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IoT-based Pet Feeding Robot Design and Development

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Abstract: Pets in the home need particular attention and care. They must be provided with food, beverages, and medicine as soon as possible. Due of most owners' hectic lifestyles, this job may not be as easy as anticipated. Inadequate attention to the requirements of pets may have serious consequences such as hunger and illness, among other things. In light of the above, this paper presents an Internet of Things-based automated feeder system that use the Raspberry Pi for remote control, scheduling, and intelligence. Its design and subsequent execution are anticipated to at least take care of the nutritional aspects of pets by delivering food, beverages, and medicine to pets on a schedule or as needed in the absence of the owner. As a result, the goal of this study is to automate the monitoring and feeding procedure, which is now done manually by pet owners. The four-wheeled system allows it to effortlessly climb stairs. Because of its body weight, the mechanism generates traction. The robot has applications such as remote feeding of every kind of animal from afar, remote exploration of the house to deceive thieves into believing someone is at home. It also lets you customise daily meals, keep your pet secure while you are away from home, store up to 7 pound, keep food fresh, and monitor your pet's nutrition. The robot may also prevent a person from eating a particular meal while allowing other animals to access the food. All these features attract owners of more than one animal to the robot.
Keywords: Internet of Things, Pet Feeder, Raspberry Pi, Remote, Camera vision, Drive mechanism, GUI etc.

I. INTRODUCTION

The pet food robot is in great demand since pet care is a customer-specific task, and we want to make it easier for clients to feed their animals from anywhere in the world easily and intelligently.

Any animal needs a lot of tasks. This includes entertaining, expressing your concerns and feeding them on time and properly, of course. Not all of you are nevertheless a pet expert; it may be tough and time consuming to manage your pet's food. Overeating and obesity are two of the most serious health problems for dogs. They are generally content with whatever is provided to them, especially when they are younger. Many adult pets are fed in an unscientific manner, which may result in a limited lifetime. Another issue with feeding dogs is that users may not always be at home on a regular basis since they need to go to another nation for work or leisure. Being preoccupied with personal goals while still caring for a hungry young guy at home is always a source of worry for users. The third issue we want to address is the fact that there is currently no device on the market that can administer food for dogs while being watched in real-time by its owner.

However, pets may not be aware of the possible health risks associated with consuming the incorrect diet. Petnet, Auto Pet Feeder, and Automation Pet Feeder are a few examples. This can be set at regular times to dispense food, but lacks real-time monitoring and mobility As a consequence, we intend to solve the feeding issues of consumers via the development of a semi-automatic pet feeder operated by phone and laptop, which can manage the right food based on live video input.. An Internet of Things (IoT)-based automated feeder system may help with pet care management. The latter technology will allow pet owners to remotely handle essential requirements that can be automated while doing other time and attention-demanding activities. Regardless, This pet is amused by our robot and prevents it from feeling lonely. In addition, the robot has small speakers which may pass the speech stream of the user to the livestock, giving the animals the idea that their owner is close by.

We also have a device that can stream us from the house on live video. It can definitely help us avoid robbery. It can even remain out and keep a look out of our home continuously as a backup lookout dog and, since it is running on electricity, when it detects someone infringing the wearer's property, it recognises the thief's presence and makes a video-recording of the insect. In addition, the robot continues silently to wander about the house, warning that someone is there. And distract it till the police come.

Moreover, we are symmetrical in design. Thus, it can continue function, even if the robot falls (for the basic design). The design is also thus designed that stairs (cough and large-diameter pneumatics) may easily be climped and the robot can go around the house freely.

II. LITERATURE SURVEY

Several studies have been published in the literature in an effort to automate certain human tasks. For example, Asadullah et al. [1] used an Arduino board, Bluetooth, a Smartphone, an ultrasonic sensor, and a moisture sensor to remotely control up to eighteen household appliances. If used as a plant irrigation system, the technology can also monitor water level and soil moisture. Ricci [2] developed techniques and systems for home automation that determine the condition and/or activities of a household and give information to a distant owner. As a result, the home owner may identify and monitor tenants remotely. A voice-enabled system employing a virtual assistant that takes speech as input to operate electrical devices in a distant place was presented. The virtual assistant is capable of natural language processing. As a result, gadgets in the technology network may be remotely controlled using voice.

