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11. Exploring the Intersection of IoT and Pet Care: Design and Implementation of an IoT based Pet Feeder

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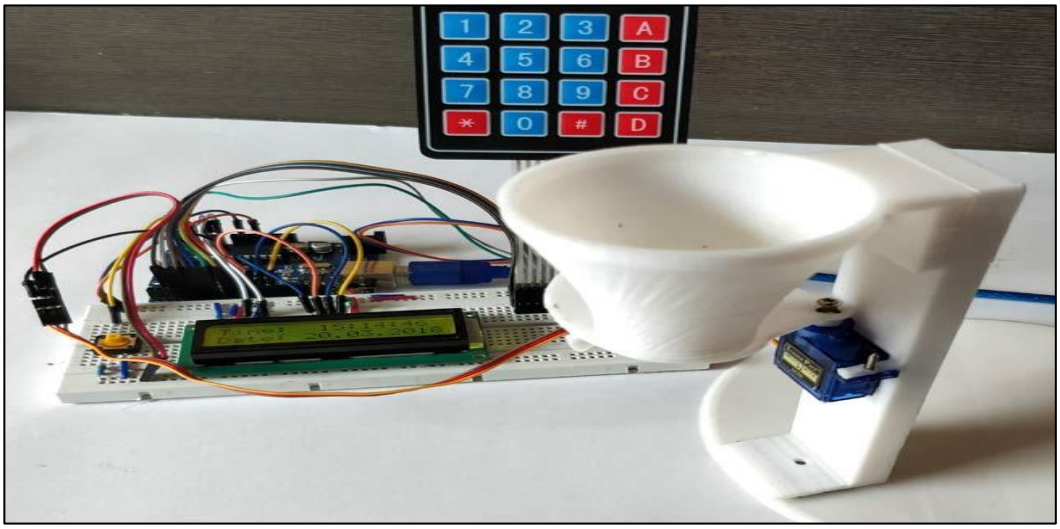

Abstract:

This chapter delves into the intricacies of designing and manufacturing a prototype for an IoT-based Pet Feeder, aimed at automating feeding processes for pets. Many of us face challenges in maintaining regular feeding schedules for our pets amidst busy lifestyles, particularly when away from home for extended periods. The solution presented here, the "automated pet feeder," addresses this issue by dispensing food at predetermined intervals as needed. The operational logic of the system is pre-programmed into the NodeMCU, an IoT module based on the ESP8266 Wi-Fi Module. This device features two servo motors, each connected to separate bottles containing different types of pet food, thus enabling a multi-feed capability. An IR sensor detects when a pet approaches the feeder, triggering a notification to the owner's smartphone via an installed application.

The owner can then remotely respond to the notification to initiate the feeding process, facilitated by the NodeMCU's internet connectivity. Thing Speak serves as the designated cloud platform for facilitating communication between the Android application and the NodeMCU, enabling seamless information exchange throughout the feeding process.

Keywords:

Automated feeder; NodeMCU; IoT module; ThingSpeak, Wi-Fi Module

11.1 Introduction:

This innovative pet feeder system is designed to cater to the needs of beloved pets like cats and dogs. It not only dispenses food and water but also monitors their movements. Equipped with various embedded components, this machine ensures that pets are fed and hydrated without requiring human intervention.

The IoT, or Internet of Things, is a network that links together a wide array of objects, including vehicles, appliances, structures, and devices. These objects utilize embedded system hardware components to facilitate connections and data sharing over the internet. By leveraging network configurations, users can remotely control their gadgets and devices, leading to enhanced accuracy and efficiency. This accessibility and efficiency make IoT a valuable tool for consumers across various sectors. As the quest for enhanced quality of life continues to grow, the Internet has permeated every aspect of daily existence over the years.

Through the concept of "connecting the unconnected," IoT has revolutionized the ability to perceive and manage the physical environment by imbuing objects with intelligence and linking them via a sophisticated network. IOT based pet feeder is one of the new technologies for feeding pets. It will help pet's owner to take care of their pet while they are not at home. Even the owners are not at home, they still can feed their pet. IOT based pet feeder is built to help pet owner taking care of their pet.

