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MODERNIZATION OF THE GAME COUNTRY USA, INC. DAY II GAME FEEDER

Joshua Berry

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by

JOSHUA BERRY

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May 15, 2015

ABSTRACT

MODERNIZATION OF THE GAME
COUNTRY USA, INC. DAY II
GAME FEEDER

Joshua Berry, EE

The University of Texas at Arlington, 2015

Faculty Mentor: David Wetz

The Day II Feeder dispenses a pre-programmed quantity of feed at pre-programmed times of day to attract wildlife to its location at predictable intervals. Its patented design incorporates a light sensor that monitors ambient light and uses sunrise and sunset as time references. This project replaces the feeder's currently outdated and complicated electronic control system and 24-switch physical programming interface with a completely new and user-friendly design that receives all control and programming settings wirelessly via Bluetooth from a companion smartphone application. This allows more user-selectable options for feed times and feed quantities. Also, all of the old electronic parts have been replaced with modern higher quality and significantly smaller surface mount parts. This has been accomplished without significantly increasing the feeder's cost or power consumption, or decreasing its

reliability. Its control parameters are much more versatile, and several additional features have been added. It uses the same physical housing, motor, and battery as the current design, so that it is a drop-in upgrade.

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CHAPTER 1

INTRODUCTION

1.1 The Day II Feeder

The project assigned to our group encompasses the design of a unique, modernized version of the Day II Feeder, which is currently manufactured by Game Country Inc. [1]. This feeder is designed to dispense corn or other feed at specified times of the day in order to attract wildlife to the location of the feeder at predictable intervals for hunters, wildlife photographers, and other wildlife enthusiasts. The goal is to modernize the electronic control system of this feeder, which currently uses parts and methods that are 15-25 years old.

1.1.1 Day II Feeder Design

The patented design of the feeder incorporates a light sensor that continuously monitors the ambient light of the feeder's surroundings over the course of several days and records the light/dark patterns in order to determine sunrise and sunset times each day. Once a pattern has been developed, the feeder can predict sunrise and sunset times, and use them as a reference for feeding times. Any inconsistencies in the light levels will be ignored because a real-time clock keeps track of the time passed since the last sunrise or sunset, and also looks for persistence in the measured values over time in order to make feeding decisions. This product is currently extremely reliable, and draws very little power, often running for months on a single 6V lantern battery. This reliability and ease of use have made this feeder very popular, and it already has an established customer base. The cost of the control board is currently about $10, and is roughly 25% of the total unit production cost. The unit is sold for around $75 [2], and the price for the updated version can be increased in proportion to any added cost of the newer components.

Currently 24 DIP switches on the control board inside the case of the feeder allow limited range of control over several variables [3]. The first 8 switches control the dispensing motor run time and speed. The remaining 16 switches control the number of feed times per day and the timing of feeding times. The new design will maintain all of the functionality of the original model, but will discontinue the use of switches to program the feeder and use a smartphone app to perform all control and programming functions wirelessly, using a mobile device. Smartphone control via an app will allow very precise, versatile, and customizable control of the feeder (unlike the current switch system), and allow for future upgrades in functionality. For example, the current switch control only allows 1 - 16 feedings per day, with a fixed spacing of 1 hour. The app will allow one feed time, or many feed times, at customizable timings and different run times/speeds for each feed, all of which will be updated based on changes in sunrise and sunset times. The range of the wireless connection will be limited to a maximum of around 100 meters. The control app will be built for both Android and Apple IOS as part of the project, and will be designed to be extremely user-friendly. This will all be accomplished without significantly increasing cost and power consumption of the control unit, or decreasing its reliability. It will also fit in the same housing and use the same battery type as the previous version.

1.2 Game Feeder History

Game feeders have been around for the past few decades [4]. They have a very strong and stable market. Hunters and animal enthusiasts alike want to attract game at set times of day, day after day, so animals become accustomed to receiving food from the same place every day. Users must be able to program these feeders for different seasons to fit the feeding times for the animals as well as their own preferences. Although some users will use the feeders near their homes, most feeders are used on game reserves, or ranches, where they replace the batteries in the feeder, program it, fill the reservoir with food and then leave it until the next season, after which the process repeats. In between seasons hunters want to continue attracting game to condition the game to come near their feeders to eat. This way, when hunting season arrives, hunters can reliably find a higher density of game animals near the feeder.

1.2.1 The Proposed Project

The new owner of Game Country Inc. requested a new feeder be designed that is useful in all three situations: for those with daily access to their feeders at home, for those who only have access every few weeks at a reserve or photographing location, and for those who have access every few months, at some distant hunting location. Since a large majority of big game are crepuscular [5], meaning they are mostly active at dawn and dusk, it is important that the feeding times are based around dawn and dusk and not on a normal 24 hour clock. This ensures that the animals expect food at regular feed times based on their normal feed cycle, which follows the varying natural light-dark cycle of each day and not the inflexible 24-hour clock that humans typically follow.

This project will use a light sensor to continuously monitor ambient light so the feeder can adjust feed times from week to week without any user input. The feeder should also be able to run for weeks to months on a 6V lantern battery. This project takes the next evolutionary step in making the current Game Country Inc. Day II Feeder more modern and convenient for all users by redesigning the control circuitry around Bluetooth connectivity for programming. The Android and IOS apps will allow many users to simply use their existing mobile device (such as a smartphone) to program the feeder. Since the apps are not limited by physical switches and a fixed number of digital I/O pins, there will be many more options for setting the feed times, feeding motor speed, and length of motor run time per feed cycle for this device. Bluetooth was selected for this project because of the three wireless communication methods commonly available in a mobile device (cellular, Wi-Fi, and Bluetooth), it does not require a network like cellular communication, has lower power consumption than Wi-Fi, and has short to medium communication range, making it the best choice of the three.

Animal enthusiasts who use game feeders at home will have the option of dispensing feed while they are outside animal watching without disturbing the animals that are there, because Bluetooth has a maximum range of around 100 meters line-of-sight. Hunters who need to reprogram it every few weeks during the active seasons can simply change the settings using their smartphone without having to open the case or disturb the feed reservoir. For the times when the reserve is not being used for a few months, the users can program the feeder and leave it for longer periods of time without worrying about draining the battery, because the BLE113 (the Bluetooth module that will be used for the proposed design) has a peak power consumption of 30mA during

Bluetooth operation (which will be operating at near zero duty cycle) and sleep mode power consumption down to 0.5 uA (it will spend most of its time in the uA range) [6].