Automation-based Internet of Things (IoT) is becoming more flexible and popular, according to Singh et al. [4]. Because of its capacity to offer smart control of appliances at specific areas, the technology improves human lives. In light of this, the latter created a prototype that uses a sensor and an Arduino device to manage household appliances such as lights, fans, energy usage, and the level of a gas cylinder, among other things. They were able to identify the presence or absence of human objects in the target area, control energy usage, and check gas levels using the solution. Similarly, an IoT-based feeder system should be able to automate feeding and other pet-related supplies or demands. Such an IoT-based feeder system may be programmed to administer exact amounts of food or other provisions at specified time intervals, reducing the amount of time owners spend feeding and monitoring domestic pets [5]. In addition to providing respite to pet owners, an automatic feeder system may be designed to be operated with the touch of a button or remotely through voice commands (as in [3]) and a web application with a user-friendly interface.

Aside from the benefits that automatic pet feeders provide their users, they can also regulate the amount of food given to pets because they can be programmed to dispense specific amounts of food, ensuring pets are not malnourished or overfed, which can lead to obesity, especially when the pets are still very young. In light of the above advantages, Ibrahim et al. [5] created an Arduino microcontroller-based method. A pet feeder is controlled by a microcontroller. The later authors used finite element analysis to determine the maximum stress the mechanism can take; they had significant success, which gives information into how to enhance the system. Jadhav et al. [6] automated fish feeding using an existing Smartphone application (Blynk). They contended that owning and seeing fish at home, like cats, dogs, and cows, may decrease stress. Fish, unlike other household animals or pets, need special care, thus automation will reduce human effort in managing its requirements.

A conventional pet feeder, according to extant literature, should include a dispenser that distributes dry pet feeds; the quantity of food supplied may be controlled by a motor. The number of revolutions made by the motor typically affects the amount of dry pet food delivered. The Gravity Feeder [7] was one of the earliest automatic pet feeder systems developed; it includes a hopper full of pet food that is delivered evenly via its ports to a bowl. The feeder continues to fill the same dish while the pet consumes the food. As a result, the constant filling of the bowl may be considered the disadvantage of this simple pet feeder. This indicates that a pet owner would be unable to limit the quantity of food eaten by the pet. Similarly, Yaomin [8] created an automated pet feeder system with a food hopper and a feeding tray. The hopper has a user-friendly interface, and the incorporation of IoT into the pet feeder device would enable users/owners to operate the pet feeder remotely. It will also allow owners to watch their pets and ensure that appropriate feeding is always carried out. The suggested concept would allow pet owners to roam freely, knowing that their pet would be properly cared for by the automated pet feeder.

III. MATERIALS AND METHODS

This section describes the materials and techniques used in this research. The section covers the components utilised as well as ideas related to this effort. Furthermore, the method for selecting specific materials and fabricating and assembling the suggested automatic pet feeder is described. The components required for the construction of the automated pet feeder are a Raspberry Pi, a shaft, a stepper motor, a relay, and a food container.

A. Raspberry pi

The Raspberry Pi Foundation created a series of microcomputers known as the Raspberry Pi. The Raspberry Pi was created primarily to encourage basic computer skills in schools and poor nations across the globe. According to the Raspberry Pi Foundation, about 5 million or more Raspberry Pi devices were shipped in 2015, with cumulative sales exceeding 19 million by early 2018. Because of its usage of Python as a primary programming language, the Raspberry Pi eventually became the world's third best-selling general-purpose computer [12].

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Raspberry Pi is available in a variety of versions, including the Raspberry Pi 1, 2, 0, 3, B, and B+. The Raspberry Pi model B, which was released in 2016, is one of the most current. It features a 1.2GHz 64-bit four core CPU, built-in 802.11n Wi-Fi, and USB boot capabilities.. The Raspberry Pi model B plus (+) was introduced two years later. It features a faster CPU (1.4GHz), Power over Ethernet (PoE), USB boot capability, and a network Boot, making model B + an ideal microcomputer for this research because of its processing speed and ability to connect to a home network for remote access [12].

