Cat Nanny: Affordable Cat Caring System

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Abstract— There are more than 94 million cats owned in the United States. According to the US department of labor, there are 127 million full time employees who spend an average of 8.5 hours at work and away from home. This means that almost all cat owners with a full time job or classes do not spend enough time with their cats. The most automated pet feeders on the market are very expensive and most popular affordable solutions are not smart enough. In this paper, we propose an affordable and smart cat caring system, Cat Nanny, that provides feeding, playtime, and monitoring.

Keywords— Cat Caring System; Affordable solution;

I. INTRODUCTION

Nowadays people have a busy daily schedule, so they are either away from their home for most of the day, or traveling. As a result, this is a problem for pet owners because they end up leaving their pets with no food and no playtime that could affect the pet. In 2018, the American Pet Products Association (APPA) conducted the National Pet Owners Survey, which reports that 47.1 million households owned at least one cat [1]. The Bureau of Labor Statistics reported in 2018 that approximately 128.5 million people were employed full-time [2]. Also in 2018, the National Center for Education Statistics reported that 19.9 million people were going to be attending college classes [3]. With so many people being away from home all day, there are a lot of cats that spend all day alone. If cats are left alone for multiple days at a time, or if the owner went on a business trip or vacation, cats could become clingy, aggressive, groom themselves excessively, or urinate on their owners belongings [4].

In this paper, we propose a complete cat caring system, Cat Nanny. Cat Nanny includes a mobile application, food and treat dispensing, monitoring, and playing systems. Cat Nanny helps the average busy cat owners take care of their cat with an affordable, easy-to-use solution. To achieve this we use a Raspberry Pi connected to sensors and a webcam, and build a simple Android application. We use the technology of temperature and motion sensors integrated into the build of the feeder in order to give Cat Nanny an advantage over other automatic pet feeders in the market.

The rest of this paper is organized as follows. In section 2, we discuss the existing products that allow owners to feed their pets remotely, and point out the weaknesses or missing features. In section 3, we present the design and implementation of the Cat Nanny. In section 4, we test how well Cat Nanny works when the owner is in different locations away from home, as well as show the benefits the Cat Nanny provides to both the cat and the owner. Finally, we conclude this paper with a summary of what we have achieved with Cat Nanny.

II. EXISTING SOLUTIONS

On Amazon, the most popular automatic cat feeders are the Iseebiz Automatic Cat Feeder, the WOpet Automatic Pet Feeder, and the WOpet SmartFeeder. Iseebiz allows you to feed your pet 4 meals at scheduled times with portion control, record your voice so it plays when they eat, and uses an infrared (IR) sensor to stop dispensing food [5]. The WOpet Automatic also allows you to schedule up to 4 feedings per day with portion control and allows you to record your voice [6]. The WOpet SmartFeeder is controlled through an application, allows up to 6 meals per day with portion control, and features an HD camera for voice and video recording [7].

The most popular existing solutions are considerably affordable, but they do not take advantage of new technology that can take a system as an automatic cat feeder and make it smarter. Because the affordable automatic cat feeders out there are not smart enough, sometimes they create other problems. For example, there are programmable automatic cat feeders where the user can set a time frame and frequency of when to dispense food. Because those automatic solutions do not provide the full interaction and monitoring of their cat, sometimes those scheduled services are not helpful to both cats and cat owners

In order to go beyond the existing systems, our solution is to make the ultimate system where the user can monitor and interact with their cat in different ways, whether it is watching them using a camera or by entertaining them with a game. A very important factor is unfortunately left behind, the atmosphere, specifically room temperature for cats to be comfortable and not get sick. The main issues with the current solutions are defined below.

A. Affordability

Most automated pet feeders on the market are very expensive and not suitable or affordable for college students or others with a poor stream of income. The better the feeder is, the more expensive it gets, preventing many devoted cat owners from being able to use these devices and instead having to hire a cat-sitter to check on their cats.

B. Portability

Most automated pet feeders are bulky and heavy in design, so it is not convenient or portable. A lightweight, portable solution would give owners with small homes or who move a lot the ability to have one of these systems in their home.

C. Monitoring

Of the top three feeders listed at the beginning of this section, only one gives the user the ability to check on their pet and watch if they're eating. Most automatic pet feeders do not give this option, and if they do, they are the more expensive models.

D. Activities

There are hundreds of automatic feeders and automatic play toys, but it is almost impossible to find a product that provides both. To take good care of the cat while the user is away from home, there should be more than just food being provided, the cat also needs to exercise as well to keep them from getting bored or gaining weight.

