Solar Powered PIR Security System to Monitor Wildlife

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Abstract—This paper introduces the concept of off-grid wildlife video monitoring using a security system, a microcontroller, passive infrared motion sensor and solar panels with a battery bank. We discuss heat challenges, proper placement of equipment, proofs of concept of the on grid system and off grid system, testing the survivability of the equipment located inside a waterproof box over a six day period in a Texas summer environment with temperatures over 100°F. Further discussed are the design of a battery bank, and of a structure that can accommodate mounting the three solar panels as well as to shade the equipment located inside a weather proof box. The system includes: two lead acid batteries, a DVR, an Arduino microcontroller and a relay that receives an excitation signal to turn on and off the cameras. This design was created to monitor the burrowing owl population in Franklin Mountains State Park in El Paso, Texas. Monitoring the owls will help gain an understanding of their roosting behavior and diet. This effort could help to keep them off the endangered species list.

Keywords—environmental monitoring, PIR motion sensor, power management, alternative power, remote video surveillance, solar power, off grid, on grid, microcontroller, sensor networks

I. INTRODUCTION

Athene cunicularia, or the Burrowing Owl, gets its name from their behavior. The owl lives underground, mostly in burrows that have been previously dug and abandoned by many small mammals such as prairie dogs or ground squirrels [3]. The population of burrowing owls has been declining due to loss of land from recent new agricultural and development projects and from the reduction in population of other small burrowing mammals [5]. Over the past century, black-tailed prairie dog populations have been reduced by 90-98% through eradication programs, habitat loss and fragmentation. As the prairie dog numbers declined, so did burrowing owl numbers [7]. The owls are moving into urbanized land areas and struggle to survive in the new areas. The El Paso Zoo has partnered with the Texas Parks and Wildlife Department to help the owls by building artificial nesting sites. This effort helps the owls find a new, safe place to live. Artificial homes are created by going to their habitat area and digging trenches, filling them in with PVC pipe and a nesting box [4]. The owls then can move in, set up housekeeping, and raise their young.

Burrowing Owls are protected by the Migratory Bird Treaty Act in the United States and Mexico. They are listed as Endangered in Canada and Threatened in Mexico. They are considered by the United
States Fish and Wildlife Service (USFWS) to be a Bird of Conservation Concern at the national level, in three USFWS regions, and in nine Bird Conservation Regions. At the state level, Burrowing Owls are listed as endangered in Minnesota, threatened in Colorado, and as a Species of Concern in California, Montana, Oklahoma, Oregon, Utah, Washington, and Wyoming [6]. The owls are not yet an endangered species in Texas. Creating a monitoring system that can observe their patterns of survival and activity in the artificial burrows will help the Texas Parks and Wildlife Department keep them off the endangered list, and hopefully increase their population. The implementation of a monitoring system into their habitat will give a way to collect long term data to provide insight to factors limiting species distribution, and solutions can be created to help in their studies and in conservation [10], [11], [13].

A team from the University of North Texas Research Experience for Teachers in Sensor Networks summer program is working closely with the Texas Parks and Wildlife Department to design a monitoring system. The monitoring system will be deployed at a sample artificial burrow site at Franklin Mountains State Park in El Paso, Texas. The cameras will help to understand the burrowing owls behavior during breeding season, what kind of prey is being caught, which adult owl is doing the hunting, rearing of the young and to observe the chick behavior from hatchling to fledgling [15].

This article is organized as follows: Section II discusses related literature reviews on wildlife monitoring systems, using solar power to charge batteries and running equipment, and “wake up” systems to turn the system on when there is movement as a power saving technique. Section III goes into our basic principles, procedure and results. Section IV reviews our problem-solving techniques. Section V concludes the paper.

