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Automated Pet Feeder using IoT

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***Abstract*—As the world gets more interconnected, the Internet of Things (IoT) creates a vast network of devices that routinely exchange data. IoT extends the power of the internet beyond smartphones and computers to ordinary household objects such as light bulbs, locks, smart microwaves and various technologies. Smart home devices and gadgets are becoming more popular among consumers who enjoy having all of their devices interconnected for the purposes of increased convenience, comfort, energy efficiency, and most importantly, personalization which is one of the project's focal points. This helps in solving the starvation of small pets such as dogs and cats in absence of their owners. Through this proposed design, the user can adjust the feed time, the time between consecutive feeds, and the amount of feed served. Thus, keeping the pets healthy and happy. Here in this paper, automation of pet feeders using the Internet of Things (IoT) is developed. Overweight dogs and cats account for over 55% of all population, posing major health hazards such as heart and lung problems, kidney disease, and diabetes. The proposed machine will provide a solution to this as it aids in weight management by providing the portioned feedings that pets require. Here the smart automatic pet feeder is implemented using Arduino Uno, RTC module to track time and manage feeding schedules, a distance sensor to monitor food level, and a servo motor SG90 with a wide-angle servo (0°-180°) to control the flow of the food dispensed are among the project's major components.**

Keywords—IoT, Pet feeder, Data, Arduino Uno

I. INTRODUCTION

Having a pet at home is one of the greatest joys. But regular feeding is one of the major problems in a pet's maintenance. To raise a healthy pet, each pet's meal and feeding habits must be carefully studied. When pets are not fed on time, it has a direct impact on their health. As a result, the proposed machine will provide a solution to the problems like malnutrition and obesity. The biggest benefit of this smart automatic pet feeder is the convenience as you only need to refill it every few days. This saves you both time and energy because they work on timers that are capable of dispensing several times a day to satisfy the food intake of the pet. Because the machine is IoT-based, the user's experience becomes much more personalized with the help of electronic automation and IoT. It can be used to monitor the amount of food fed to the pet at each meal in order to reduce the risk of illness. An automatic pet feeder can feed the pet based on the custom schedule and helps make it easier to maintain a regular feeding schedule and are ideal for pet owners who are constantly on the go and have erratic schedules. Parallely, is also useful for elderly dog owners who have difficulty bending over to fill their pet's feeding bowls on a daily basis. Traditional methods may exacerbate physical and emotional pressures, which these appliances help to alleviate. When compared to other machines with more intricate designs, where cleaning can be difficult and the unit may require disassembly to adequately clean moving parts, the proposed design is simple to clean and maintain. Every year, the pet care industry and business expands, thus necessitating the development of new technology-based solutions.

II. RELATED WORK

Integration of heterogeneous data from diverse devices and their capacity to undertake joint job execution is one of the primary open difficulties in IoT automated systems. By offering [1] an uniform manner of accessing and masking the heterogeneity of different home devices, interoperability appears to be the key goal in these systems. Each pet owner's lifestyle is different; [12][2] using this machine will be different from the traditional method of owners feeding their dogs by hand since it will provide more accurate feeding at the times we specify, as well as the ability to manage it from a distance, something the traditional method cannot provide. In [3] the smart pet door is a designed in such a way that it allows the pet owner to supervise the movement of their pet by utilizing a sensing tag on the collar. An automated system is built using Internet protocol (IP) camera and a microcomputer to control the automobile remotely [15][8] The microcomputer serves as a MQTT (MQ Telemetry Transport) server and accepts MQTT messages sent by mobile phones. The microcomputer delivers the GPIO (General Purpose Input/Output) signals to the motor hardware through its programmed pin configuration. The video streaming will be received by the microcomputer from the IP(Internet protocol) camera at the same time. This streaming can be relayed back to the mobile phone's screen. A new embedded development board and a new Wi-Fi development board are used in this design. The Yocto Project Linux kernel's compilation function is used by the CC3200 [7], which can automate pet feeding and watering, as well as perform regular and quantitative feeding procedures. The feeder uses IoT technology for remote control and has a more exact control of food and water supply. A remote camera can be used to monitor the pet's behaviour in real-time, and with the use of the phone, the feeding situation can be monitored in real-time [14]. This pet feeder design [10][13] has elements that make pet care more convenient for both the owner and the pet. This system also offers information about the pet's feeding, such as whether it

