



Figure 3.14: Manual valve & Electrical valve.



Figure 3.15: Power supply and main water source.

### 3.5.2 Website Application

A simple website to operate the machine remotely and control its characteristics, by connecting the SEP32 with the Arduino.

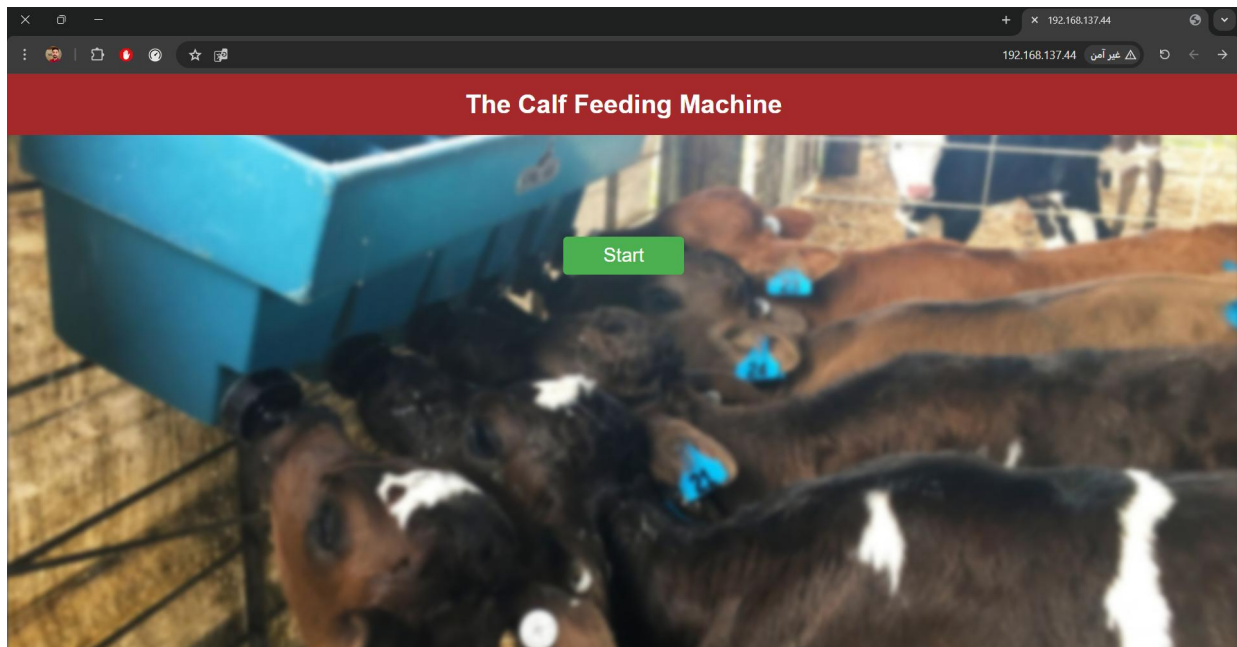


Figure 3.16: Website Application - main page.

When you press Start, the machine starts working directly, step by step, based on the previously entered and selected auto values.

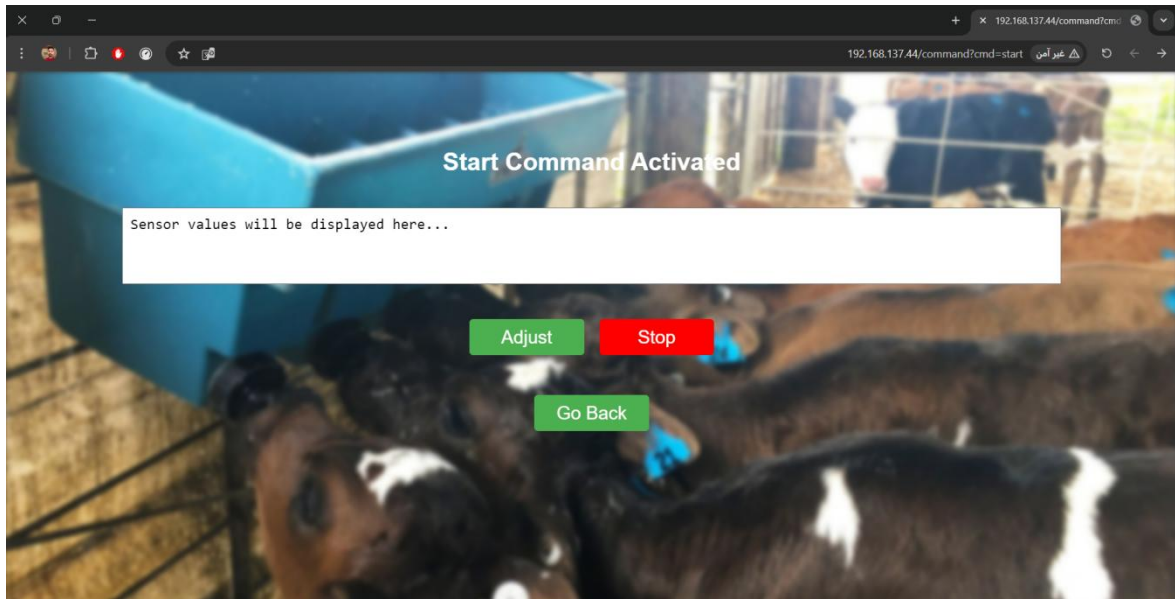


Figure 3.17: Website Application - starting page.