Automated pet feeder is one of the pet feeders that will be controlled by a wirelessly by using an android application through NodeMCU. The automated pet feeder will be automatically dispensing predetermined amounts of food at the exact times user choose with controlled by a wireless application. Through the application interface, the user selects the desired type of feed for their pet, prompting the corresponding food to be dispensed into the bowl. An ultrasonic sensor monitors the food level in the bowl, automatically ceasing the feeding process once the bowl reaches capacity.

The primary objective of this project is to provide a feeding solution for pets even when their owners are away from home. Chen et al. (2016) proposes an IoT-based pet feeder system for remote feeding, addressing the need for accessible pet care solutions for owners who are frequently away from home. Manoj (2017) details the design and development of an IoT-based automatic pet feeder system, illustrating the feasibility and benefits of automated pet care technology. Wankhede and Pednekar (2018) investigate the integration of RFID and IoT technologies for animal tracking and care, emphasizing the potential for real-time monitoring and management of pets.

Subaashri et al. (2019) introduce an automated pet feeding system with RFID authentication and GPS tracking, highlighting the importance of security and remote monitoring in pet care solutions.

Luayon et al. (2019) demonstrate "PetCare," a smart pet care IoT mobile application, offering remote monitoring and management features to enhance pet owner convenience. Finally, Quiñonez et al. (2020) present a smart pet feeder system that employs IoT for personalized nutrition, showcasing advancements in pet feeding technology and its implications for pet health. These studies collectively contribute to the advancement of IoT in pet care, offering insights into its potential applications and benefits.

This study aims to employ IoT technology for monitoring and regulating the eating and drinking habits of pet dogs. We present an IoT-based system featuring a feeding device equipped with food and water compartments, accessible and controllable through a smartphone interface.

The system facilitates monitoring to establish feeding schedules and control to manage food and water intake based on container weight, ensuring moderation and timely replenishment as necessary.

11.2 Proposed Methodology:

The primary technology employed in this IoT-based pet feeder is ThingSpeak, which oversees the system's operations according to the programmed logic on the NodeMCU. It facilitates communication with the Android application installed on smartphone. Following are the scientific objectives:

- Utilizing established technologies such as sensors, motors, Android applications, and cloud platforms, the IoT-based pet feeder streamlines the pet feeding process, allowing remote control from anywhere, anytime. This system empowers pet owners to attend to their pets' needs no matter where they are.
- The IoT-based pet feeder simplifies the pet feeding process, leveraging cost-effective and familiar technologies for user-friendly operation.
- Amidst the growing market for automated pet feeders, this model stands out for its cost-effectiveness compared to existing products.
- The accompanying Android application provides real-time updates on food levels in the bowl, enabling precise feeding of pets based on available quantity.
- This system offers a selection of multiple feeding options for pets, catering to the preferences of pet owners.

The figure 11.1 outlines the framework of an IoT-powered pet feeder. It shows how sensors connected to the NodeMCU ESP8266 transmit data to it, which is then forwarded to the ThingSpeak Cloud for storage and analysis. An Android app interacts with the cloud, allowing users to view and respond to pet feeding data. The NodeMCU retrieves feeding schedules from ThingSpeak, enabling it to dispense food to pets accordingly. This setup enables remote monitoring of pet feeding status using ThingSpeak software, offering convenience and peace of mind to pet owners.