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is eating or not, and whether it is eating in the right amount, which aids in the elimination of the overfeeding problem. By supplying the left feed first, this arrangement also helps to reduce feed waste. With its interactive remote control [9], this design also eliminates the traditional manual adjustment of pet feeders. In terms of advancement, several elements can be changed, such as using a camera instead of sensors for priority feeding of pets. On request, this device can also send a short video clip [5] [6] to the owner through multimedia message of the pet during feed time. Remote monitoring, feeding, body temperature analysis, and other health issues can all be diagnosed with IoT [4]. Also, tackled the problem of animal identification over vast distances using sensors integrated into Radio Frequency Identification (RFID) tags that can be monitored using Global Positioning System (GPS).An automatic [11] pooping pad, a Raspberry Pi camera, and a smartphone application .The food is dispensed and distributed across three layers of the automatic feeder. The feeding mechanism is controlled by Arduino, and the serving size is determined by a weight sensor. The automatic feeder and pooping pad are both monitored using a Raspberry Pi webcam. The Raspberry Pi serves as both a client and a server. Unfortunately, the application is only available in Korean.

III. Proposed Work

A. System Design

1) Arduino Uno R3: It is used to control the Pet Feeder activities for various applications. Figure 1, shows the block diagram of the proposed IoT pet feeder. An open-source hardware and software of Arduino is used for initiating user-friendly communications, which creates single-board microcontrollers for controlling the digital devices. The Arduino Uno R3 is the most recent version of the Arduino Uno. The Arduino board and Integrated development environment (IDE) software serve as the reference versions of Arduino, which can be updated. The Uno-board is the standard model for the Arduino platform and is the first in a series of USB-Arduino boards.

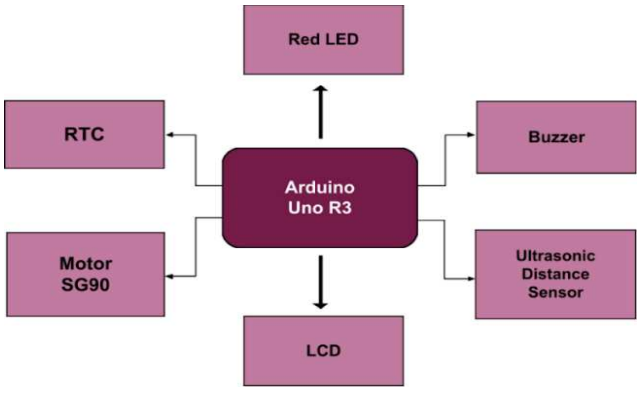

Fig. 1. Block diagram of IoT Pet Feeder

A wide range of microprocessors and microcontrollers can be used in Arduino board designs. The boards having digital and analog I/ O pins that can be used to connect to expansion boards (shields) or breadboards (for prototyping) and other circuits are considered. Serial communications ports, including USB on some models, are also used to load programs on the boards. The microcontrollers can be programmed using the C and C++ programming languages as well as a standard Application programming interface (API) dubbed "Arduino language". The Arduino project includes an IDE and a command-line tool (Arduino-cli) written in Go, in addition to traditional compiler toolchains.

2) Red LED: An average 5mm has a 2V forward voltage drop and a forward current of 20mA. When a LED is connected to the Arduino, a current-limiting resistor must be used

3) Piezo Buzzer: It is used instead of the electromagnet used in typical speakers. The piezoelectric effect is used to generate sound waves. To produce a sound at the specified frequency could be achieved by applying a square wave.

4) Real-Time Clock(RTC): RTC is an electronic device that measures the passage of time (usually in the form of an integrated circuit). The Real Time Clock module's onboard battery ensures that the computer retains the correct date and time even when the system is powered down. Once this module is installed, set the correct date in the computer and save it using the Time Preferences or Set Clock command. After which the workbench clock will always display the correct time.

5) Servo Motor SG90: Is a low cost and high output power servo motor. It can rotate up to 180 degrees and each step can be a maximum of 90 degrees. It requires only one output pulse signal to control its movement. For accurate position control, the servo is used (unlike a DC motor). The red/orange wire is 5V, the black/brown wire is ground, and the white/yellow wire is the control signal. However, colour schemes vary. Because servos can draw a lot of power, the 5V cable must be connected to a separately controlled 5V source rather than the Arduino's 5V supply.

6) Ultrasonic Distance Sensor: Devices that generate or sense ultrasound radiation, are known as transducers and ultrasonic sensors. Transmitters, receivers, and transceivers are the three broad categories they fall under. Transceivers can both transmit and receive ultrasound, whereas transmitters turn electrical signals into ultrasound. Arduino Ultrasonic distance sensor is used to measure the distance of the object using Sound Navigation and Ranging (SONAR). Ultrasound is emitted at a frequency of 40KHz or 40000 Hz.