III. CAT NANNY

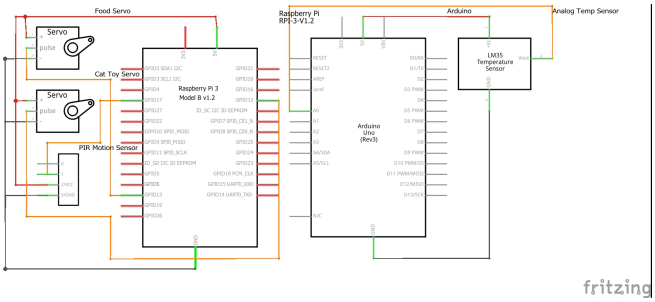

Fig. 1. The schematic diagram of Cat Nanny

Cat Nanny is designed to be more affordable than the other cat feeders mentioned in section 2. Cat Nanny also includes toys and temperature monitoring, while other products on the market do not. The existing cat feeders and monitors on the market have either expensive electronics or expensive materials, or even both, which makes the system even more expensive than it is. In order to make our solution affordable, we use Arduino UNO microcontroller, Raspberry Pi3 Model B V1.2, PIR motion sensor, VMA320 Analog Temperature Sensor and FS90R Servo Motors to have the features needed with a fraction of the price of the Cat Feeders on the market. The schematics of the Cat Nanny are illustrated in Figure 1.

We decided to make the system to be portable and durable enough so that it would not raise the cost of the build. One of the factors that made portability possible is having the cat food bowl to be detached from the system so we can easily remove it and clean whenever is needed. We also added a custom-built application that connects to the system and controls it from anywhere with a Wi-Fi connection to the Internet. This makes our system stand out against other competition systems on the market with an expensive price and app.

3.1. Mobile Application

The Cat Nanny application is a simple Android application that connects to the Cat Nanny system through a Wi-Fi connection. The application prompts the user to register and login to the system. The application has a simple user interface with the needed features for ease of use and accessibility. As shown in Figure 2 left, the user logs in to the main screen. It features a video feed, temperature, and buttons to feed, treat and play as seen in Figure 2 right. Also, the user can set reminders, look up statistics, and view settings.

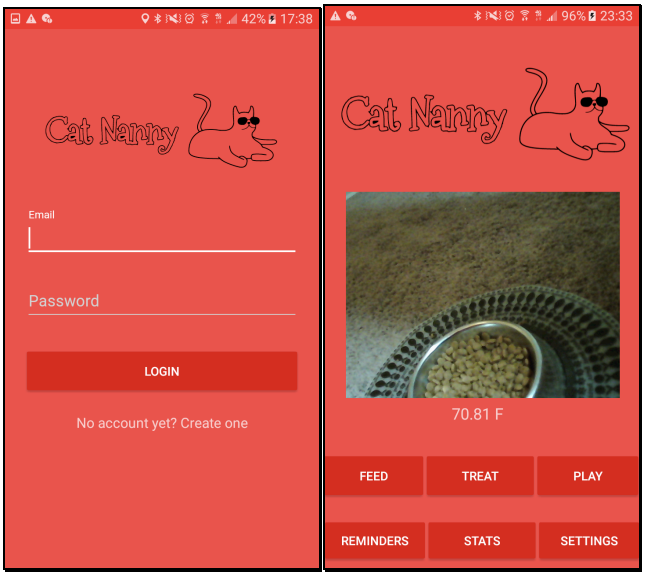

Fig. 2. The login and main screen of the application

The application communicates with the Cat Nanny device through the use of the Volley library, which allows you to send requests over HyperText Transfer Protocol (HTTP) to a remote server, which in our case is a Python Flask server listening on port 5000 on the Raspberry Pi [8]. Through the use of Volley, the application sends a request, *http://192.168.1.130/servo?type=feed*, to activate the food servo. The function defined under the route "/servo" calls the function in the main script that controls the servo. The implementation for this is shown in Figure 3.

```
// create HTTP connection to Python script on Raspberry Pi for feed button
Button feedButton = findViewById(R.id.btn_feed);
feedButton.setOnClickListener((view) -> {
        StringRequest feedRequest = new StringRequest( url "http://192.168.1.130:5000/servo?type=feed",
                new Response.Listener<String>() {
                    @Override
                    public void onResponse(String response) {}
                },
                new Response.ErrorListener() {
                    @Override
                    public void onErrorResponse(VolleyError error) {}
                });
        RequestQueueSingleton.getInstance(getApplicationContext()).addToRequestQueue(feedRequest);
});
```

