Smart Pet House

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***Abstract*—Pets need special treatment and special care. Due to nowadays busy life style, this task is not as simple as it used to be. The goal of this work is to introduce, design and implement a smart pet house. The objective is to allow pets' owners to automate simple things, like monitoring, lighting, feeding and air conditioning controls. Implementing smart pet houses will assure pets' owners an increased comfort and peace of mind especially when pets are unattended. Features included in the house are a monitoring system, a ventilation system, and an illumination system. The aim of introducing smart technology in the pet house is to achieve more effective, efficient, comfortable, secure and smart pet management system. Various functions that serve the purpose of the work have been developed and a small prototype has been designed and implemented as a proof of concept.**

Keywords—smart; pet; house; pet house; embedded systems

I. INTRODUCTION

The purpose of this work is to design and implement a "Smart Pet House". The term "Smart House" is a hot topic nowadays, especially with the ongoing advancements in technology. Since the concept is similar, however the occupants are different; we will adopt the same definition of the "Smart House" for our "Smart Pet House", noting that the occupants are "PETS".

A "Smart Pet House" is a residence for pets wired with technology features that monitor the ambient circumstances as well as the activities of their residents (pets). This is to improve their overall quality of life, increase independence and prevent emergencies. Pet owners need a way to automate the process of monitoring, feeding and taking care of their pets. Today's world of working Dads and Moms and the nature of job assignments that generally lead to pets being unattended for long hours a day has raised a lot of concerns. This makes it necessary to look for alternative ways to handle the task of taking care of the pets.

The proposed 'Smart Pet House' will have all the necessary functions to operate. Functions include feeding, watering, cleaning, illumination, ventilation and monitoring – All done smarter. The proposed smart pet house will help lessen the load on pets' owners of taking care of their pets. In this design, pet houses are transformed from a stone or wooden box into an interactive overall system that includes innovative technology. Making pet houses more interactive will eventually enhance owners' lifestyle in addition to their user experience.

The rest of the paper is organized as follows: literature survey is presented in Section II. Section III details the design and implementation of our smart pet house. Finally, the paper is concluded in Section IV.

II. LITERATURE SURVEY

A pet house is a small shed commonly built in the shape of a house, a shelter intended for a pet. It is a structure in which a pet is kept and it is intended to provide a safe place for pets outdoors. Humans often build "houses" for pets that resemble smaller versions of human domiciles, built by humans. These include bird-houses, hen-houses, chicken-coops and pet houses; while housed agricultural animals more often live in barns and stables. Pet houses are often used when the pet is kept outdoors in the garden and on areas around a house and/or a farm. Pet houses come in many different shapes and styles and are made from a variety of materials including wood, plastic, aluminum, and steel. Pet houses also vary by their intended use. Some houses are designed to sit stationary in your back yard. However, there are also portable pet houses.

Although the term "Smart House" was first used in the 1980s, the concept is far from new. The early documented attempt to envisage something very similar dates back to the 1960s, with Walt Disney's Experimental Prototype Community of Tomorrow (EPCOT), presented in 1966. A Smart Home will not be able to accomplish much without appliances to control, nor will it be able to communicate to these devices in the absence of a controlling network/interface.

A common definition of a Smart Home is of an "electronic networking technology to integrate devices and appliances so that the entire home can be monitored and controlled centrally as a single machine" [1]. Another term that describe the same technology is "domotics", which derives from the Latin word "domus", meaning home, and "informatics", meaning the study of the processes involved in the collection, categorization, and distribution of data. However, since this technology is still very much in flux, other terms are also used in the literature with equivalent meaning, such as: "home automation", "smart house", "digital home" or "electronic home". Furthermore, note that,

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although the terms “house” and “home” have different meanings in the English language, they are often used alike in this context.

For the most part, the work done in the field of smart homes has been mostly targeted to humans. The market of having smart pet homes has been so far overlooked. A very recent attempt was by Samsung [2] as they introduced the first smart pet house. Features included in their house are, an electronic feeder, a dog-sized treadmill, a hydrotherapy pool and a TV. For the time being, this house is priced at $30,000, which could be very expensive for a lot of interested customers.