7) LCD: Light-modulating characteristics of liquid crystals combined with polarizers are used here. Liquid crystals do not directly emit light, instead, they use a backlight or reflector to create colour or monochrome images. The 162 corresponds to a two-line display with 16 characters per line. Each character is presented in a 5x7 pixel matrix on this LCD.

B. Software Design

1) Flow Chart: The diagrammatic representation of the algorithm is shown in figure 2, through a flowchart.

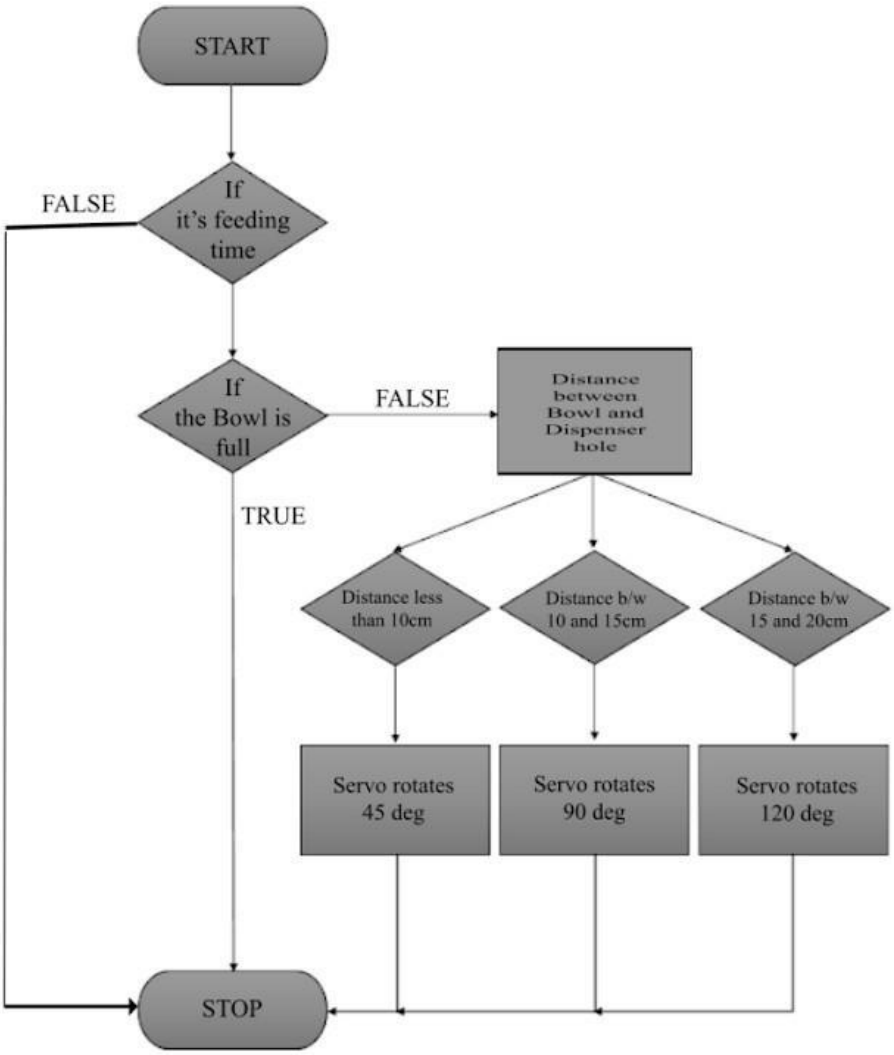

Fig. 2. Flow chart of pet feeder for simulation

a) Arduino Programming and Interfacing: Arduino is an open-source electronics platform that uses simple hardware and software. Arduino boards can take inputs - such as light from a sensor, pressing a button, or a Twitter message - and convert them to outputs, such as turning on an LED, triggering a motor, or publishing anything online. By providing code, instructions could be relayed to the board's microcontroller. The Arduino programming language (based on Wiring) and the Arduino Software (IDE) based on processing are used to accomplish this. Arduino senses the environment by receiving inputs from add-on devices such as sensors and can control the world around it by adjusting lights, motors, and other actuators.

2) Wokwi Arduino Simulator: The proposed design is simulated on the website www.wokwi.com. Wokwi Arduino Simulator was developed to address many more missing features and it runs on AVR8js platform. It is a web-based Arduino Simulator. Wokwi Arduino Simulator runs on a web browser on both mobile and PC platforms. The interface is clean, providing virtual components and the Arduino sketch side by side, which can also format code and upload it to a real Arduino (in Beta). Since the website is mobile-friendly, coding is possible on the go.