II. LITERATURE REVIEW

Sensor networks are being deployed in the most diverse application scenarios, including rural and forest environments. In these particular contexts, specimen protection and conservation is a challenge especially in natural reserves, dangerous locations or hot spots of the reserves [13]. Most of the research that has been reviewed is based on Wireless Sensor Networks. The system being developed in this research project is not wireless but uses many of the same concepts as the wireless sensor network. To help save on energy consumption, a wired security system was modified. The reason for the modification was that the selected security system (SWANN) detects motion digitally, comparing frame-to-frame on the video feed, the motion detection happens at the DVR. A passive infrared sensor (PIR) will detect motion at the camera’s location and the DVR will record only when there is motion.

Energy limitations on wireless sensor networks have partially been addressed in most current architectures [1]. The architecture of the system consists of three main parts: a.) the maximum power and control of the module to work in the most efficient conditions, b.) how the energy collected from the solar panel is stored into the energy storage devices and c.) the output needs to be generated as a stable voltage supply for the power applications [2]. The Wild Watch team is designing a sensor monitoring network that will run off grid with solar panels and lead acid rechargeable batteries. Solar energy is a way to harvest
energy. It is a way to harvest energy in outdoor environments due to its relatively high power concentration [2].

The monitoring system is going to be placed in an area that has limited accessibility to humans, which will keep the chance of tampering or destruction down. The system needs to become as natural to the wildlife as possible to preserve the original project goals of minimal human disturbance in observing the owls. By taking the surveillance system off-grid and conserving energy by the wake-up system, the monitoring system will require less frequent maintenance and field visits to retrieve data.

Cameras from the security system are deployed along with PIR nodes that will send a signal to the Arduino to activate the camera to start recording when motion is sensed. Sensor nodes that are placed in remote areas generally require significant battery power to survive long periods of time [1]. By creating a wake up system with an Arduino UNO board for the monitoring system, it will allow for the cameras to be turned off and on when there is motion detected by the PIR, supplementing the DVR motion detection. The sensors will need a self-healing design in order to allow them to heal from energy over-utilization failure and resume service [1]. Using Arduino based technology is one of the best answers to many of the problems with wireless sensor networks. The Arduino UNO has many features that make it beneficial in wireless sensor networks and many technology applications. The Arduino UNO has an easy to access embedded system [8]. Also, PIR motion sensors are going to be ideal for the system because they do not require any devices or signal from detecting objects to be tracked, they can work in a dark environment, are inexpensive, and easy to use [9]. Processing data from PIR sensors does not require much power therefore having little effect on our overall power consumption.

The sensors have a region based tracking algorithm, and the detection region of the sensor is not continuous but divided into several detection zones [9]. The sensors used in the field have a wide sensing area of 10 meters with about 90 degree state that has a detection distance of a maximum of 10 meters and a detection range of 110ºF horizontal and 93ºF in vertical distances. Table 1 shows the comparison between the performance of the PIR sensor provided in the data sheet and the actual performance obtained by the lab test. The horizontal detection range was significantly different in the lab when compared to the manufacturer specifications. The cause needs to be analyzed if sensitivity is an issue during deployment at the burrows. Figure 1 shows the horizontal and vertical view of the detection zones of the passive infrared sensor according to the datasheet [9].

<table>
<thead>
<tr>
<th>Item</th>
<th>Datasheet</th>
<th>Lab Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection Distance</td>
<td>10m (32.8088')</td>
<td>9m (29.5288')</td>
</tr>
<tr>
<td>Detection Range</td>
<td>Horizontal 110º</td>
<td>90º</td>
</tr>
<tr>
<td></td>
<td>Vertical    93º</td>
<td>90º</td>
</tr>
</tbody>
</table>

Table 1: The Comparison of the performance of the PIR Sensor

Figure 1: Horizontal and vertical view of detection zones of the PIR sensor according to the datasheet

As previously mentioned, energy conservation is one of the greatest
challenges in sensor network designs because battery depletion can disable the sensors. The sensor will spend a great amount of its time in idle mode not sensing anything and a small bit of time actually transmitting information [10]. According to the wireless sensor network for wildlife monitoring article the sensors are in their transmitting mode less than 0.8% of the time, 99.2% of the time spent in idle mode [10]. Remote sensing requires energy usage that can be conserved by enabling the sensor to enter a sleep state while in the idle mode which will help to save on energy.