Fig. 3. The Volley request for the Feed button

In order to receive the webcam feed, the application instead uses the Picasso library, which was developed by Square and provides a simple way to load images into an Android application [9]. Picasso also allows you to specify a URL to load images from, so images from the webcam feed are retrieved by the URL *http://192.168.1.130/8081*. The Picasso code is shown below in Figure 4.

```
// stream the video feed from Cat Nanny using Picasso
final ImageView vidFeed = findViewById(R.id.vidFeed);
final Handler vidHandler = new Handler();
vidHandler.postDelayed(() -> {
        Picasso.get().load( path: "http://192.168.1.130:8081")
                .placeholder(vidFeed.getDrawable())
                .noFade()
                .networkPolicy(NetworkPolicy.NO_CACHE, NetworkPolicy.NO_STORE)
                .memoryPolicy(MemoryPolicy.NO_CACHE, MemoryPolicy.NO_STORE)
                .into(vidFeed);
        vidHandler.postDelayed( r: this,  delayMillis: 1000);
},  delayMillis: 1000);
```

Fig. 4. The Picasso image loading

3.2. Physical Device

The device, as shown in Figure 5 left, is an affordable Internet of Things (IoT) cat care system. Cat Nanny feeds, gives treats, and plays with a cat, all controlled through the Cat Nanny application. In Figure 5 right, the electronic components are presented. The Raspberry Pi is the central hub of the device, providing 5V power, ground, and output for the two servos and the motion sensor. The temperature sensor is powered by and outputs to the Arduino, which is connected to the Pi through a Serial USB cable. The servos and motion sensors are controlled by a Python script that uses the RPi.GPIO library. The outputs from sensors and servos are inserted into a SQLite database hosted on the Pi, which the application then reads the data from. As mentioned above, the application communicates with the device through a Flask server listening for HTTP packets on port 5000, and the Pi is also running a script that uses OpenCV to capture a picture every second. That script is run by the second Flask server mentioned in the previous sub-section, which is the URL the app uses to receive the webcam feed.

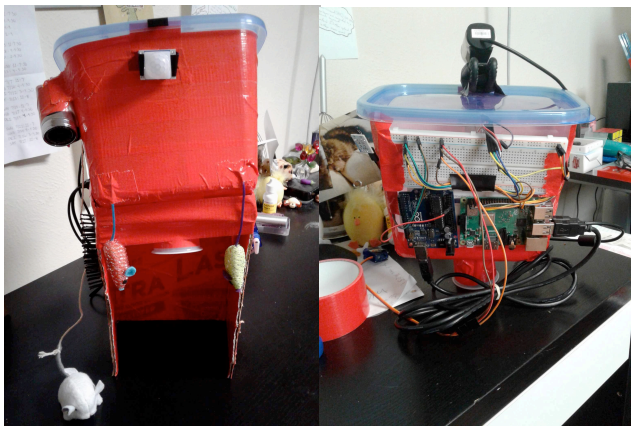

Fig. 5. The Cat Nanny device

The webcam, shown in Figure 6, is used to monitor the cat whenever the application is opened. By using this camera and the motion sensor, the user receives a notification when their cat is at the device and looking for food or treats. The webcam is controlled by the OpenCV script and the data is transmitted wirelessly by the Flask server listening on port 8081.

The device features a 3.2L food container with a divider placed inside to hold the cat food and treats. There is also a food bowl to catch the dispensed pet food, and a plastic dispensing valve that is controlled by an attached servo motor to dispense the food or treats.

Fig. 6. The Cat Nanny webcam

The toy system is a feature that promotes motion and exercise as a way to interact and play with the cat when the user is away. The toy system consists of four toys. Cat Nanny has a feather toy controlled by a servo and two hanging mice toys as shown in Figure 7 left. Cat Nanny also has a larger mouse toy tied to a string, and a face scratcher, shown in Figure 7 right. First, the feather toy moves around in a circle, the noise of the servo motor will attract the cat's attention and the cat will then bat at the moving toy. Second, the small hanging mice are also for the cat to bat it, they are in the cat's field of view when they walk up to the Cat Nanny having them hanging will intrigue the cat. Next, the larger mouse has a long string so it can be moved around. It is designed to act as a small-scale mouse chasing game. Lastly, the face scratcher has soft prongs that the cat can rub their whiskers or side on, giving the cat an opportunity to rub their scent on the Cat Nanny while also receiving a form of affection that the owner is not present to give.