The sensor values begin to appear and update successively, and the user can press Stop to stop the machine from working directly. He can also choose “Adjust” to modify the default values for the recommended starting temperature, the amount of water, or the amount of milk required.

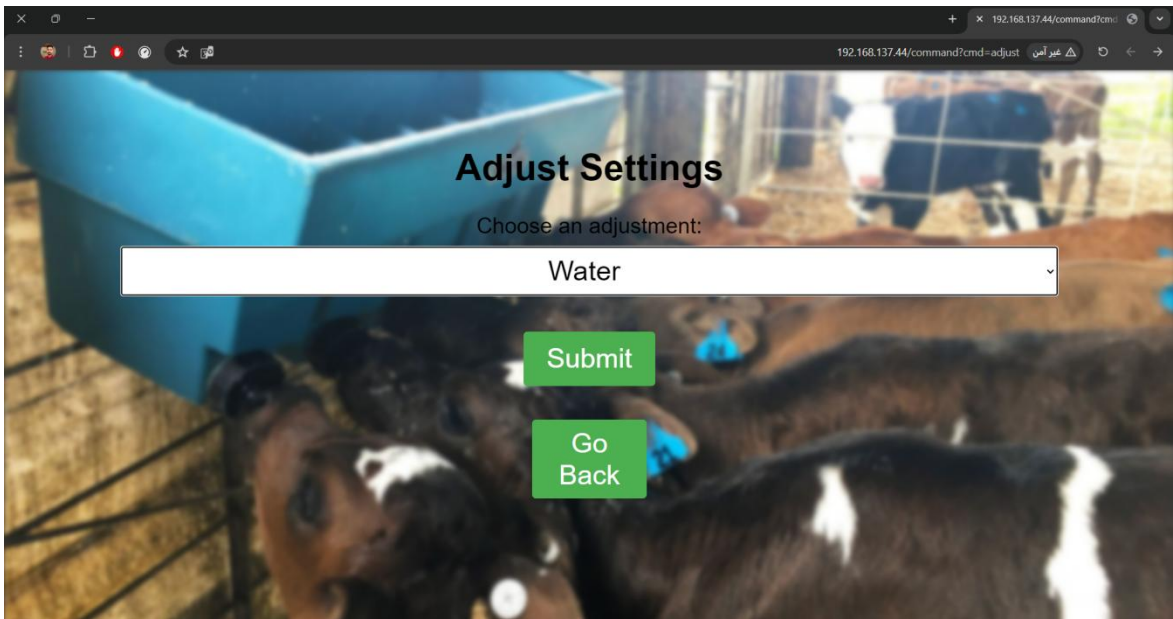


Figure 3.18: Website Application - Adjust page 1.