The currently proposed design will use the same aluminum case as the Day II Feeder, which is approximately 35cm tall, and has a footprint of about 10cm by 10cm. Therefore, the same motor and battery will also be used (see Figures 1, 2, and 3). The only change will be the control board, which attaches with two screws to the inside of the case. For simplicity of manufacturing, the new control board will use the same attachment to the case, motor, and battery as the old board. This will not be a downside, because the new control circuitry will fit on the same size printed circuit board. In fact, it will likely be a somewhat smaller layout, but not so small that it becomes impractical from a resources perspective to use the old attachment method. Also, the Day II Feeder algorithm (which determines whether or not to feed based on ambient light) will be replicated in this new device. The new code that will added to this algorithm will only be for the integration of the Bluetooth control interface, as well as the more versatile control options. The fundamental operation of the feeder will remain unchanged. The current Day II Feeder control board is a two-layer PCB, 7.6 cm long by 5.1 cm wide, with the two mounting holes 4 cm apart, radiused to the center of the board, and mounted along a centerline drawn perpendicular to the width. A standard lamp battery is rated for 12AH at 6V, which means that an average current draw lower than 5 uA will ensure about a month of runtime. A solid month of runtime for average feeder settings will be a goal for the proposed device. As can be seen from the figure below, the motor is a brush type, with a speed of 1333 RPM, and draws 4 amps at 6V. This is the main current draw, but it will only be active for a minute or so every day, with average feeder settings.

Figure 1.1: The Day II Feeder Aluminum Case

Figure 1.2: The type of 6V lantern battery used in the Day II Feeder

Figure 1.3: The motor used for the Day II Feeder

1.2.2 Background

Timed game feeders have been around for the past few decades. However, there is recent interest in bringing them up to speed with the latest technologies. All timing boards need a way to set the time of day for the desired feed times and the length of those feed times. Up until recently, this meant that that there was a dedicated control module on the board. One example is a 24 hour clock face that has switches every 15 minutes, and when it gets to a switch that is closed allows the power from the source to flow to the motor. Another example is a digital clock or real time clock (RTC) with a microprocessor that can be set to distribute feed at specified intervals throughout a fixed 24-hour day. However, any error in the clock embedded in these devices will only increase over time, resulting degrading effectiveness over time. Since these devices are made to be left to operate without human intervention for long periods of time, a better reference is needed.

The current Game Country Day Feeder II has a unique and patented design that references feed times to daybreak and sunset, which is more effective and reliable, as it does not rely on the accuracy of the internal clock over a period of weeks or months, and operates at more natural intervals for game animals. It uses dip switches to allow the user to set feeding times, the length of motor run time (amount of feed) and the speed of the motor (radial distance that the feed is spread). The use of dip switches means that for each extra option given the user the more area (and cost) the dip switches require. Figure 4 shows the dip switch configuration. The Game Country Day II Feeder uses a light sensor to adjust the feed times to sunrise and sunset times. The current circuit uses a PIC16C505 8-bit microcontroller, 24 switches for programming (3 76SB08ST), and a SN74HC157N multiplexer. There is also a MABUCHI RS 555PH-3255 motor (to dispense the feed) and motor control circuit (using a STP50N06 N-channel MOS), a crystal oscillator circuit for the real time clock running on the PIC16C505, a light sensor, a LP2950CZ-5.0 voltage regulator, and a reset button. The Day II Feeder is programmed using a set of dip switches located on the bottom of the board, which are inconvenient and limits the number of settings available to the user.

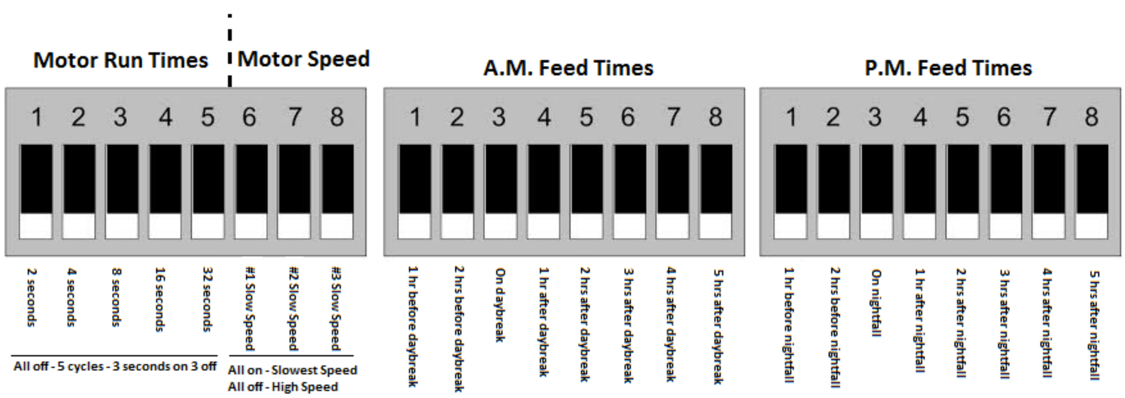

Figure 1.4: Dip switch control on the current day II Feeder

The other weakness Figure 4 highlights is the restriction that comes from the use of dip switches. There are only 5 motor run time settings, 5 motor speeds, 8 fixed AM feed times and 8 fixed PM feed times, any or all of which can be selected. Therefore, the user can only choose from 16 preset times, and has no option to customize the feeder's operation further. For example, they wanted to feed 30 minutes before daybreak, or in the middle of the day or night, they would have to choose a different feeder.