III. BASIC PRINCIPLES, PROCEDURES AND RESULTS

This project is designed to create an off grid video surveillance system for collection of visual data of the burrowing owl roosting behavior in the West Texas region. The idea for this project stemmed from the declining population of burrowing owls in the El Paso region and a similar project filming little owls in the United Kingdom. The goal of this project is to design a system at a much lower cost than video monitoring companies charge and that will allow for placing the system in remote locations by the addition of an off grid power source.

The video and power equipment that will be used must first be evaluated in the lab by an electrical engineering team at the University of North Texas, and then reevaluated at the test site outdoors before the final installation process. The first objective is to set up a mock system on grid at Isle Du Bois State Park at Ray Roberts Lake in Pilot Point, Texas as an outdoor equipment study and proof of concept. This will give information on the tolerances of the SWANN DVR surveillance system to Texas summer heat and humidity. The next phase takes the system off grid using solar energy to be able to deploy the monitoring system in the remote location in the Franklin Mountain State Park. By taking the system off grid, this will reduce the system’s power consumption footprint.

Taking the system off grid is the biggest challenge of the project due to the power hungry components involved, requiring large solar panels and a large battery bank, which will affect cost and space and mobility issues. Due to the high energy demand of the surveillance system from the infrared cameras and DVR, a plan must be devised to explore ways to minimize the power consumption of the equipment. In order to improve an off grid system, a motion-triggered wake up program must be designed so that the cameras are not powered on until there is movement sensed in the burrow. The system will be similar to motion triggered light switches installed in buildings to help conserve energy.

Power consumption is the driving factor for this project. Phase one of the project places the SWANN system [18] outside, running on grid to test the equipment’s survivability in the elements. This will allow us to verify that the DVR can withstand the outside temperatures and to test the waterproofing of the modified Pelican case. Phase two moves the system off grid, to ensure the equipment can be sustained by solar panels and again test the equipment’s durability in the outside elements. Phase three involves further power conservation by adding a relay signaled by the Arduino UNO microcontroller [17] to turn on the power to the cameras when motion is sensed and off when motion stops. There are three equations used to calculate the power consumption, battery capacity, and necessary solar panel output.
The amount of maximum power consumption per day of the DVR at 2 Amps and all four cameras totaling 2 Amps when ran 24 hours a day is calculated by multiplying the voltage, total amperes, and total hours \[(12V)(2A+2A)(24hrs) = 1152 \text{ Whrs per day}\]. Therefore, the SWANN security system will use 1152 Watt hours in one 24 hour time frame under the assumption of powered and recording 24 hours each day. The large amount of wattage being drawn by the system requires a large battery bank and a solar panel configuration with multiple panels to supply enough power to keep the system continuously running. The battery capacity is calculated on running the SWANN security system at max current draw from the batteries for two days without any sunlight providing energy from the panels. To calculate the battery capacity, multiply the total number of days without sunlight, the total amperes, and the total hours of each day \[(2 \text{ days})(2A+2A)(24hrs) = 192 \text{ Ahrs}\]. After some research on lead acid batteries, it was decided to use two 100Ahr 12V batteries to instead of a single 200Ahr battery due to the battery weight being an issue for mobility. At max consumption these two batteries can power the SWANN security system for two consecutive 24 hour periods without any sunlight. However, if the system ran two 24 hours periods without sunlight, the batteries would be completely drained.

After further research, lead acid batteries capacity should not be used to less than 50% because depleting the lead acid battery beyond that halfway charge can significantly reduce the lifetime of the battery. If this rule is to be maintained, the batteries will only be able to charge the SWANN security system for one 24 hour time frame without sunlight to maintain longevity of the battery bank. The associated solar panels max output per day is calculated by multiplying the total hours in a day and total amperes plus the batteries capacity and dividing by the total number of days spent recharging the batteries \([(24hrs)(2A+2A)+(192Ahrs))/(2 \text{ days}) = 144Ahrs per day]\). Again, to run the SWANN security system continuously at max consumption by factory specifications, it takes 192Ahrs. Therefore, it was concluded to further reduce power consumption by adding an Arduino UNO microcontroller and relay to turn the system on and off.

