Asian Journal of Applied Science and Technology (AJAST)
(Open Access Quarterly International Journal) Volume 2, Issue 2, Pages 678-685, April-June 2018

Surveillance System cum Weather Satellite Receiver for Rural Form Management

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Article Received: 01 March 2018 *Article Accepted: 09 April 2018* *Article Published: 28 April 2018*

ABSTRACT

Due to ever increasing threats to security, human and animal life, surveillance has become very important nowadays. In this paper we have proposed a design for Raspberry Pi based security IR camera with night vision mode and a weather satellite receiver that is capable of working on a solar powered battery. The surveillance camera captures images of a farm me and stores it in the memory. Raspberry Pi works like a small minicomputer and operates on a Linux platform. We use humidity and temperature sensor for sense humidity and temperature level in the area. VHF ground plane antenna, SDR and a USB audio card are used to predict the weather condition by receiving satellite images. The output from the audio card is recorded as a wave file. This wave file is decoded using a special software to generate weather map. This project can be used in agriculture, military, coastal areas, etc.

Keywords: Surveillance, Security, Raspberry Pi, SDR, Temperature and Humidity sensor, Solar Panel, VHF ground plane antenna.

1. INTRODUCTION

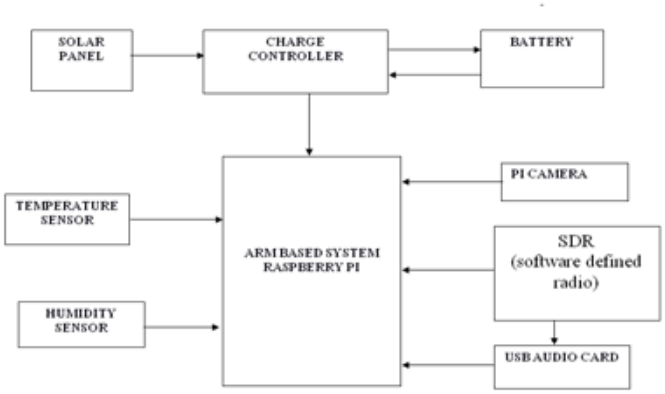
Rural areas are highly insecure because the fields and domesticated animals are hunted by carnivores and herbivores. By using surveillance camera we can monitor agricultural farms and save them from damages. The use of sensors for temperature and humidity help the farmers to protect and take preventive measures to save their crops from natural calamities like wind, rain and storms. Also the weather satellite receiver helps farmers and fishermen by providing weather maps in multiple times of a day to take preventive measures. Thanks to the low power systems used and the whole project is for rural farmers and fishermen for whom access to electricity is a very remote possibility. The system is designed for battery power with solar chargers.

2. PROBLEM IDENTIFICATION

Rural agriculturists and off shore fishermen are not accessible to weather reports in graphical form. They are bound to face damages to their crops and their own life in case of natural calamities. In addition to weather threats wild animal movements are also on the rise into the agricultural farms. An affordable low cost system could enable them for a better farm management.