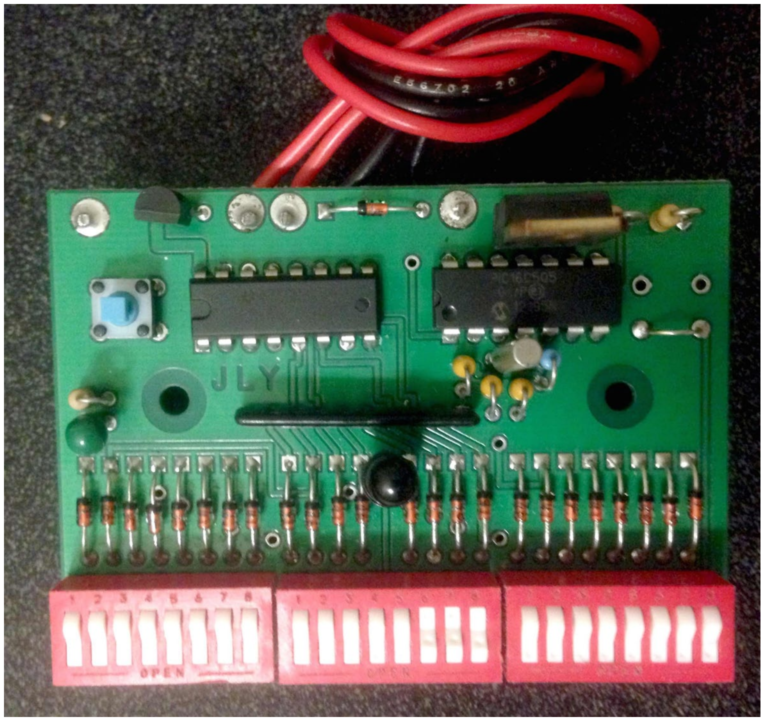

Figure 1.5: The current Day II Feeder control board

Overall, in spite of its limitations, the Day II Feeder control board is a well-designed and patented device. It has a light sensor on-board to sense the changes in ambient light, and if the reading triggers the processing algorithm, either for the sun having fully risen or set, the microprocessor checks it against past days to see if it the daybreak or nightfall time should be adjusted. This means that the occasional flashlight beam on the light sensor cannot reset the calculated daybreak time, and nightfall is not adjusted after a few days of bad weather. This algorithm requires an extensive and complex lookup table for previous light measurements. This algorithm is patented along with the general board design. The goal of this project is to take the existing Day Feeder II control system and redesign it to work with the Bluetooth control interface.

Similar to other options on the market, the Day II Feeder uses an on-board control module (the dip switches). However, since 65% of Americans own smartphones, the control module can effectively be moved off the board and into the smartphones in the form of an app. There are two major modes of communication with smartphones, whether using wired or wireless methods. The “System for operating a remote device” uses a USB port to communicate with the microcontroller.

A USB connection, or even the use of an audio connection, to program the microcontroller is an easy way to use the phone for the user interface of the timer module. It can work with all phones. Also wired connections are incredibly reliable. If the interface cable is not damaged and each device works, then the two devices will have a communication link with one another. However, with a USB port the user has to bring their own USB to Mini USB/Apple Device cord with them. This is not much of a detractor, because the cord could be left inside the device temporarily while the user is nearby. However, it could be forgotten or lost easily in the kind of environment in which the feeder will likely be. There is also the problem of exposure. If the manufacturer decides to make the USB port accessible from the outside of the housing, then it would naturally be exposed to the weather, since game feeders are meant to be left alone outdoors for weeks at a time. This means that the port could easily be exposed to rain, causing it to rust, leading to a failure in communication. A cover could be added, much like those available on waterproof cameras, but this would greatly increase the manufacturing cost of the housing. Also it requires that the cover is properly replaced every time or it will not serve the purpose of installation. The other option for USB port protection is to put the USB port on the inside of the housing. One of the goals of the project is to make the timer board easier to configure. Requiring users to open up the housing every time they want to change the motor settings is heading in the opposite direction in terms of user friendliness. While a USB connection would allow for the use of an easy to understand, off board, smartphone based, less limited user interface (as compared to the dip switches), a wireless connection will be much more mechanically sound, as well as maintaining a relatively simple interface. The proposed redesign of the Game Country Day II Feeder will implement wireless communication via Bluetooth, to avoid the downsides of a wired interface.

1.2.3 The Game Country Day II Feeder

The "Remote monitoring system for ground-based game feeder, varmint guard, tray and skirt assembly and quail feeder," US patent US20110088625, uses a cellular connection to communicate with the feeder controls. This is the user-friendliest option available. It is available from anywhere your phone can connect to the Internet. It has a sensor array that includes a camera, a motion sensor, a rainfall sensor, a barometer, a thermometer, and a hydrometer. This takes it a step further than the current board owned by Game Country. It can feed based on data from the internal camera, or based on motion detected by the motion sensor. It can also make feeding decisions based on the weather. Before going out the hunter will know the conditions and plan accordingly. Also, the camera will let the user know what kind of game is approaching the feeder. Once out in the field the user can control any feeder from anywhere nearby, triggering an immediate feed if desired.

However, this option has two major downsides. The first is decreased battery life. Each sensor must be powered while taking a measurement, and to make the data available on a smartphone app in real time, the sensors must be powered up quite frequently. The camera has the highest power demand on the battery, because of the large amount of data obtained from a picture, which must be stored and sent using very high speed electronics. Using only the motion sensor as a trigger would decrease the power usage, but even if the camera deactivated to save power, communication must be maintained with the network, which requires periodic transmissions. The time between transmissions could be increased in order to save more power, but this would increase the time between the user first attempting to receive data, and the feeder being aware of the request. Even if it was acceptable to have some lag time between the user first looking for the device and the device response, the power saved is a direct cost to the user convenience.

The second major trade-off is the cost for this kind of device. The cost of this board is significantly more than the current cost of the Game Country Day II Feeder. Currently the full kit with board, housing, and motor costs $75. The estimated cost of the feeder specified in US patent US20110088625 $700 - $1,200. Part of the cost is from the equipment that would go into the feeder, but an addition source of cost is the network that would be required to support such a device. Figure 6 shows the suggested network set up to provide support for the Wi-Fi device.