C. Methodologies

Pet feeder can be used in a variety of ways. Here in this method, it is programmed to fill the bowl at a specific time, and refill the bowl when it is empty.

Here, it is programmed in such a way that the buzzer starts buzzing from time to time indicating the amount of pet feed left in the feeder. Once the buzzer is turned on, the food dispenser controls the amount of food to be released based on the quantity of feed consumed by the pet. The components used are Arduino Uno R3, Ultrasonic distance sensor HC-SR and Servo motor SG90.

1) Algorithmic Steps:

- Pin Connections:
  - i) Pin 7 and 6 for the ultrasonic distance sensor
  - ii) Pin 2 for the servo
  - iii) Pin 3 for the buzzer
  - iv) Pin 8 for LED
- Initialization for all the components is done in the function setup( ).
- In the function loop( ), for sensing the distance through ultrasonic distance sensor, the microseconds is

converted into centimeters with the function microseconds t to Centimeters ( ) and formula, cm=(duration*2)/29, where duration is the time taken for the pulse to go from low to high.

- Time and date are displayed on the 16x2 LCD display in the format: the first line has the time in hh-mm-ss and the second line has day then followed by the date in format dd-mm-yy.
- Then the time intervals are set by the user for which the servo motor turns on and rotates according to the following conditions:
  i) If the distance measured in cm is 10, the servo rotates by 45o, and returns to 0° after 10 seconds, simultaneously the LED and buzzer are turned on to attract the attention of the pet for 5 seconds.
  ii) If the distance measured is between 10 cm and 15cm, the servo rotates by 90°, and returns to 0° back after 10 seconds, simultaneously the LED and buzzer are turned on to attract the attention of the pet for 5 seconds
  iii) If the distance measured is between 15 cm and 20cm, the servo rotates by 90°, and returns to 0° after 10 seconds, simultaneously the LED and buzzer are turned on to attract the attention of the pet for 5 seconds.

If none of the conditions are satisfied, then the servo doesn't rotate at all and nothing happens.

- SetDateTime( ) is used to set the real date and time.
- DecToBcD() is used to convert decimal to BCD with the formula: ((value/10*16)+(value%10))
- BcdToDec() is used to convert BCD to decimal with the formula: ((value/16*10)+(value%16))
- The above two functions are used for the purpose of displaying the date and time on the LCD.

IV. Results and Discussion

It's easy to operate, no complexities involved in the process. Light weight, easy to move around as it uses on board battery in RTC it can be operated with electricity. Hence, this model helps in eradicating the overweight and obesity problems seen in dogs and cats that account for over 55% of the population, posing major health hazards such as heart and lung problems, kidney disease, and diabetes.

A. Simulated Diagram: (see figure 3)

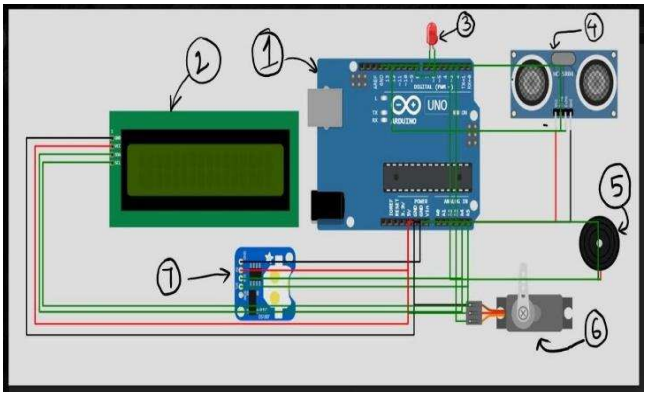

Fig. 3. Labeled Simulated Wire Diagram of the pet feeder

From the figure 3:

1) Arduino Uno R3
2) LCD
3) LED
4) Ultrasonic Distance Sensor
5) Piezo Buzzer
6) Servo Motor SG90
7) RTC

B. Observations

Simulating the hardware parameters using the soft tool, and creating all possible conditions of the feeder fullness, the following observations are made based on simulated results as given in Table 1.

TABLE I. Different conditions for Servo Motor rotations

Distance Measured by the distance sensor	Condition	Rotation done by Servo
Less than 10 cm	The pet has eaten very less amount of food	45°
Between 10 to 15 cm	Pet has eaten a moderate amount of food	90°
Between 15 to 20 cm	Pet has nearly completed the dispensed food	120°

1) Distance less than 10 cm: For the condition of less than 10 cm, consider the distance between the bowl and the dispenser hole as 6 cm. So, the arm of the servo rotates at 45°, opening the dispenser hole for 10 seconds. During this, even the LED and Buzzer are ON for 5 seconds, as shown in Figure 4.