Another very recent attempt as well is T-Pai [3]. It is an intelligent dog house with features of auto feeding, online interaction, auto sterilization, auto toilet, constant temperature system, and access control system. The system is still not being sold and the price is not announced so far.

In this work, we aim at building a smart pet house with the most basic and needed features and provide it at a reasonable price.

III. DESIGN AND IMPLEMENTATION

A. Design

The proposed smart pet house looks like an ordinary pet house and it is made of a recycle-able hard plastic. An electric fan is installed on the roof. The fan will be connected to a temperature sensor to turn it on/off automatically. A Camera is installed in the entrance to monitor the movement of the pet. An IR sensor is used to detect the presence/absence of the pet. LEDs are mounted on the interior ceiling of the pet house. LEDs are connected to a light sensor to turn them on/off automatically. A feeder is placed inside the pet house. All components are controlled through a Visual Basic interface that can be accessed directly/remotely or via the Web. The system provides data logging functionality. The system will create logs of the actions performed and the user can generate a report to check all the logs. The system also has the capability to send email notifications to the user in the case of any malfunction. Email messages will contain the error code when applicable. Fig. 1 presents a 3D design of the proposed smart pet house.

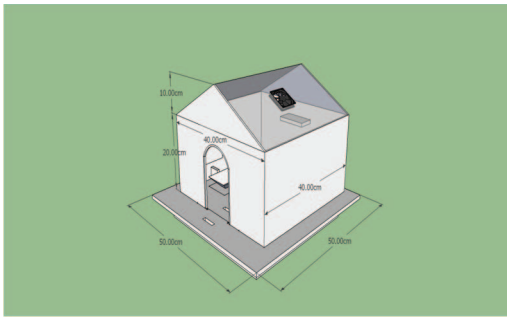

Fig. 1. 3D Design of Smart Pet House

B. Components

To implement the proposed design, components purchased are provided below. The purchased components were used to build the desired outcomes. They were first tested independently, and then integrated with each other to reach the desired functionality.

TABLE I. PURCHASED COMPONENTS FOR SMART PET HOUSE PROJECT

Item Name	Quantity
Phidget Interface Kit 8/8/8 [4]	2
Dual Relay Board	1
IR Reflective Sensor 10cm	3
Phidget Advanced Servo 8-Motor	2
Hitec HS-422 Deluxe Servo	1
USB Camera	1
Precision Temperature Sensor	1
Fan 5 - 12 VDC	1
Light Sensor 70000 lux	1
LEDs	3
Feeder	1
Wires, connections, and sleeves	1

The Phidget interface kit is an IO board that is used to connect analog sensors and control switches. It can handle up to 24 devices and could be connected to any PC using USB. Libraries are readily available under Visual Basic for interfacing functionalities.

The total cost of the purchased components is KD 250, which puts the total price of the home at just about $ 1000 when adding the tablet PC and home construction prices.

C. Circuit Diagram

Fig. 2 illustrates how the components are connected together in order to produce the desired functionality. Note that the PC in the figure is actually a tablet PC.