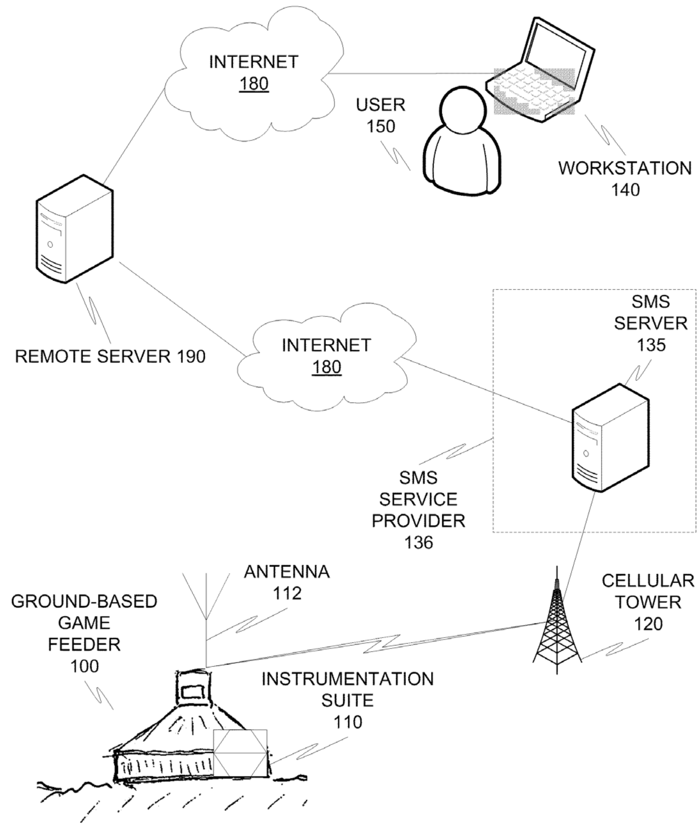

Figure 1.6: The support network necessary for Patent No. US20110088625

Another wirelessly controlled device used for wildlife feeding is the Sneaky Feed [7]. It also performs control and functions for a game feeder wirelessly from a smartphone app, but it is a separate retrofit or modification that can be done, and requires some work, and some knowhow. It is also around $150, and that cost does not include the cost of the actual feeder mechanism, which would be similar to the existing Day II Feeder. It uses Wi-Fi, and not Bluetooth, which means that it has slightly greater range, but much less battery life. This device is perhaps the most similar of all to the proposed project, as a smartphone is used to provide detailed programming and test functions. The Day II feeder will have an even lower price, and will not require the integration of the device onto an existing feeder. It will also use the Bluetooth, which has a short to medium range, and is very low power consumption.

Figure 1.7: The Sneaky Feed

The proposed redesign of the Game Country Day II Feeder will provide a much more cost-effective option that will still maintain all the functionality required for a game feeder. It will be much more versatile and user-friendly than the current Day II Feeder, and will provide a reliable control system design that can be expanded in the future, if more features are desired. Currently, more features are not desired, only an upgrade of existing features with an improved user interface. This interface will be wireless, as previously mentioned. The interface will require an app to be built for Android and IOS, but after the initial development, there is no need for constant maintenance. Every year or so the app will need to be updated for the current IOS and Android; but this will be a relatively simple task. This redesign will bring Game Country Inc. into the Smartphone era without requiring a new IT branch of the company or requiring the negotiation of a contract with a cellular provider.

CHAPTER 2

METHODOLOGY

The proposed control board will maintain all the capabilities of the Day II Feeder, but will greatly expand the versatility of the control, as well as providing a smartphone app for the user interface. The four main parameters that will be controlled are the number of feed cycles, the timing of each feed cycle (referenced to daybreak and sunset), the length of each feed cycle (motor 'on' time), and the dispersion distance (motor speed). The number of feed times per day will be adjustable from 1 to 24 times a day, with a maximum of 12 feeding times in the AM, and 12 in the PM. One option for a user interface that will do this is shown in Figure 8 below:

2.1 Feeder Control

```
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
                                  ________________________________
Number of PM Feed cycles: l Enter number from 1 to 12 l
                                  --------------------------------------
                                  ________________________________
Number of AM Feed cycles: l Enter number from 1 to 12 l
                                  --------------------------------------
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
```

Figure 2.1: Setting feed times

Using the app, the previously selected number of feed times will be adjustable in 10-minute increments continuously throughout the entire day, in two sets, from midnight to noon and from noon till midnight, as shown in the example in Figure 9 below (setting feed time 5 in the AM and feed time 12 in the PM):

```
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

Feed time    1    2    3    4    |5|    6    7    8    9    10    11    12

(midnight) Sunset - 6 --------------------- Sunset --------------------- Sunset + 6 (noon)
           _______________________________________|_____________________
                                                   (slider (ex. sunset + 2:10))

Feed time    1    2    3    4    5    6    7    8    9    10    11    |12|

(midnight) Sunrise - 6 -------------------- Sunrise --------------------- Sunrise + 6 (noon)
          _________________________|_____________________________________
                                    (slider (ex. sunrise - 1:40))

\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
```

Figure 2.2: Setting number of feed times

The motor speed will be controlled in terms of percentage of maximum, and will be continuously adjustable in 10% increments, starting at 20%, with an option (which will likely be heavily used) to simplify this process by setting them all to be the same, as shown in the following example in Figure 10:

```
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

All the same (  )

Different      (o)

        Feed [AM - 1  <]          <------ This is a dropdown menu
             [AM - 2    ]
             .....
             [PM - 12  ]

20% ------------------------------------------------------------------ 100%
________________________________|____________________________
                         (slider (ex. 60%))

\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
```

Figure 2.3: Setting motor speed

The motor run time for each feed will be adjustable similar to the way that the motor speed is, in 1 second increments from 1 to 100 seconds long, with an option (which will likely be heavily used) to simplify this process by setting them all to be the same, as is shown in the example in Figure 11 below:

```
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

All the same ( )

Different      (o)

        Feed [AM - 1  <]          <------ This is a dropdown menu
               [AM - 2   ]
               .....
               [PM - 12  ]
                      ________________________________________
Feed Duration: lEnter number of seconds between 1 and 100 l
                      ----------------------------------------------------------

\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
```

Figure 2.4: Setting motor run-time

Note that the above examples are only to illustrate the exact characteristics of each control and are not exactly like the graphical interface used in the app, which is separate from this project. The flowcharts for the new device, as well as the flow chart for the algorithm that will be used for feeding decisions (from the Game Country Patent) are shown below:

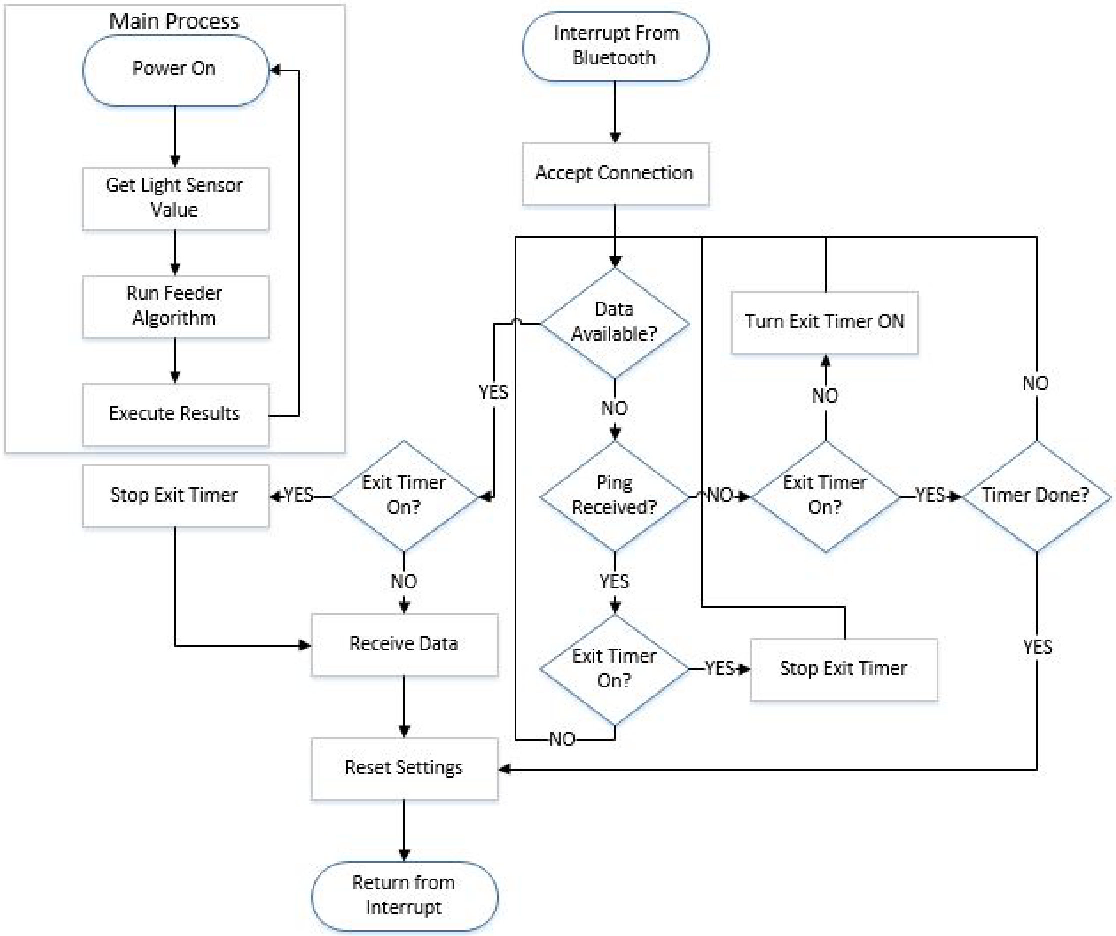

Figure 2.5: Feeder Flowchart

The flowchart below was provided in the Game Country Patent for a wildlife feeder controlled by a light sensor. It shows the algorithm for the code starting with the light sensor input value, and ending with the resulting action required by the feeder.

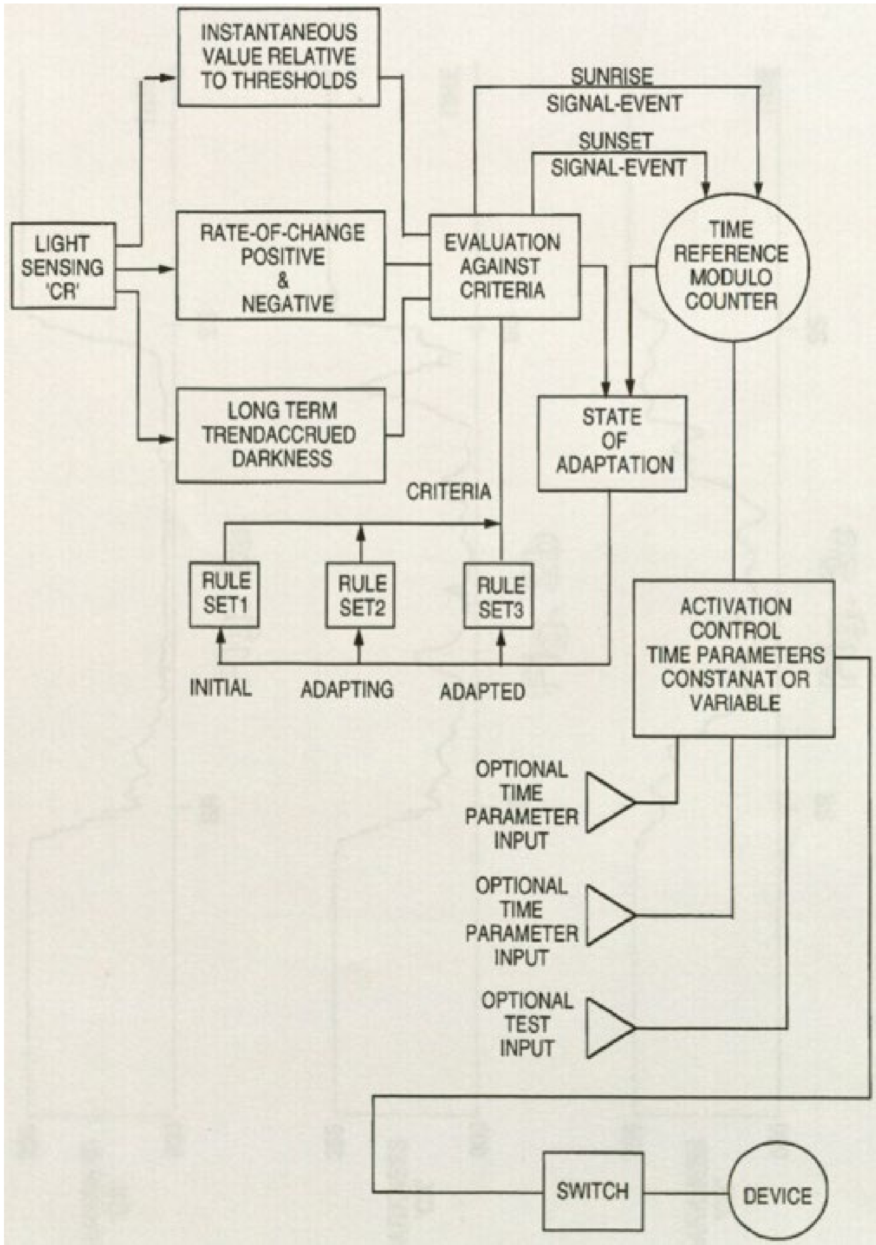

Figure 2.6: Light sensor processing algorithm

The flowchart below shows the execution of the rest of the code on the microcontroller described in the Game Country Patent, starting with the beginning of code execution (Reset, or power on), and looping infinitely.