B. Cortex-A53

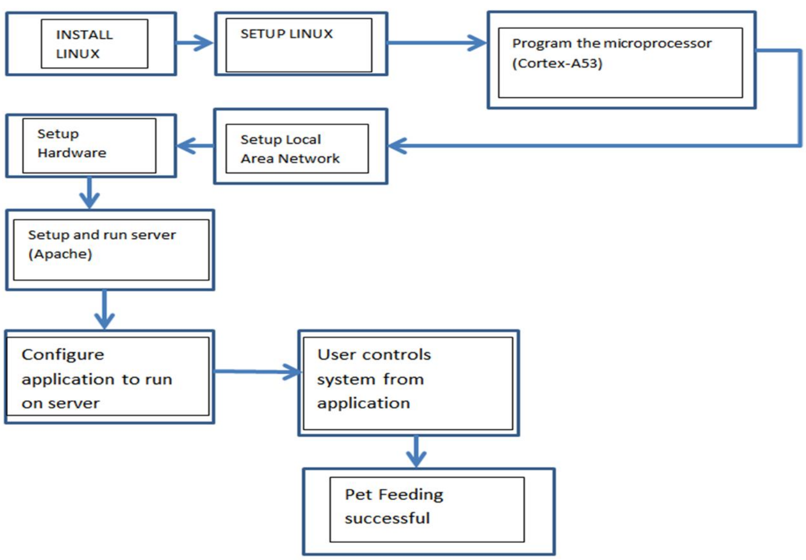
The Cortex-A53 is the power engine that drives the Raspberry Pi B+. Because the CPU is mainly 64 bit, it is extremely quick. The Cortex-A53 CPU features four cores, each with its own L1 memory system and a single shared L2 cache. The performance and high degree of power efficiency of the Cortex-A53 CPU are its most beneficial features [13].

C. Pi-Camera module

The Raspberry Pi Camera Module is a high-quality 8-megapixel Sony IMX219 image sensor developed for Raspberry Pi and equipped with a fixed-focus lens. Since the introduction of the Raspberry Pi Zero [14], the Raspberry Pi module has gained prominence. The Pi camera offers video resolutions of up to 1080p30, 720p60, and 640x480p90, making it an important component for creating a monitoring system for the research.

D. Automation Process

The block diagram in Fig 2 below depicts the process of automating the proposed feeder system. Each element of the design is critical for the system to operate properly. Because of its compatibility with the Raspberry Pi, the suggested device is intended to run Raspbian (a Linux-based operating system) and is powered by a Cortex a-53 CPU. A local server (Apache) is also installed to allow for simple management of the whole system. Raspbian OS is installed initially when executing the automation procedure shown in fig. 2 below. The Cortex A53 microprocessor, which controls the whole automated system, is then programmed.



Fig;1.The suggested automated pet feeding system is shown as a block diagram.

IV.EXPLAINATION

The user has been built using the tkinter python GUI toolkit to build a graphical user interface (GUI). The GUI helps guide the movements of the robot for feeding animals. The gadget is connected to the internet, such as a smartphone or a laptop. The Real VNC software, which is constantly linked to internet, connects to the Raspberry Pi 3 in Germany. Raspberry Pi 3 is connected through serial peripheral interface with the Arduino Uno on the robot (SPI). An RF-SPI connection is provided by the NRF24L01 1-mile radio unit, which connects to the Arduino Uno and Raspberry Pi 3. fully integrated, ultra-low-powered transceiver system (IC) for the 2.4 GHz Industrial, Scientific, and Medical (ISM) band (ULP). Authentic ULP, utilising coin cells and AA/AAA batteries, delivers battery-powered power for months to years using 14 mA, sub-A power down mode, intelligent power management, and a 1.9–3.6 V supply range.