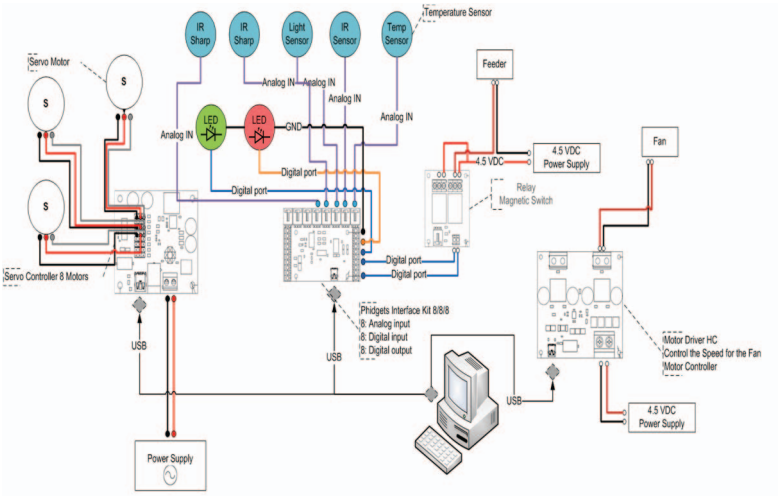

Fig. 2. Circuit Diagram

D. *Assembly and Testing*

1. *The Controlling Application*

A Visual Basic interface is developed to control the hardware components in the pet house. The interface is installed on the PC to which the components are connected. It is also available for access from outside through the Web or remotely. Fig. 3 shows the interface developed.

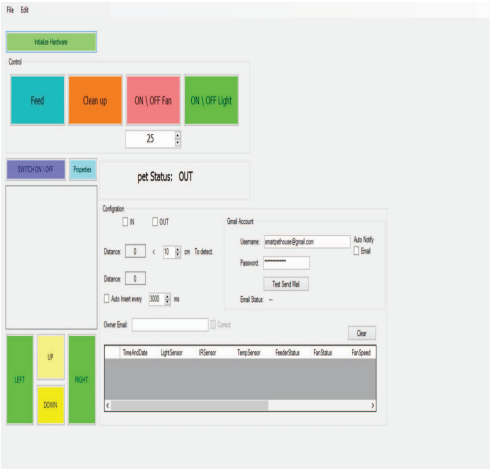

Fig. 3. Controlling Interface of the Smart Pet House

2. *The Smart Ventilation Subsystem*

The smart pet house has a smart ventilation subsystem composed of an electric fan and two temperature sensors. The fan installed on the side of the pet house is controlled by the PC. The fan will turn on when the ambient temperature goes above a pre-programmed value and it will turn off when the ambient temperature goes below a pre-programmed value. Both values could be set by the owner through the controlling application. Also the fan can be turned on/off manually through the controlling interface. Fig. 4 shows the temperature controlling interface.

Fig. 4. The GUI for Temperature Sensor Set up

3. *The Smart Illumination Subsystem*

The smart pet house has a smart illumination subsystem composed of a light sensor and three LEDs. The LEDs installed in the inner wall of the pet house are connected to a light sensor. They will turn on when the light level goes below a pre-programmed value and they will turn off when the light level goes above a pre-programmed value. Both values could be set by the owner through the controlling application. The LEDs can also be turned on/off manually through the controlling interface. Fig. 5 and Fig. 6 show the light controlling interface.

Fig. 5. Setting the Threshold for the Light Sensor

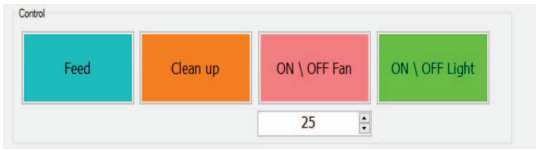

Fig. 6. Buttons used to turn on/off lights

4. *The Monitoring Subsystem*

The smart pet house has a smart monitoring subsystem composed of a webcam and a motor to rotate the cam in various directions. There is also an IR sensor to detect the presence of the pet inside the house. The camera can be turned on/off manually through the controlling interface. Moreover, the camera could be rotated Left/Right/Up/Down. Fig. 7 and Fig 8. show the camera live feed and control panel as well as the camera settings panel.

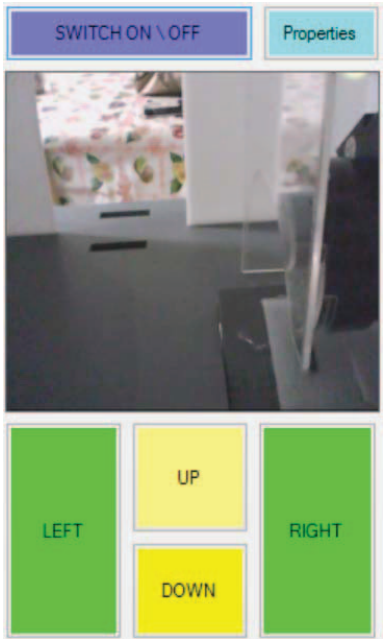

Fig. 7. The GUI for the Smart Monitoring Subsystem – I.