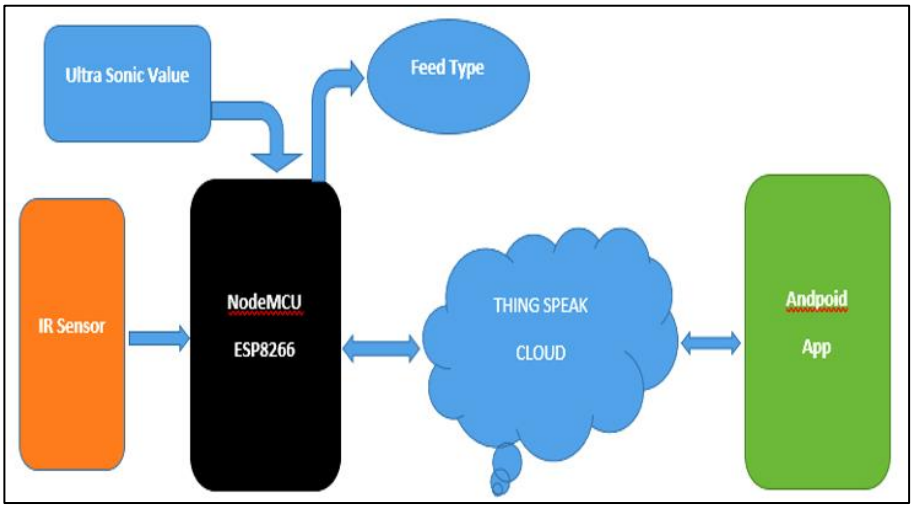

Figure 11.1: Block Diagram Representing the Design Flow of Automated Pet Feeder

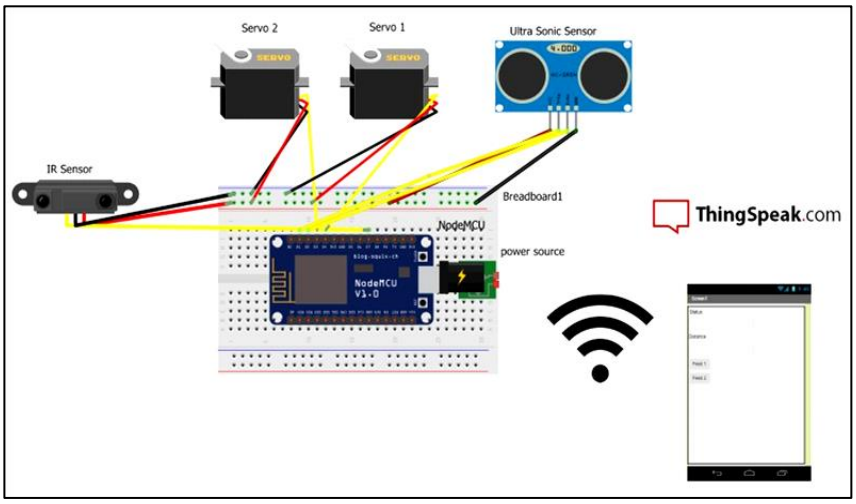

Figure 11.2: Circuit Diagram representing the breadboard connections of IoT based Pet feeder

A. Wiring:

In the figure 11.2, the colours of wires represents the following usage:

Red wire: This colour wire represents the 5V power to the circuit from the NodeMCU.

Black wire: This colouur wire represents the GND provided to the circuit from NodeMCU.

Yellow wire: This color wire represents the connections between the output pins of sensors, servo motors and to digital pins of NodeMCU.

We opted for NodeMCU as our platform for this project due to its open-source nature, specifically tailored for IoT applications. With its integrated ESP8266 Wi-Fi module, NodeMCU seamlessly connects to various cloud platforms. Moreover, it offers a cost-effective solution, consuming minimal power during processing. Our setup involves attaching sensors and motors to the pins of NodeMCU in the following configuration:

- D1 pin of NodeMCU is connected to the ECHO pin of the ultra-sonic sensor and D2 pin is connected to TRIG pin of the sensor.
- D3 and D4 pins of the NodeMCU are connected to the two different output pins of Servo motors.
- D7 pin of the NodeMCU is connected to output pin of the IR Sensor.

Through the programmed network NodeMCU get connected to the ThingSpeak website which monitors the system through the android application and responds accordingly.