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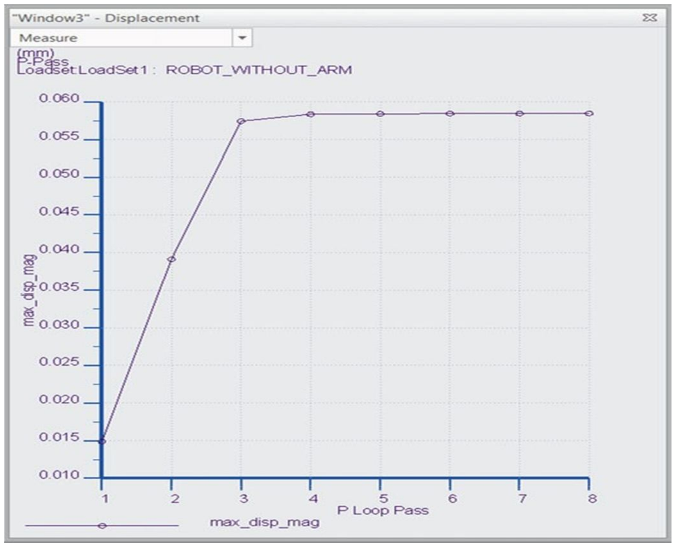
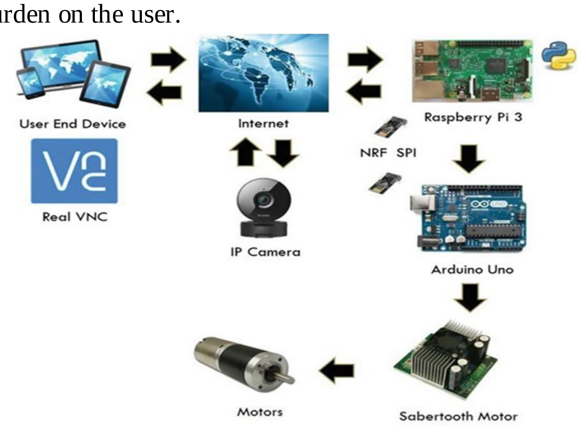


Fig;2.Maximum displacement as a function of P loop pass is shown graphically.

In order to control the robot's motions, the Arduino uses a motor driver called Sabre-toothed. Arduino is not capable of providing enough current and voltage to meet the high voltage and current needs of the motors. as high as 60V was utilised with our motor driver, which meant we needed a large amount of power (a large amount of voltage was required) (up to 32 V). When the user releases the button, a function of the python script on Raspberry Pi 3 is executed. A collection of strings (such as "Speed," "Direction," etc.) are sent through RF-SPI connection to the Arduino. The HD IP Camera feed is constantly accessible to consumers through their Internet cameras. It is simple to locate and care for the animal thanks to this technique.
In addition, the robot is provided with a robotic 6-DOF arm to select food off the rack and take it to the animal and then place it in front of the animal. When the user approaches the animal, the food drop feature is pre-coded and the user needs only to invoke the food drop feature. This reduces the burden on the user.



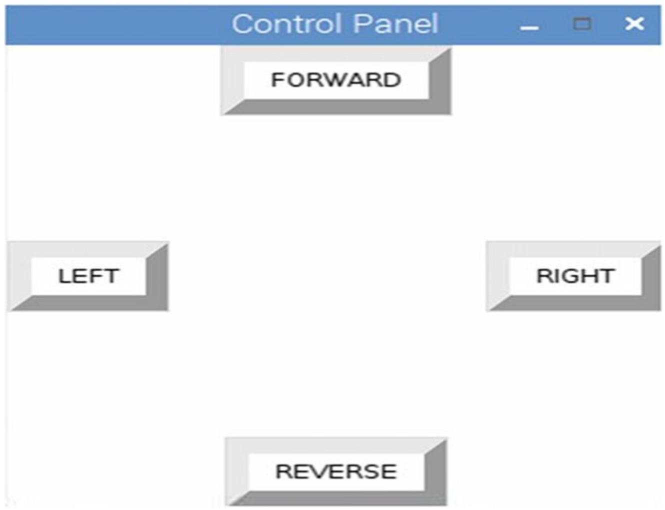
Fig;3.The depiction of the system

A. Graphical User interface

Tkinter, the Python library for creating GUIs, is used. Python had, and still has, the most widespread GUI (Graphical User Interface) library in the Python world, and that is Tkinter. Plus, there is a thin object-oriented layer on top of Tcl/Tk. Although Tkinter is not the only Python GUI development toolkit, it is by far the most often used. No matter how often it is used, it is still the most common. When you first run a programme, it generates a window named 'Control Panel' with four buttons: Forward, Backward, Right, and Left. The robot advances when you click the ‘Ahead' button, and moves in the correct direction when you hit the ‘RIGHT' button. Anywhere in the world where there is an internet connection, you can use VNC to access the Python GUI. It is possible to build a more user-friendly graphical user interface.