The solar panel supplier, Windy Nation, states that a three panel kit will fulfill the power consumption requirements of the cameras and DVR. According to their calculations the three panel kit is rated from 900-1500 Watt hours per day and 75-150 Ampere hours per day [16].

The task of doing a proof of concept by implementing an on-grid system and deploying it at Isle Du Bois State Park presented many variables that we did not account for and additional parts were needed. The SWANN Home Security System was chosen for this project. The SWANN security advanced series system with a DVR, four cameras, power adapters, BNC video cables, and mounting equipment were purchased through Amazon for $500. A Pelican weather proof box for $300, BNC extender cables for the camera 100 foot for $30 and a 200 foot cable for $50, two 40lb. sealed marine lead acid batteries from Concorde Battery out of West Covina, California, and three 100W solar panels from Windy Nation. The sites for the cameras were spaced further apart than the original 50 feet, so longer 100’ BNC cables were needed to run the cameras from the DVR to the four burrows locations. Also purchased was electrical tape, duct tape, waterproof sealant, chain, locks, and a 100
foot extension cord. The additional circuitry was purchased at Tanners Electronics—items such as resistors, LEDs, capacitors, relays, breadboards, wire packets, and potentiometers.

A 1.5” hole was drilled in the back of the Pelican box to pass the wires from the cameras and the power source to the DVR. The hole was then plugged with a rubber stopper to fill excess space and waterproof silicone sealant was placed around the cables, preserving appropriate positioning to avoid damage to the cables. This will keep water, bugs, and dust out of the box and off of the equipment.

The Pelican box was placed in the shade outside in the Texas heat, which is obviously a huge concern because the upper temperature limit of the SWANN system is 104ºF according to specifications. The temperature limit is easily reached during the summer. Many ideas were discussed on procedures to keep the system below the temperature limit so that the electronics would function properly. After installing the on grid system, it was determined that the equipment was running properly and all the space in the box and the shade from the tree kept the DVR cool enough to run properly. Placing the box on the bare earth allows the ground to act as a heat sink, pulling the heat that is generated from the electronics out of the box. It was also decided to paint the black Pelican box a sand beige color in order to help reflect some of the rays and not absorb so much heat.

To begin the research, it was necessary to learn the performance diversity of the cameras while recording in different light conditions. The question was posed: will the image quality be affected by different light conditions and proximity to the creature being filmed. Four cameras will be installed in different light intensity settings above ground. To test medium light, a camera will be installed inside a standard song bird nesting box. To test low light, two cameras will be installed inside two different above ground (to minimize disruption at the local site) man-made pipe burrows for small animals such as rabbits, skunks, and ground mice. To test clarity in extremely low light, a camera has been installed inside a nesting box that is positioned between two pipe runs, similar to those at the El Paso site. The cameras have been setup to record when motion is detected 24 hours a day. Initial testing showed that the cameras performed...
well in all light conditions even at night because the cameras have infrared sensors. For the burrowing owls, the artificial burrows are buried in the hillside, so the cameras will be in very low light conditions yet biologists need clarity in the video feed to identify what items are being brought into the nest by the occupants.

Figure 4: Outside view of the bird house with camera setup

Figure 5: Inside view of the birdhouse

Figure 6: An artificial burrow, hidden by leaves

After running the monitoring system at Isle Du Bois on grid, it was established that it was configured properly and meeting all the expectations of a wildlife video monitoring system. After looking at the video from the days it was deployed at Isle Du Bois, the task of determining the proper settings for the motion sensitivity presented itself. The SWANN security system hotline was contacted for help in setting the sensitivity to what was needed. After setting the sensitivity the system was ready to be taken off grid. Placing the system off grid will allow for remote monitoring where a grid-tied power supply is not feasible.