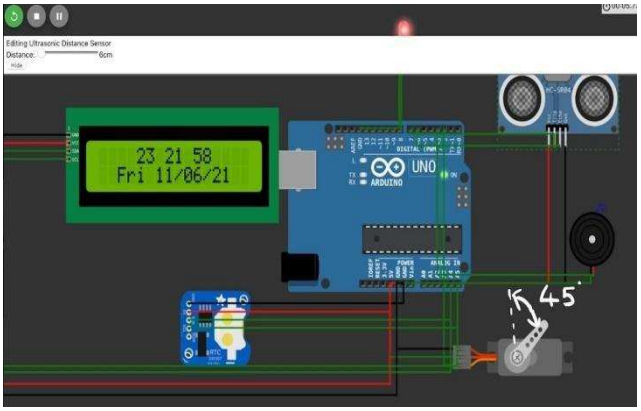

Fig. 4. Simulated Output when distance is 6 cm from bottom or top

2) Distance between 10 to 15 cm: Simulated output when distance is 13 cm is as shown in figure 5. For the condition of the distance between 10 to 15 cm, consider the distance between the bowl and the dispenser hole as 13 cm. So, the arm of the servo rotates by 90°, opening the dispenser hole for 10 seconds. During this, even the LED and Buzzer are turned on for 5 seconds.

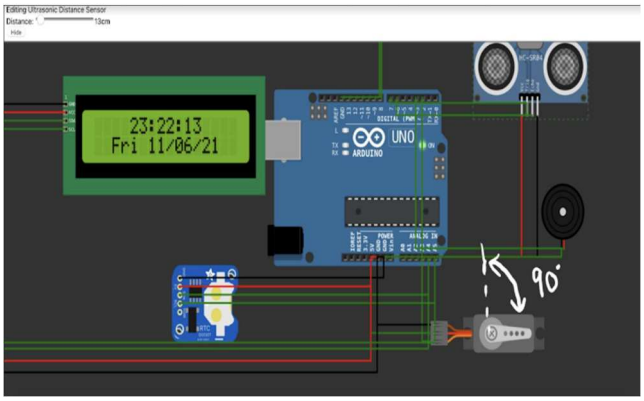

Fig. 5. Simulated Output when distance is 13 cm from bottom or top

3) Distance between 15 to 20 cm: For the condition of the distance between 15 to 20 cm, consider the distance between the bowl and the dispenser hole as 17 cm. So, the arm of the servo rotates by 120°, opening the dispenser hole for 10 seconds. During this, even the LED and Buzzer are turned on for 5 seconds as shown in Figure 6.

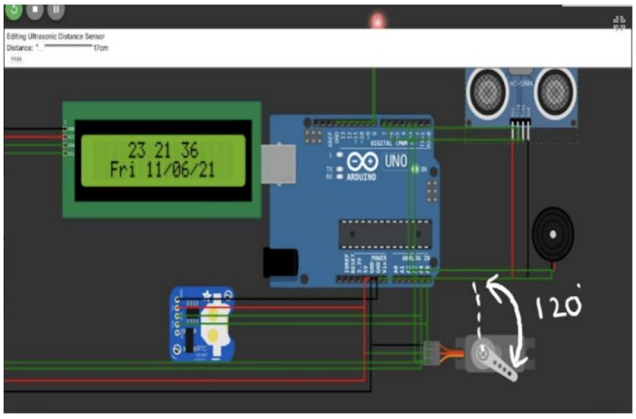

Fig. 6. Simulated Output when distance is 17 cm

V. Conclusion and Future Scope

This prototype design will provide the features that will make pet care easier for both the owner and the pet. As mentioned previously the component requirements include Arduino Uno R3, Ultrasonic distance sensor HC-SR, Servo motor SG90, RTC, Buzzer and LED. With the above simulated results, the intake of pets can be monitored. Also, different pet food needs can be altered like the amount of food dispensed, or the time for which the dispenser hole is kept open, along with the number of times the pet is fed.

When compared to previous editions, this design has a lot of new features. The feed time, the time difference between consecutive feeds and the quantity of feed supplied can all be adjusted in this design. This design also includes a call for the pet when it's time to eat, as well as a refill reminder. The present trend of integrating pet management and IoT technology promises fascinating advances in the future. For further and deeper research, more functionalities can be added to the Automated Pet Feeder, such as an additional camera that allows the owner to monitor whether or not his or her pet is eating its meal. In addition, an RFID tag can be used in pet collars, which allows to identify the pet identity in case of multiple pets.

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