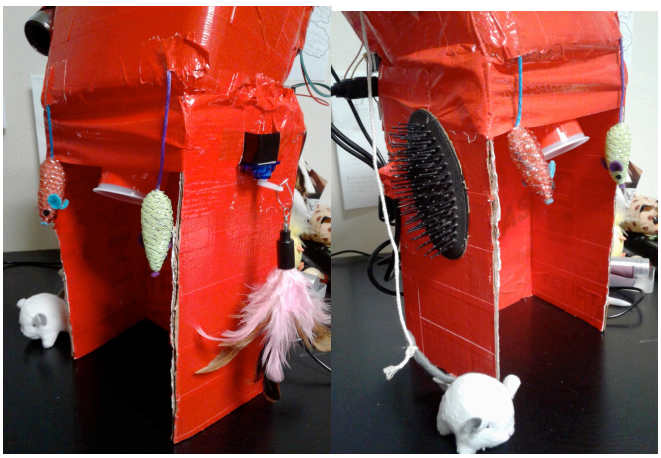

Fig. 7. The Cat Nanny toys

The motion sensor detects motion and notifies the user through the application if their cat is in range of the system and

may be looking for food if there isn't any left in their food bowl. It is controlled through the main script of the Raspberry Pi and the mobile app sends a query to the database once every 60 seconds to check if motion has been detected. This amount of time was chosen to avoid overwhelming the user with notifications if something else happened to be detected by the motion sensor or if the cat was just walking by.

The temperature sensor monitors if the room is warm enough for the cat. The ideal temperature for an indoor cat is between 45 °F [10] and 100 °F [11]. By allowing the owner to keep track of the temperature, they can see right away if their heating or air conditioning breaks and take the steps to get it repaired right away. The owner then avoids a situation where they come home from their trip and their cat is ill because of being too cold or hot. This feature also enables the owner to change the temperature remotely if they have a smart thermostat like a Nest or other product.

IV. EVALUATIONS

For requirements, the Cat Nanny needs to be able to communicate with the mobile application both in the home and from long distances. The system also needs to be able to reliably dispense food and treats without any clogs or malfunctions. Finally, the system needs to be able to reliably move the feather toy around when the Play button is pressed in the application.

TABLE I. CONNECTIVITY

Cat Nanny Connectivity	**Locations**	
	Response (ms)	***Reliability (%)***
Home	1	100
1 Mile away	1	100
Across the city(> 3 mi. away)	1	100

For communication, we have tested the application from different locations to see if the HTTP connection between the Cat Nanny device and application is able to stay open until the owner closes the app. The reliability criteria is that the user must be able to log in, press the Feed, Treat, and Play buttons, open Reminders, Stats, and Settings, and keep a constant webcam feed, so the percentage is calculated out of 8 points. The results of these tests are summarized in Table 1.

Next, to test the reliability of the food dispenser, we pressed the Feed and Treat buttons 25 times each, for a total of 50 function calls, to observe how many times the dispenser does not release the food or treats. The results of our tests were that the Cat Nanny was able to provide food 25/25 times, and treats 25/25 times, providing 100% feeding reliability. To test the reliability of the cat toy, we also pressed the Play button 25 times to observe if there were any malfunctions and the results showed that the play toy worked 25/25 times, also providing 100% reliability.

Finally, we evaluated the cost of the system and compared both that and the functions it provides to the WOpet SmartFeeder, the most popular automatic cat feeder on Amazon that uses a mobile application. The cost of the system is $70 while the Iseebiz costs $59, the WOpet automatic feeder costs $90, and the WOpet SmartFeeder costs $130, placing the Cat Nanny on the less expensive end of pet feeding products. The SmartFeeder features up to 6 custom portioned meals per day, an HD camera, and voice recording. The Cat Nanny features unlimited set food portions, treat dispensing, an HD webcam, four toys to play with, and a scratching surface for when the cat wants to be pet. For almost half the price, the Cat Nanny provides more than just food; it provides treats, play time, and grooming, making it a complete cat care system instead of just a wirelessly controlled pet feeding device.

V. CONCLUSION

The Cat Nanny is for busy pet owners who want to make sure their cats are taken care of while they are away, while also minimizing costs. We provide a phone application to have an ease of use feature to the system and also most importantly a way to control the system. The application is simple and straightforward to the features of the system. The simple application interface is designed not only to make it easier to use, but also not expensive. The build of the system is done mainly to prove a concept that the system works and having the needed features as well, but keeping in mind the portability aspect of it.

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