The solar panels will generate enough power to run the system and provide shade for the Pelican box. The mounting and shade structure will be made out of plated steel slotted angle iron. Twelve eight foot pieces were purchased and cut to size accordingly for the frame. Washers, lock washers, nuts and bolts less than 3.5 cm were used to assemble the frame. Various dimensions were cut to be able to adjust the height of the structure to achieve the 33 degrees tilt needed for the solar panels at the Pilot Point, Texas latitude.
All the mounting and shade structure parts were purchased at Lowes Home Improvement Store. A chop saw was used to cut the angle iron to desired size while a face safety shield was worn to protect the face from metal sparks. After all the pieces were cut, they were laid out according to the diagram. They were then assembled and held together by a bolt, lock washer, regular washer, and nut tightened with a ratchet. The panels were attached to the angle iron by using door hinges. A metal file was used to smooth the rough edges of the angle iron and to round off the corners to avoid injuries. The structure is now completed and ready to be implemented into the wild.

The Arduino UNO is going to be used to "Wake Up" the video monitoring system. To better manage the power consumption, the “motion” detected digitally by the DVR is now being detected analog by the PIR to turn on and off the camera power supply. As mentioned, the overall goal is to reduce the power consumption so that more wildlife
conservationists will be able to install this off grid system at their sites to monitor activity. As a result, motion will now be the trigger from the camera location that turns on the cameras, and therefore signals the DVR to record. By doing this, the camera power is now managed to only be utilized when it is needed for recording. The Arduino UNO is going to send a simple excitation signal once motion is detected to a relay that will be responsible for passing power to the load from the battery and panels.

The Arduino pins cannot directly power the 12V load (cameras), so the low voltage (5V) from the UNO pin is used to control a higher voltage circuit. Also, if PC fans are to be added for cooling purposes, the current output of the Arduino pins (40mA) is not sufficient to drive a 270mA PC fan. A separate power source is needed to drive the high load components and have a relay to switch them on and off. A diode across the relay coil protects the Arduino pins from reverse current when the relay is switched off as the current will run through the Arduino pins to ground.

For the deployment of the off grid system, the mounting and shade structure was placed in an area that receives direct sunlight from the South. The solar panels were mounted at a 33 degree angle to match the latitude coordinates of the area. The structure itself weighs around 120 pounds, but to add addition anchors, T-posts were stationed next to both of the back poles of the structure and attached with metal wire. The Pelican box was placed in the middle compartment on top of the bottom railings to help aid in holding the structure down and to give shade to the box. In order to add shade to the Pelican box, window screen was placed and secured around the solar panel structure. A charcoal fiberglass screen wire was used, it allows for ventilation as well as blocking up to 90% of the sun’s heat and glare. Leaves, dirt and rocks were piled under the Pelican to act as a heat sink.
extra cables were placed inside the box. After everything was in place inside the box, next came hooking up the solar panels. All the positive 12 American wire gauge solar panel cables were hooked up to each other using the multi-contact 4 branch and the multi-contact 4 connectors while all the negative 12 American wire gauge solar panel cables were hooked up to each other using the multi-contact 4 branch and the multi-contact 4 connectors. The multi-contact 4 connectors provide a reliable and water resistant way for conveniently making electrical connections between the solar panel and the extension cable. After wiring the solar panels together using the appropriate wiring diagram, there will be one photovoltaic positive cable and one photovoltaic negative cable coming from the solar panels. The photovoltaic positive cable connects to the photovoltaic positive terminal on the solar charge controller see. The photovoltaic negative cable connects to the photovoltaic negative terminal on the solar charge controller. Before connecting the solar panels to the charge controller, the charge controller needs to be connected to the battery bank of the 12 volt batteries.