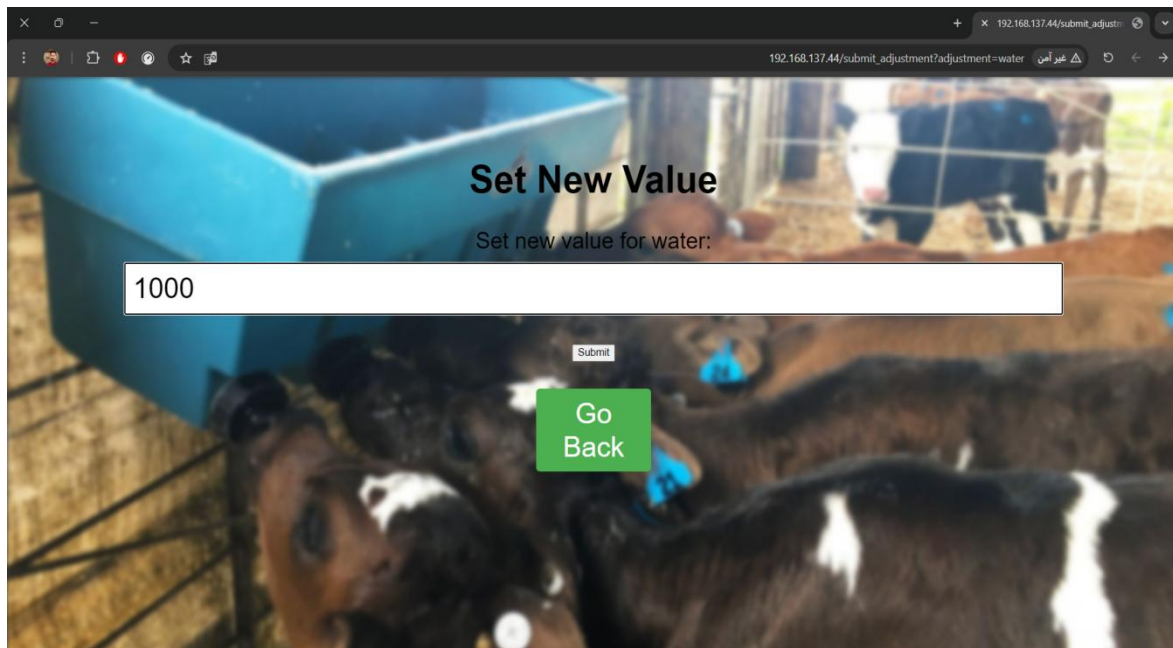


Figure 3.19: Website Application - Adjust page 2.

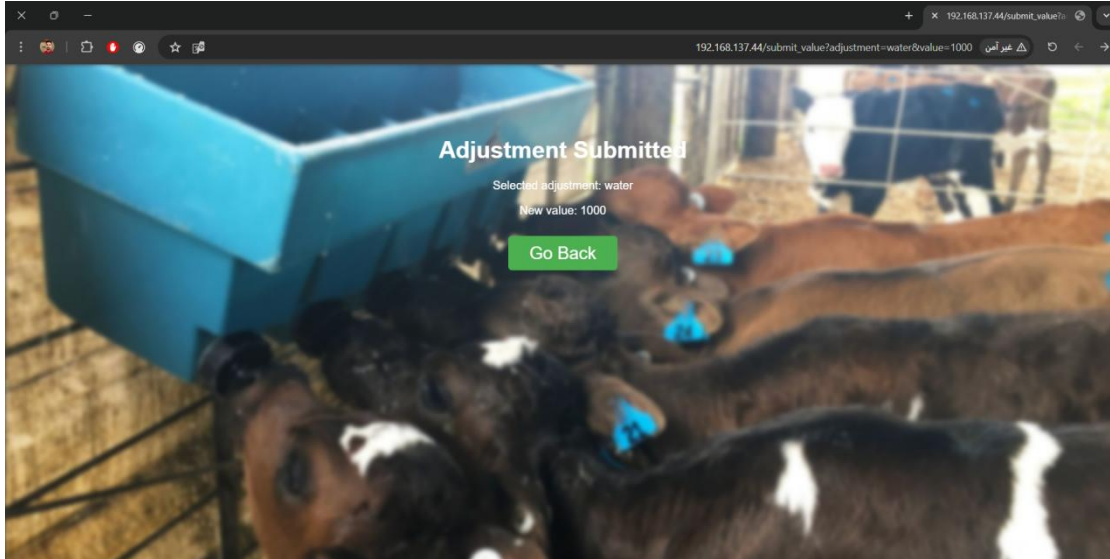


Figure 3.20: Website Application - Adjust page 3.

# Chapter 4

## Conclusion

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The calf feeding machine project successfully addresses the challenges of manual feeding in agricultural settings by introducing automation, smart features, and remote monitoring capabilities. The project demonstrates significant improvements in feeding consistency, labor efficiency, and calf health, highlighting the potential for widespread adoption and positive impact in the livestock farming industry. The innovative design and integration of advanced technologies set a new standard for precision and convenience in calf rearing practices.

### 4.1 Results and Analysis

Highlighting the key outcomes and evaluating the system's effectiveness. The analysis is divided into three main sections: Smart Features and Convenience Enhancement, Mechanism and Security Features, and Mobile Application Features.

### **4.1.1 Smart Features and Convenience Enhancement**

The calf feeding machine incorporates several smart features designed to enhance convenience for farmers. The automated milk dispensing system ensures consistent feeding schedules, significantly reducing the manual labor required. The integration of real-time sensors provides accurate monitoring of milk levels, temperature, and water levels, allowing for precise control and adjustments.

This automation leads to better management of feeding practices, minimizing errors and ensuring optimal nutrition for the calves. The system's user-friendly interface further simplifies operation, enabling farm workers to manage feeding tasks efficiently and effectively, ultimately contributing to improved farm productivity and calf health.

This project not only automates candy can production but also focuses on user convenience and safety, setting a new standard in industrial process automation.

### **4.1.2 Mechanism and Security Features**

The calf feeding machine's mechanical design emphasizes reliability and security. Calves are guaranteed milk that is just the right temperature thanks to the heating element, which keeps the milk at the ideal level. For the calves' nutritional demands, the automatic mixing system carefully blends milk powder and water to the right concentration. Temperature thresholds and fail-safe mechanisms are examples of security elements that are integrated to safeguard the calves from potential threats, such as feeding at incorrect temperatures or concentrations.