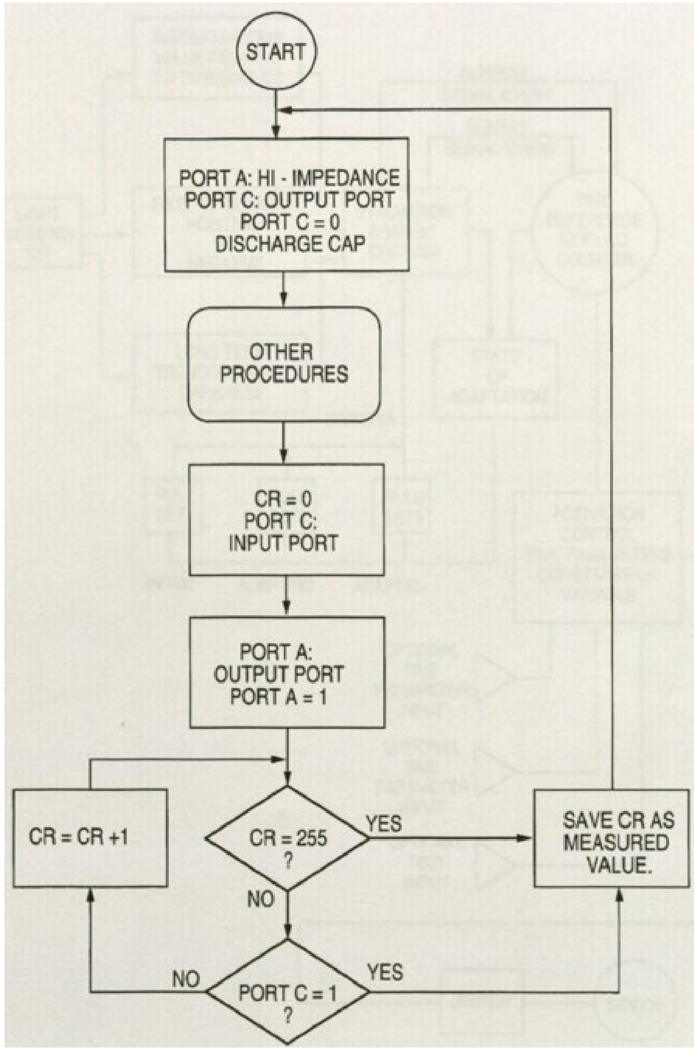

Figure 2.7: Game Day Patent

The block diagram for the entire control system (including the battery and motor) is shown below in Figure (15):

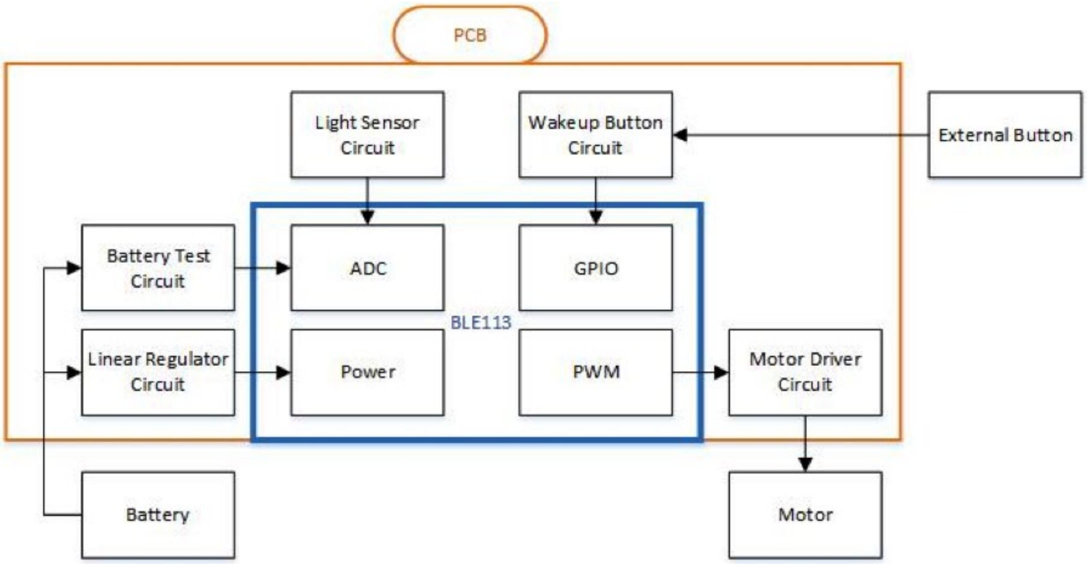

Figure 2.8: Product Block diagram

2.2 Hardware Development

2.2.1 The Bluetooth Module

This is the most important step, as the Bluetooth module used determines many details about the device that would not be known otherwise. The decision to use a pre-built module rather than design a circuit around the base chips included (a microcontroller and RF chip, or combination of the two) is that it makes the circuit for this device much simpler and easier to fabricate, and relies on a proven part that has already seen use in industry, without adding more than a small percentage increase in cost, which will be more than offset by the decreased manufacturing process complexity. It has also already received certifications for its wireless behavior from all of the major certification commissions, such as the FCC. The BLE113 module from Bluegiga was selected for this project. This device was selected because of its Bluetooth Smart capability (Bluetooth Low Energy, or Bluetooth v4.0), which is compatible with both other Bluetooth Smart devices, as well as Bluetooth Smart Ready Devices, which together make up the majority of the current mobile market. Bluegiga also provides an IDE and a scripting language, as well as a communication protocol that works over both UART and USB interfaces, and allows direct programming of their Bluetooth modules by a computer. Also, the BLE113's built in 8051 microcontroller can perform all of the necessary I/O functions. Therefore, all application code can run on the BLE113, which means that a second microcontroller is not needed.