After connecting the solar panels to the charge controller, the basic off-grid power hub was connected to the charge controller. The power hub is a simple connection from the charge controller’s single load terminals to both the DVR and cameras. The camera cables were double checked to make sure they were connected and then ran through the box to the DVR. A monitor was hooked up to check that the DVR settings were set correctly and receiving the camera feeds. The box was chained to the mounting/shade structure from each handle. After installing the off grid system, the solar panels started receiving sunlight and charging the batteries to power the security system during the coming night hours.

The next phase is implementing a relay board to further conserve power and prolong battery life. It was originally decided that the Arduino UNO would turn the SWANN security system DVR and cameras on but it takes 45 seconds for the DVR to boot up and actually start recording data when motion is sensed. The idea was altered to have just the cameras switch on when motion is detected and have the DVR constantly on and armed, while turning the cameras completely off when no motion is sensed. By cutting the power to the infrared cameras will prolong
their life; they have a lifespan of 10,000 hours.

Figure 18: Relay board schematic

Figure 19: Relay board prototype

The relay board is a power hub for the charge controller, DVR and Arduino UNO that are constantly consuming energy. The camera terminals are switched on to supply power whenever the PIR sensor sends a signal to the Arduino, that then sends an excitation signal to the relay that switches the power rail to the cameras.

Now that the system is set up to run off grid and only record when motion is sensed, it can be deployed to El Paso where all three cameras will be placed in one man-made owl burrow when it is installed at Franklin Mountains State Park in El Paso.

Figure 20: Sample diagram of equipment layout

IV. PROBLEM SOLVING

Installing the on grid monitoring system presented some challenges. We had to place the box within 100’ of a power supply. The cameras had to be placed within 100’ of the Pelican box. Some of the initial burrow sites had to be moved to accommodate the distance between the box and the cameras. Each time the burrow sights are changed, the likelihood of getting activity in that burrow is decreased due to the lingering human scent.

It was discussed that the DVR would need ventilation; a temporary solution was to place the box in the shade. As stated before, the highest acceptable performance temperature for the SWANN monitoring system is 104ºF. If slit vents are cut into the side of the box to allow air to flow through, invaders, water and dust would get in the box. The water and dust would damage components on the DVR, and the bugs/small mammals could damage the cables. The idea of putting a screen on the inside of the
slit vents was brought up, but it was soon discovered that bugs eat most mesh, and that dust would still find its way through the tiny holes. We decided to try the box without vents and use the ground as a heat sink.

However, water moisture is a concern for electronics. An idea to keep the moisture out is to place silica packets inside the box to absorb any moisture that crept in from accessing the equipment and residual humidity. A humidity controlling device was also discussed that would be connected to the power hub. Yet, this would draw more power from the batteries. As of now, the on grid system was deployed without any precautions for humidity.

Another limitation was the 100ft. extension cord; this made it more difficult to test. It was first decided that adding more camera cables to the original cable to make the length longer to reach the burrows, but that could affect the video quality. The original artificial burrow locations had to be moved so that the 100ft. camera cables could reach them, which was unfortunate because any wildlife that had established itself in the burrow was disrupted.

Theft and vandalism are not a huge concern at Isle Du Bois, but considering the expense of the equipment and time put into the project, it was in our best interest to chain the Pelican box to the nearest tree. Keyed locks were also installed on the box as to secure the equipment inside. As for the cameras, they were duct taped and zip tied to the burrows.