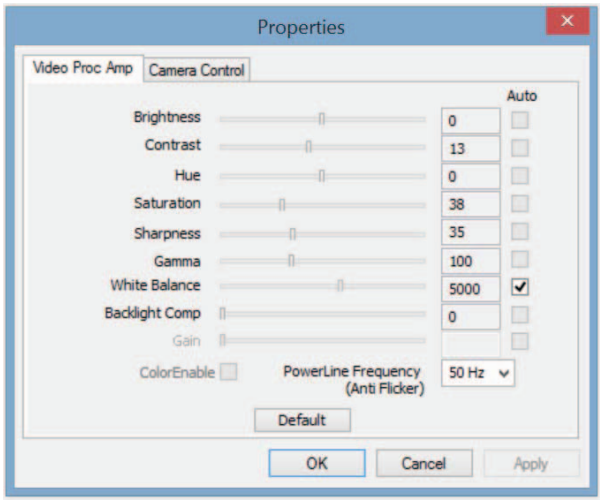

Fig. 8. The GUI for the Smart Monitoring Subsystem – II.

Another part of the smart monitoring subsystem is an IR sensor, placed at the entrance of the house. The sensor is used to detect the presence or absence of the pet in the house and update the status accordingly. Fig. 9 shows the GUI implemented for this functionality.

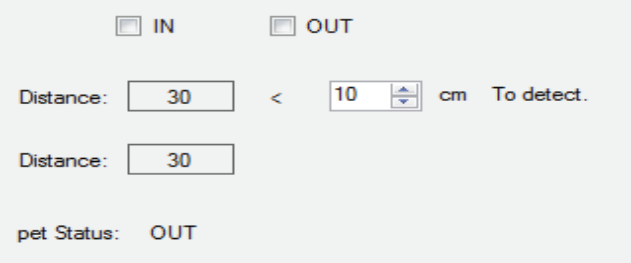

Fig. 9. GUI to detect the presence of the pet in the Pet House

5. *Feeding and Cleanup*

The pet owner can connect to the controlling interface in order to check the status of the food in the feeder. The level of food in the feeder is detected using an IR sensor installed for this purpose. If no food is detected, the pet owner can give an instruction to the feeder to release the food to the bowl from which the pet eats. Also, the owner can give an instruction to feed the pet every X number of hours (for example, every 4 hours for a cat and every 6 hours for a dog). Fig. 10 shows how this can be done through the controlling interface.

Fig. 10. GUI for the feeder

The pet owner can also give an instruction to clean up the feeder using the controlling interface. In this case, the eating bowl will be flipped over and the food inside the dish is poured inside an area designed for this purpose. Fig. 11 shows how the cleanup functionality is implemented.

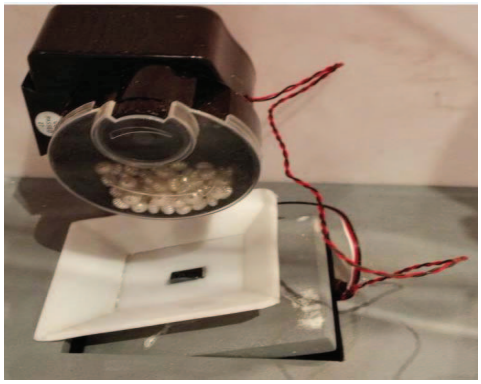

Fig. 11. Feeder cleanup process

6. *Data Logging/Reporting*

The smart pet house system provides data logging functionality. The system creates logs of the actions performed and the user can generate a report to check all the logs. Data is inserted into logs on pre-defined intervals. Fig. 12 shows the GUI implemented for this functionality where you can setup the logging duration.