B. Flow Chart:

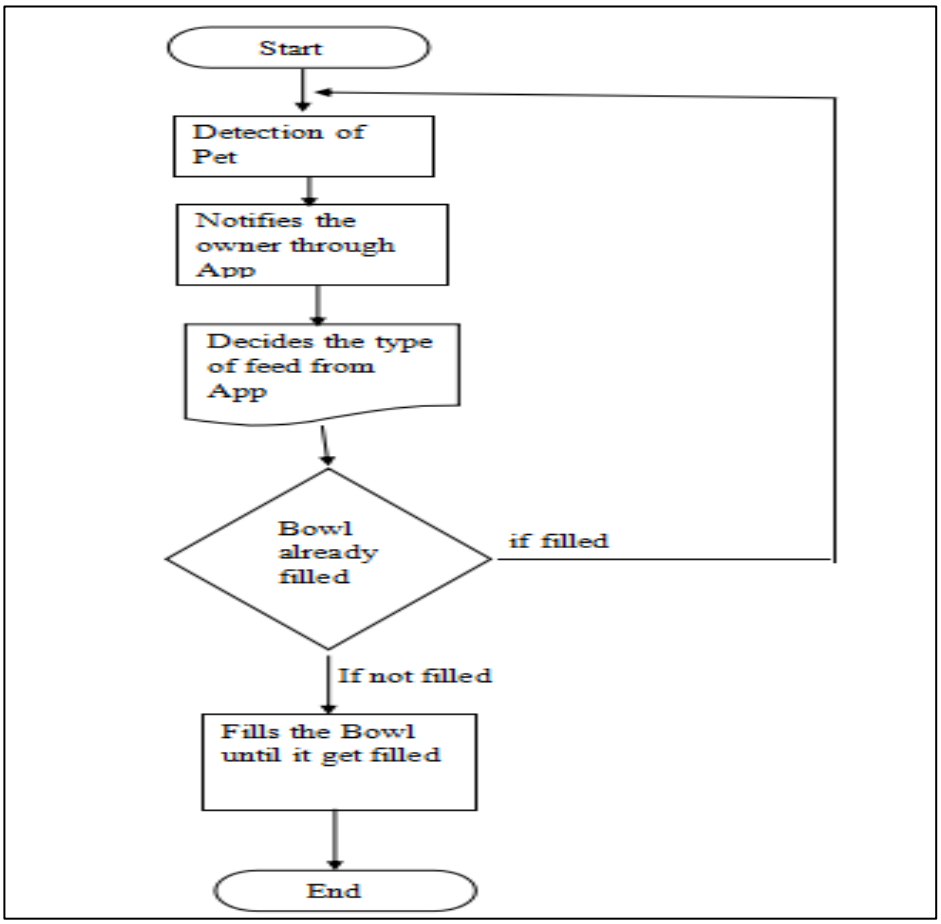

Figure 11.3: Flowchart Representing Workflow of The Prototype

11.2.1 Working of the Designed System:

Figure 11.3 depicts the flow diagram for notifying the pet owner via the app.

The owner can select the feed type and the servo motor, controlled by the weight sensor, dispenses the appropriate amount of food into the bowl.

The proposed pet feeder system utilizes NodeMCU ESP8266 as its primary controller, with a servo motor serving as the valve for the food dispenser. This IoT-based pet feeder is designed to automatically feed pets at the owner's discretion, accessible from anywhere via an Android application. The system incorporates an ultrasonic sensor, IR sensor, servo motor, and NodeMCU to achieve its functionality. All components are housed within a 2x2 feet wooden box. The system's operation involves the following steps:

Initially, the presence of the pet is detected using the IR sensor, as illustrated in Figure 11.4 (a). This information is then transmitted to the ThingSpeak IR Channel by the NodeMCU, establishing an internet connection. Subsequently, the pet's status can be monitored via the Android application. Upon selecting the desired feed option in the application, the corresponding update is sent to the AppChannel. NodeMCU then processes the request from the application, triggering the appropriate action. For instance, if the owner selects feed1, the servo motor attached to that feed rotates, dispensing food into the bowl. The same process occurs for other feed options as chosen by the owner.