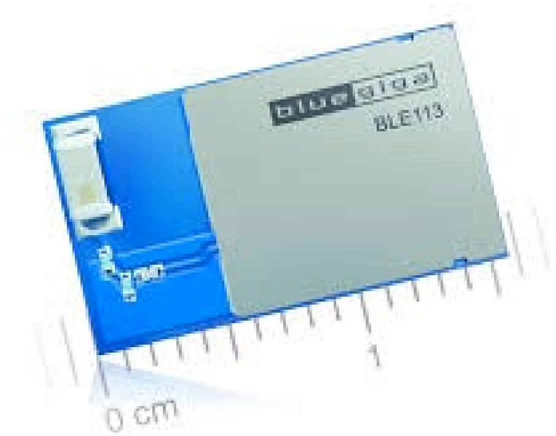

Figure 2.9: The BLE113 module

Figure 17 below summarizes the ecosystem that Bluegiga has provided with the BLE113. It will allow the programming of the Bluetooth module using their scripting language (BGScript), and also allow communication from the application on the device and the application on the phone using their parser and conversion layer, which can go through UART or USB. All stack and profile processing will happen automatically inside the device, which will make the process of programing and communicating with it much simpler, as so much of the work has already been done. Also, the device is very small, less than 2 cm on a side, yet will contain the majority of the components that will be required for the proposed device. Learning a brand new programming language took a considerable amount of time. However, the author has written a BGScript application for the BLE113 that thoroughly tests most of the key functions required by the proposed design. There are multiple files involved, some of which require specific knowledge of certain universal Bluetooth protocols (specifically the GATT file, which denotes how data will be communicated). The documentation for this file was a bit lacking, so it took longer than expected to write it. The main application now incorporates a software RTC, hardware interrupts, ADC, digital I/O, and PWM. Some of the code for the actual Bluetooth communication has been written as well. BGScript is capable, but a bit clumsy at times, especially for PWM. However, a large percentage of the BGScript code has now been written. The flowchart for the BGScript application is shown in Figure 4. All of the code described in this diagram has been written, but still needs thorough testing.

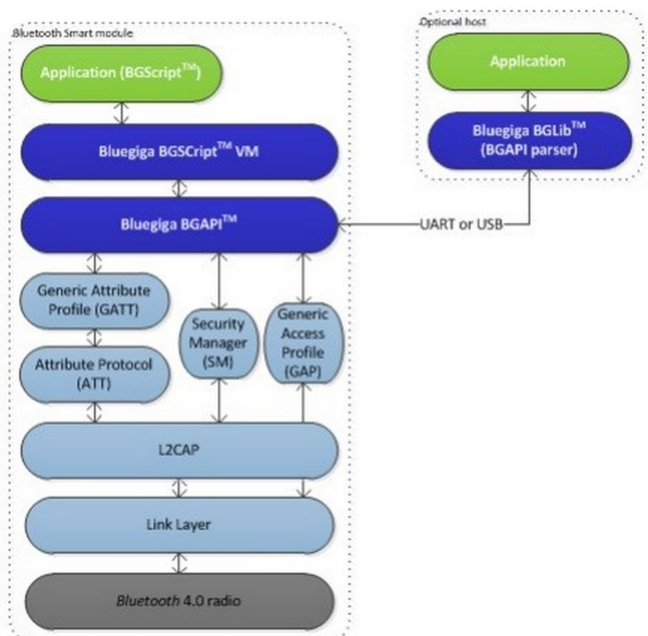

Figure 2.10: The Bluegiga Bluetooth module ecosystem

2.2.2 Prototyping the Circuit

This circuit will initially be a replica of the existing Day II Feeder circuit, and will be used for any testing and modification that takes place before the new circuit with the Bluetooth module is designed (such as testing a different light sensor, testing the disassembled hex code, etc.). The parts (enough to build two) and circuit diagram for this have already been obtained, and it will not be difficult to build the circuit on a breadboard. This will also confirm our existing circuit diagram (provided by the new owner of Game Country Inc.), as it is hand drawn and may have errors. The circuit (redrawn to fix some known errors) is shown below in Figure 18 below:

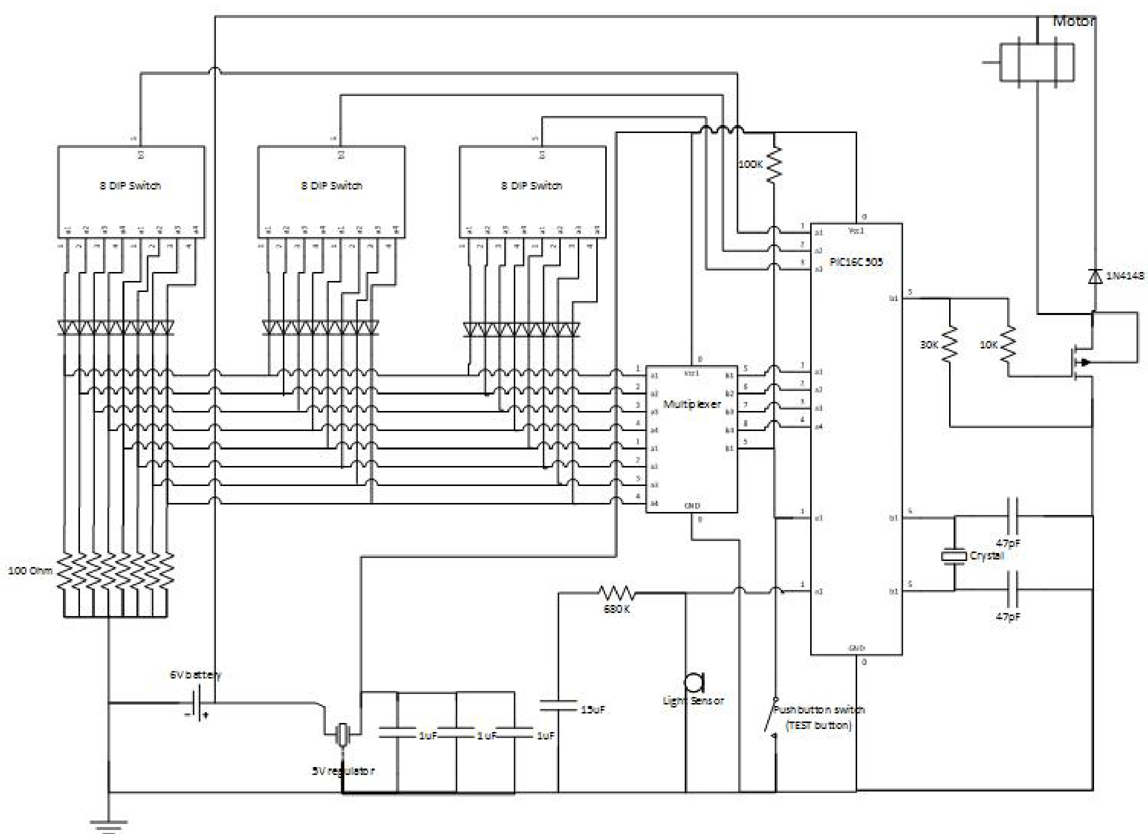

Figure 2.11: The circuit diagram for the control system (including the battery and motor) This step was originally planned in order to do initial prototyping of new parts.

However, the parts that will be used for the new circuit are simply not compatible with old design, primarily because of the different operating voltage (3.3V vs. 5V microcontrollers). Therefore, this step has been eliminated. However, two Day II Feeder circuits were partially constructed before this was decided, and a great deal more has been learned about the original design, especially the light sensor circuit.

The owner of Game Country Inc. provided the .hex file of the code that is currently being used to program the microprocessor on the circuit. The original assembly file for the same was misplaced by the company, therefore requiring us to understand and disassemble the hex code, and write its equivalent assembly code. This step is essential because it is the key to understand the working algorithm that is currently in use. The code was not completely converted, but it was converted sufficiently do decode the basic algorithm, which is currently in the process of being written for the BLE113.

2.2.3. Select New Parts for Design

New surface mount parts have been selected for the linear regulator circuit, the motor driver circuit, and the light sensor circuit. Key parts chosen include a logic level MOSFET, a 3.3V LDO Linear Regulator, a visible light sensor, and some surface mount ceramic capacitors. These parts were all chosen based on the many requirements of the end product, including cost, efficiency, low quiescent current, temperature performance, and operating voltage level. Any improved parts that work well will be used in the final version. Other parts that have not had replacements chosen because they will not be necessary on the new design are the multiplexer chip, the dip switches, and the diodes. As was stated in the introduction section, the 6V non-rechargeable lantern type battery, the current Day II Feeder case, and the current Day II Feeder motor will all be used again in this proposed redesign. This step has been completed, except for any revisions due to the failure of one of the current parts during testing.

2.2.4 Test Bluetooth Communication

This step has been completed. The code programmed on the Bluetooth Device successfully communicates with the mobile device through all of its data characteristics.

2.2.5 Prototyping the Modernized Circuit

During this step the developer prototyped and thoroughly teste the entire control circuit, using the battery and motor from the Day II Feeder. This was accomplished on a breadboard first, and then a proto-board. Since surface mount parts are used, individual breakout boards have been purchased to match the parts obtained. Eventually, a PCB will be designed using that circuit. It will also be designed to seamlessly integrate into the aluminum case for the Day II Feeder, which will still be used for this device.

2.3 Further Tasks to be Completed

2.3.1 Final Testing

The method for testing the final prototype will use another microcontroller to supply a varying voltage that will mimic the response of the light sensor over the course of a day. The second microcontroller will also sense when the motor is turned on, at what speed it is turned on, and for how long. The second microcontroller will also be connected to three other devices: a real time clock, a coulomb counter (will measure current to the prototyped circuit), and a SD card logger. All of these parts have already been obtained. The second microcontroller will write the time stamp from the real time clock, the data from the coulomb counter, the data from the motor, and the light sensor output sent to the prototype to the SD card logger at a specified interval, as well as whenever the motor is activated. This will allow the test to run for some time, and allow the data to be analyzed en masse after the fact to confirm its operation.

2.3.2 PCB Design

Once the prototype circuit has been thoroughly tested, a PCB will be designed and ordered from a PCB fabrication company. There will be many considerations for the design of this PCB, including giving the BLE113 module's antenna sufficient clearance, preventing noise transfer throughout the circuit, ensuring sufficient current carrying capability, and correctly fitting in the Day II Feeder aluminum case. All these details will be considered for the design of the board. This will take time, but this attention to detail is necessary for any commercial product.

CHAPTER 3

CONCLUSION

The proposed device along with its companion control app will revolutionize the Game Country line of wildlife feeders, and will fill a niche in the market that has been waiting to be filled for some time, which marries the simplicity of a light controlled, timed feeder with aspects of the more modern, but more complex and expensive wirelessly controlled solutions that are available from other manufacturers. The resulting device will have the simplicity, reliability, long operating time, and low cost of a Day II Feeder, but will have some of the capabilities of much more expensive feeders and feeder add-ons at a fraction of the cost, in order to provide the user with a easy to use, streamlined control interface. The app will control the number of feed cycles per day, the timing of the feed cycles, the length of each feed cycle, and the speed at which it is dispersed. There will be multiple and versatile options for each of these four variables, which will allow users to customize the operation of the device in order to meet any requirements and preferences they may have. Also, the feed timings will all be directly referenced to the heartbeat of the wild, the rise and fall of the sun, using the patented Game Country ambient light-processing algorithm. This device and app will also provide a starting point for future expansion and development of more Bluetooth enabled feeders for the Game Country lineup, as well as an expanded app or apps for other operating systems sometime in the future that may be sold as an upgrade.

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BIOGRAPHICAL INFORMATION

Joshua Berry is an Electrical Engineering Major with a Computer Science Minor at the University of Texas at Arlington. He has worked in Femtosatellite and High Altitude Balloon research and as a Teaching Assistant for a freshman EE course while enrolled at UT Arlington. He has obtained several merit-based scholarships and recognitions, including the Brenard and Ann Svihel Scholarship Award, the John M. Goodwin Memorial Scholarship, and admission to Eta Kappa Nu, the IEEE honors society. He plans to become a professional engineer, and eventually obtain his Master's Degree in Electrical Engineering with a focus in the area of Embedded Systems.