By guaranteeing the health and welfare of the calves and giving farmers piece of mind, these precautions help to ensure the overall dependability and safety of the feeding procedure.

### **4.1.3 Mobile Application Features**

The calf feeding machine's flexibility and use are greatly increased by the addition of a mobile application. Farmers may remotely monitor and manage the feeding process by using the smartphone app, which also provides them with real-time notifications and updates regarding the machine's status and feeding schedules.

Even in situations where farmers are not physically present on the farm, quick interventions and modifications are made possible by this remote control capacity. Users may effortlessly explore and utilize the app's features thanks to its user-friendly design and functionality, which offers a smooth experience that promotes effective farm management. Not only is it more convenient to monitor the feeding procedure from anywhere, but it also guarantees that any problems can be quickly resolved, thus protecting the calves' health.

# Chapter 5

## Discussion

The introduction of the calf feeding machine has had a significant effect on agricultural practices. The device greatly decreases the labor needed to physically feed calves by automating the procedure, giving farm workers more time to concentrate on other important duties. This increase in efficiency results in financial savings as well as possible increases in farm productivity. Furthermore, the automated system's consistency and accuracy guarantee that calves get the proper nutrition in the appropriate amount at the optimum temperature, improving their health and growth. The feeding process's reliability is further improved by the decrease in human error that comes with manual feeding techniques.

Calf health and well-being directly benefit from the calf feeding machine's capacity to maintain accurate milk mixes and regular feeding schedules. The equipment lessens the possibility of digestive disorders and other health problems that may result from uneven or improper feeding by making sure that calves receive milk that has been correctly mixed and heated. Better growth rates and general health are supported by this uniformity, and these factors are essential for the production of robust, healthy cattle. Incorporating security elements, like temperature controls and fail-safe mechanisms, provides an extra degree of protection and guarantees the safety of the calves.

The project's inventive approach is emphasized by the incorporation of cutting-edge technologies like automatic mixing mechanisms, real-time sensors, and remote monitoring through a mobile application. Together, these technologies produce a feeding system that is incredibly effective and user-friendly. However, the project also had to overcome several obstacles, such as technical ones about system integration and sensor calibration. Iterative testing and improvement were necessary to overcome these obstacles, highlighting the significance of a strong development process. The limitations imposed by Palestine's transportation problems and current violence further complicated the project's implementation, calling for remote cooperation and different approaches to problem-solving.

Limited funding required the team to prioritize essential components and seek cost-effective solutions without compromising quality and functionality. The economic instability in the region further complicated efforts to secure additional resources. Despite

these challenges, the project successfully delivered a functional prototype, demonstrating that innovative agricultural solutions can be developed within tight budget constraints. Future iterations of the project may benefit from additional funding sources, such as grants or partnerships, to further enhance the system's capabilities and scalability.

# Chapter 6

## Conclusions and Future Work

### 6.1 Conclusions

By focusing on preserving the ideal milk temperature and precise concentration, the research has improved calf growth and health while reducing the dangers connected with hand feeding procedures. Farmers can now rest easy knowing that the feeding procedure is dependable and safe thanks to the addition of security features and fail-safe devices.

Remote monitoring and control of the feeding process is now possible for farmers thanks to the creation and deployment of the mobile application, which has increased accessibility and introduced a new level of flexibility. This remote control feature has come in very handy, particularly in difficult situations where there is limited opportunity for actual presence on the farm.

Despite notable impediments such as financial limitations, transportation problems, and regional instability, the project was able to produce a workable and efficient solution. The creative application of technology and ingenuity in surmounting these obstacles underscores the possibility for additional progress in agricultural automation.

## 6.2 Future Work

While the calf feeding machine project has achieved its primary objectives, there are several areas for future development and enhancement:

### **1- Enhanced Mobile Application Features:**

Future iterations of the mobile application could include predictive analytics to optimize feeding schedules based on calf growth patterns and health data.

Integration with broader farm management systems could provide a more comprehensive solution, allowing farmers to oversee multiple aspects of farm operations from a single platform.

### **2- Advanced Sensor Integration:**

Incorporating additional sensors to monitor calf health parameters, such as weight and activity levels, could provide more detailed insights and allow for more tailored feeding regimens.

Enhancing sensor accuracy and reliability will continue to be a priority to ensure consistent and precise data collection.

### **3- Collaboration and Research:**

Continued collaboration with researchers, industry experts, and farmers will be crucial in driving innovation and ensuring the machine meets evolving agricultural needs.

Participating in research projects and pilot programs could provide valuable feedback and insights for ongoing improvements.

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