(a) **(b)** **(c)**

Figure 11.4: (a) IR Sensor attached to pet feeder (b) Bottle (feeder) attached to servo motor (c) Ultra Sonic attached to pet feeder

The servo motor continues to rotate until the feed bowl is detected as fully filled. This measurement is achieved through the Ultra Sonic Sensor positioned above the bowl, as depicted in Figure 11.4 (c). Once the sensor detects that the bowl is filled, the servo motor automatically ceases rotation.

11.2.2 ThingSpeak:

To integrate an object into the IoT ecosystem, a combination of hardware and software components is essential. Beyond mere data connectivity, the inclusion of sensors to gather data or actuators to receive instructions becomes necessary.

For instance, a digital thermometer can serve to measure temperature. Subsequently, the collected data must be transmitted to a network of interconnected servers, commonly known as "the cloud", which hosts various applications.

The cloud infrastructure employs visualization techniques, which enable multiple physical servers to operate collaboratively while appearing as a single entity to users. Despite operating independently at the physical level, this approach streamlines tasks like software updates and storage adjustments, enhancing overall system flexibility and manageability.

For connecting an object to the IoT, the focus is on the ThingSpeak API. In this project, two channels have been created to facilitate communication between the Android application and NodeMCU. These channels serve as repositories of data logs for efficient information retrieval.

ThingSpeak serves as the chosen cloud platform for this project due to its open-source nature and versatility in IoT applications. It provides a cost-free solution for connecting microcontrollers like NodeMCU to the internet for automation purposes. ThingSpeak offers channels where data can be stored in fields, accessible either publicly or privately through graphical representations.

API keys are provided for seamless data updating and retrieval. In this project, two channels are utilized: one for uploading data to the cloud with two fields, and another for receiving information from the Android application to control the system.

However, one challenge with ThingSpeak is its 15-second update delay, causing communication lag between the Android application and NodeMCU. This limitation can be addressed by subscribing to a commercial account on ThingSpeak. Figure 11.6 showcases the channels created within ThingSpeak, while Figures 11.7 and 11.8 illustrate graphical representations of the fields in the IR Channel and AppChannel, respectively.