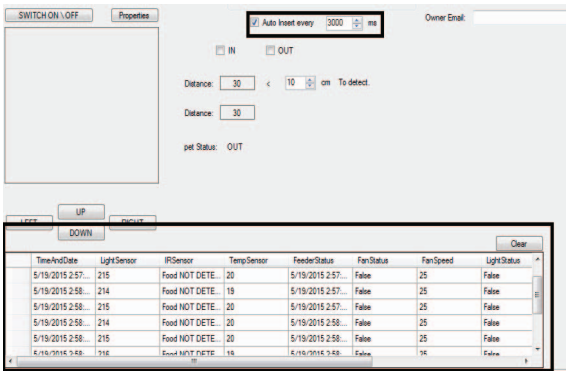

Fig. 12 GUI for the Data Logging Functionality

7. Troubleshooting/Email Notifications

The System has the capability to send email notifications to the user in case of any malfunction. The email message will contain the error explanation when applicable. Fig. 13 and Fig. 14 show how the email is set up using the controlling interface. The figures show a sample test email sent using the implemented troubleshooting functionality.

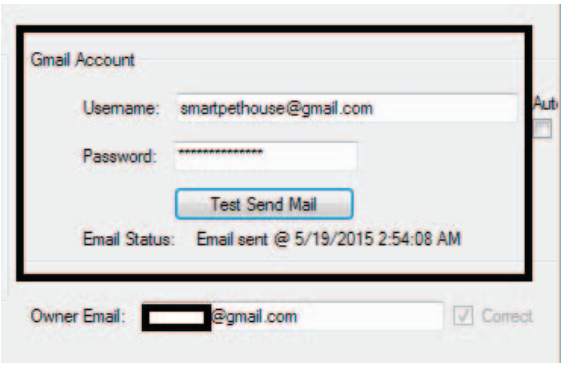

Fig. 13. GUI for setting up email notifications

Fig. 14. Sample Troubleshooting email

E. Safety Considerations

In order to assure the safety of the pet while inside the house, the following safety measures have been considered:

1. The pet house was built from a durable material (hard plastic) that can hardly be broken and can withstand the outdoor heat, rain and wind.
2. All components are fixed tightly in the main body of the pet house using screws and they cannot be removed easily by the pet.
3. Power supplies, the Phidgets interface and most wiring is hidden in the bottom section of the pet house and cannot be seen by the pet.
4. The fan is protected by a hard plastic case to protect it from being hit or broken by the pet and is fixed tightly to the ceiling of the pet house.
5. The feeder is protected by a hard plastic case to protect it from being hit or broken by the pet.

F. Impact On Environment/Owners

The designed smart pet house is a green environment product in the sense that:

1. The pet house is entirely made from hard plastic, a material that can be recycled once it is not needed.
2. All hardware components can be recycled when the time comes.
3. Energy conservation: LEDs, the feeder and the electric fan are turned on only when needed thus reducing the energy consumption of the house.

When it comes to pet owners, especially working people, the smart pet house will allow owners achieve more effective, efficient, comfortable, secure and smart pet management system. Pet owners will enjoy their leaves, vacations and outdoor times without being concerned about leaving their pets unattended.

IV. CONCLUSIONS

The goal of this paper is to introduce, design and implement a smart pet house. A smart pet house is a pet house equipped with smart features such as a Smart Monitoring System, a Smart Ventilation System, a Smart Illumination System and Data logging and troubleshooting features. The objective is to allow pets' owners to automate simple things, like monitoring, lighting, feeding and air conditioning. This helps to achieve a more effective, efficient, comfortable, secure and smart pet management system. The implemented system had all the necessary functions to operate. Various functions that serve the purpose of the system have been developed and a small prototype has been designed and implemented as a proof of concept.

In future work, it is intended to address the issue of power consumption of the pet house thus increasing its life time. In addition, we also aim to add advanced fault detection schemes covering all the used components. Adding a water container on top of the feeder is another direction as well.

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