Once the system was placed off grid and not in the shade of a tree, the concern of heat inside the weatherproof box presented itself again. Now that the two 40lb. lead-acid batteries along with the DVR and power hub were inside the weatherproof box, more heat would be produced. Even though the Pelican box has the solar panels shading it part of the day, precautions still needed to be taken. The ideas of building a hut to house the equipment or burying the equipment were discussed. At Lake Ray Roberts State Park, they will not allow anything deeper than six inches to be dug in the project’s limited time frame, so the burying option was not possible. The shade structure would be a possibility, as would burying it when the system is deployed in El Paso. The pros of building a hut would be it would be easy to access the DVR to retrieve data, keeping it ventilated and to monitor the temperature of the equipment. The cons would be it would be more noticeable and attract more attention. The pros of burying the box is it would be out of sight and protected. The cons would be that a person would have to dig it up every time to retrieve data. As part of the solution at Isle Du Bois, the box was painted a beige color and solar screen was installed around the bottom of the structure to shade it from the afternoon sun. Beige was picked to help it not absorb as much heat from the sun and it would similar to sand color to enable it to blend with the environment better in El Paso, which would increase the likelihood of burrow habitation by reducing distraction caused by the equipment. The Franklin Mountains State Park is located very close to the United States and Mexico border and Texas State Parks and Wildlife has mentioned that equipment sometimes gets tampered with or stolen so hopefully the color will help to camouflage it.

The cameras were still recording but one was recording just a solid black screen, occasionally it would flash a dark gray or blue. There was clearly something wrong with it, after looking at the cables a few of the camera cables had been damaged from being nibbled on by animals, rubbed open
from pulling them through the brush and cut from the angle iron that was laid over top of the cables crossing the roads. The cables had to be replaced in order to get the camera feed to show up on the screen when viewing the recorded data.

During the final testing phase the power consumption, battery life and solar panel output under the specifications provided by the product manufacturer were proven to be inaccurate. The SWANN home security technical support stated that the system pulled 4A total, 2A for the DVR and two amperes for all the cameras. After testing the systems power consumption with the ammeter the DVR pulls 0.69A regardless of how many cameras are plugged into the system, while the set of four cameras pull 0.44A in the light and 0.67A in the dark. This means that instead of using four amperes the system only needs 1.36A. It was also discovered that the recording quality, motion settings, and light intensity did not affect the DVR’s power consumption.

As stated before, the max power consumption was estimated at 1152Whrs per day, but it was calculated that by only using 1.36A the power usage will be 391.68Whrs per day. When adding the relay and motion sensing to the system the power usage is theoretically decreased to 263.04Whrs per day because the cameras will be turned on an estimated eight hours a day due to motion instead of being on 24 hours a day feeding to the DVR. To run a 12 volt system at 4A for 24 hours, it would take 192Ahrs battery capacity. After finding out that system does not pull the full 4A the amount of Ahrs needed drops to 43.84Ahrs. The solar panel output originally needed based on the two previous results at four amperes was 144Ahrs per day, now it has dropped down to 32.88Ahrs per day at 1.36A.

V. CONCLUSION

Video monitoring is an important means of studying wildlife. The project’s goal was to take a standard home video monitoring system and deploy it off grid in the field. By perfecting this system, it will lower the cost of video monitoring and make it feasible to use on a wider scale. By taking it off grid and reducing power consumption, the system can be placed in remote locations where wildlife is more active and in their native habitat. The monitoring system can observe the pattern of survival and activity in the artificial burrow, which will increase the species population and long term survival of the species. Collecting long term data helps to provide new insight into factors limiting species distribution and helps create solutions to help in species conservation. The SWANN security system remained functioning properly in high temperatures and was properly waterproofed. The system recorded motion in the burrows both on grid and off grid. The batteries were charged by the solar panels. The cameras recorded both day and night time feeds. The system is power efficient and does not leave a huge footprint. The idea for this is very simple to do as an at home project. The security system while big and bulky, worked perfectly for monitoring remote areas. The solar panels received sunlight and powered the battery bank, the Arduino UNO switches the SWANN security cameras on and off when motion is detected and animals are active around the manmade burrows providing video for data.

After running the SWANN security system off grid, the solar panels were sufficient for charging the batteries for six days with two of those days being without sun. The idea of using solar panels, battery banks and
electrical engineer to monitor wildlife is very capable and ideal.

Since the power consumption has been calculated a lot lower than originally thought it is possible to decrease the amount of solar panels used to one instead of three, and one battery instead of two or the system that is deployed can run three SWANN home security systems therefore monitoring more burrows.

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REFERENCES


APPENDIX