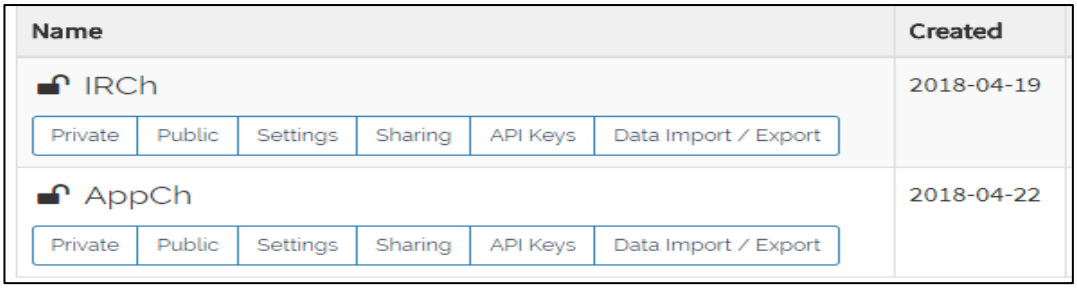

Figure 11.5: Channels in ThingSpeak

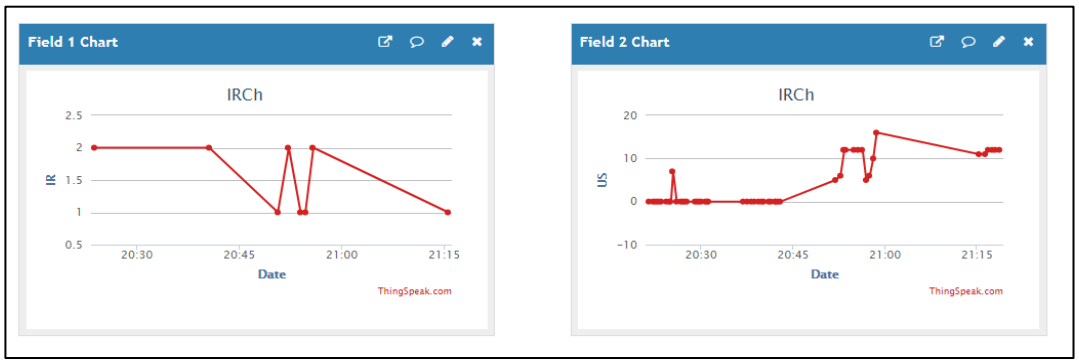

Figure 11.6: Field Graphs of IRCh in ThingSpeak

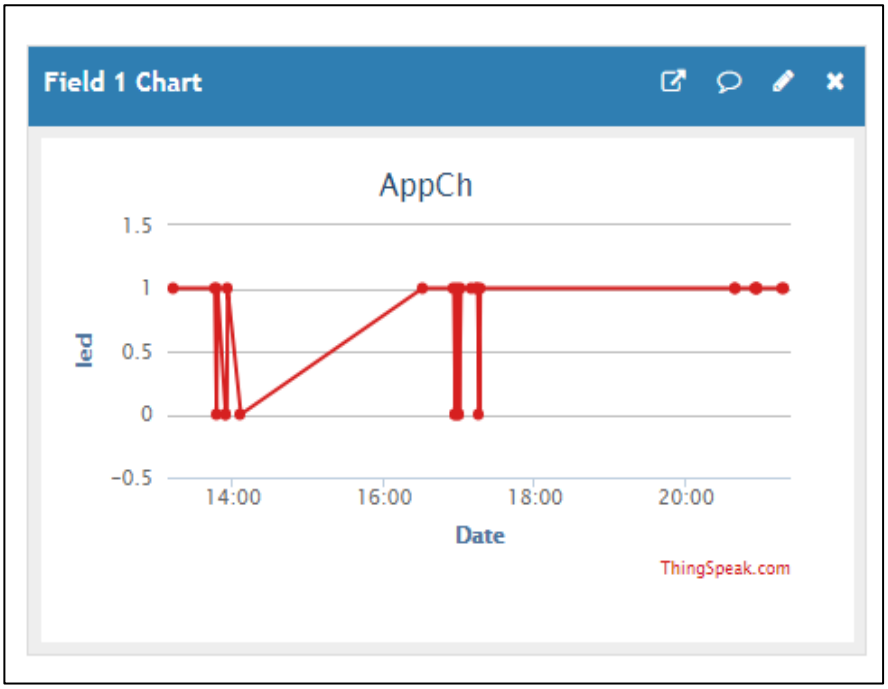

Figure 11.7: Field Graphs of AppCh in ThingSpeak

11.3 Result and Discussions:

With this IOT based pet feeder, it is easy for pet owners to take of the pet's even if they are not present at home. And to make this cost effective we have used sensors which are available anywhere. As a result, It also helps pets to get habitual to automated feeding. The concrete results of this design are as follows:

- Less cost
- Easy maintenance
- Low power consumption

11.4 Conclusion:

The increasing focus on human-device interaction has led to numerous studies aiming to create more natural and intuitive service request processes. The merging of pet care and IoT technology represents a promising development in this field.

This system, often referred to as smart-home technology, includes features like the smart pet feeder. The results not only demonstrate significant improvements in IoT-based pet feeders but also cater to the needs of pet owners. The core concept of IoT suggests potential new operational and connectivity methods, including a possible clean-slate approach. As the definitive operational framework for IoT is yet to be established, there are numerous research avenues to explore. Our next step involves integrating other pet care devices such as litter boxes and pet cams into our system to address a wider range of pet owner needs, covering health monitoring and entertainment for pets. Furthermore, the challenge of connecting the myriad networking devices worldwide remains pivotal. Future efforts will focus on studying IoT gateways and long-distance pet detection to enhance our system.

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