B. Raspberry Pi-Arduino RF-SPI Communication

The SPI bus has been created with full duplex serial communication in mind. serial connection (Series Peripheral Interface). Real Time Clocks are typically used with the SPI bus for communication with flash memory and sensors (RTCs). Typically, Serial-to-SPI masters are used to interact with slaves through SCK, MOSI, MISO, and SS lines. At the same time, wiring was done for the Arduino and Raspberry Pi, and the NRF24L01 was connected to the SPI interface.



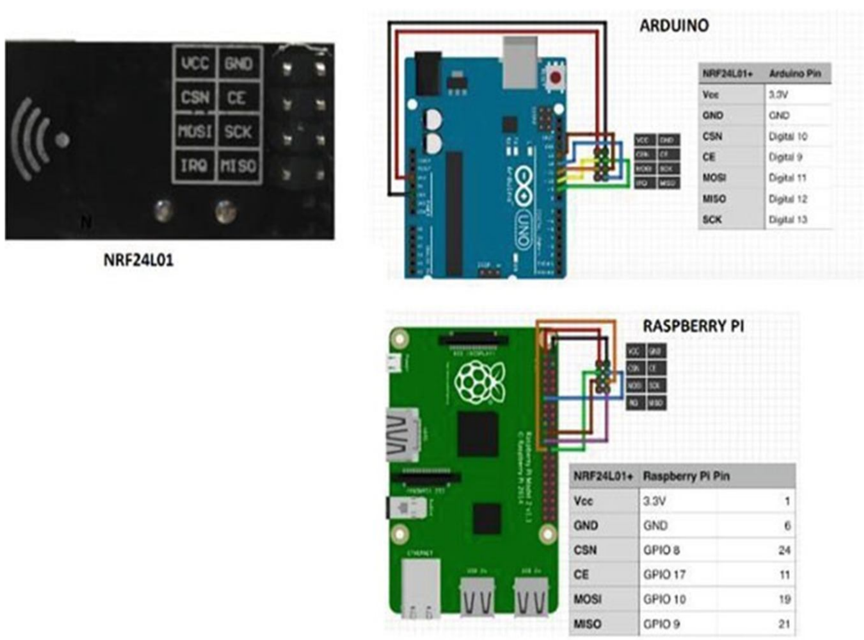
Fig;4.GUI

C. Camera feedback

The IP camera is connected through Wi-Fi Protected Setup to a wireless network (WPS). The Router is continuously connected to the Internet, and by inputting the IP address of the camera, the user may see the camera through the Internet cloud. In 1080p live videos of what the robot sees for pet feeding, the user receives in real time feedback. This helps the user to take the robot to the required place. Figure 9 shows the user's Live Input Camera setup.

D. Mechanical layer and Management

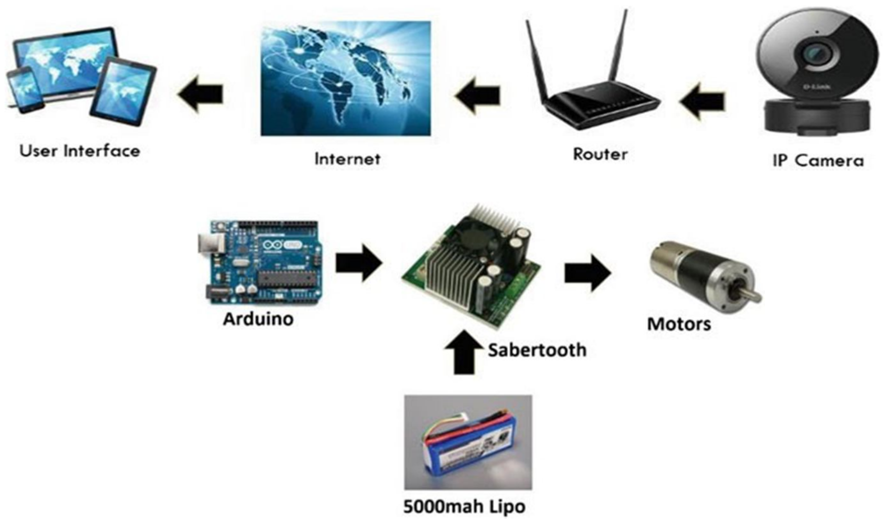
The pet robot has four high torque 7 A motors that allow it to traverse across rough terrain with ease. The four-wheel system is designed so that the robot can move even if it is knocked down. This characteristic enables it to ascend and descend.



Fig;5.SPI communication

Fig;6. Camera setup

The stairs without incident In order to turn the 28 A 12 V motor system in the proper direction, the Arduino's output controls the Sabertooth motor driver. The robot's 5000 mAh 12 V lithium polymer battery provides electricity. The Arduino and HD camera use the sabre-tooth motor driver's 5 V regulated power supply. By using a diode and a safety circuit, this system is fully safe against back current and short circuit. Figure 10 depicts the system's power management and mechanical layers.



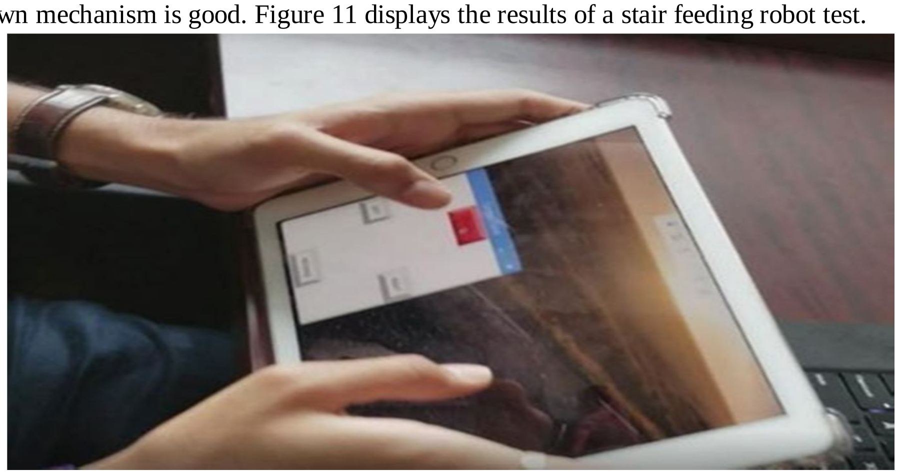
Fig;7.Mechanical and power management

V. RESULTS AND DISCUSSION

The robot was tested to play the job of a worker and feed his pet home. In Figs 8, 9 and 10 the many scenarios are illustrated till they reach the desired result.

Figure 8 shows a person sitting at an office with the GUI of the pet feeder, trying to feed his pet in his or her house.

Figure 9 shows a food-filled and office pet-fed robot. Figure 9 shows The camera feedback is displayed to the user while guiding the robot on its approach to the objective. Figure 10 shows. While there have been some reports that animals may sometimes be fed at home through a home animal feeding robot without any issues, the overall performance has been praised. It has been shown that the four-wheeled up and down mechanism is good. Figure 11 displays the results of a stair feeding robot test.



Fig;8.The user is seated in the office.

Fig;9.At-home pet feeding robot

Fig;10.The pet feeding robot has arrived at its destination.

Fig;11.Staircase test for a pet feeding robot

VI. CONCLUSION

We think that we have accomplished our objective through thorough research, coding, and testing in the area of pet feeding. Our design goals were all completed. Thanks to the internet, we were able to see the camera positioned on the robot as if it were really live. We used the smart device's GUI to manage the pet feeding process carefully. It's possible the pet feeding robot might climb and descend the stairs easily. Our product differed from other products because of the all-terrain vehicle design we used for the prototype. It is furthermore in use to move the pet's food from the storage to the on-board platform with the use of the 6 DOF robotic arm. In this example, the pet consumes the food that appears on this platform. This had the unfortunate effect of putting the programme into real-time operation, which also met the performance requirements.

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