3. PROPOSED SYSTEM

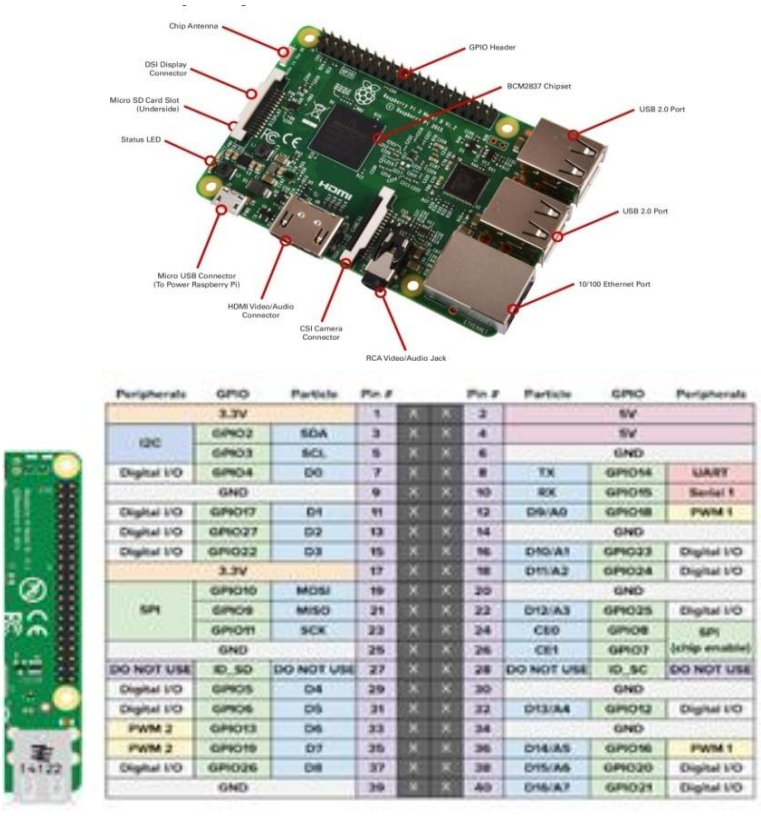
The distinctive feature in this set up is its low cost. Also it is powered by sunlight rather than typical electrical energy source so that the system can be implemented in hill areas and off shore fishermen boats. The whole set up is integrated using a Raspberry Pi module. The camera captures the farm area continuously and stores the video images in memory card. Depending on the storage capacity of the memory card recording duration can be controlled by software. An FM receiver tuned to receive signals representing weather satellite image transmitted from a selected satellite at a predetermined time duration of a day(minimum of two times a day) The data thus received will be stored as audio file in the memory card. The memory card with saved data can then be installed in a smart phone. Using appropriate software, video and satellite images can be played back on mobile screen.



Fig(1): Proposed system model.

4. RASPBERRY PI -3

The Raspberry Pi is a credit card sized computer that plugs into your TV and a keyboard. It is capable of being a little computer which can be used in electronic projects and for many of the things that your desktop does like spread sheets, word-processing and games. It can also play high definition videos. Raspbian is the recommended operating system for normal use on a Raspberry Pi. Raspbian is a free operating system based on Debian, optimized for the Raspberry Pi hardware. Raspbian comes with over 35,000 packages; precompiled software bundled in a nice format for easy installation on your Raspberry Pi. Raspbian is a community project under active development, with an emphasis on improving the stability and performance of as many Debian packages as possible.



Peripherals	GPIO	Particle	Pin #			Pin #	Particle	GPIO	Peripherals
	3.3V		1	X	X	2		5V	
I2C	GPIO2	SDA	3	X	X	4		5V	
I2C	GPIO3	SCL	5	X	X	6		GND	
Digital I/O	GPIO4	D0	7	X	X	8	TX	GPIO14	UART
	GND		9	X	X	10	RX	GPIO15	Serial 1
Digital I/O	GPIO17	D1	11	X	X	12	D9/A0	GPIO18	PWM 1
Digital I/O	GPIO27	D2	13	X	X	14		GND	
Digital I/O	GPIO22	D3	15	X	X	16	D10/A1	GPIO23	Digital I/O
	3.3V		17	X	X	18	D11/A2	GPIO24	Digital I/O
SPI	GPIO10	MOSI	19	X	X	20		GND	
SPI	GPIO9	MISO	21	X	X	22	D12/A3	GPIO25	Digital I/O
SPI	GPIO11	SCK	23	X	X	24	CE0	GPIO8	SPI (chip enable)
	GND		25	X	X	26	CE1	GPIO7	SPI (chip enable)
DO NOT USE	ID_SD	DO NOT USE	27	X	X	28	DO NOT USE	ID_SC	DO NOT USE
Digital I/O	GPIO5	D4	29	X	X	30		GND	
Digital I/O	GPIO6	D5	31	X	X	32	D13/A4	GPIO12	Digital I/O
PWM 2	GPIO13	D6	33	X	X	34		GND	
PWM 2	GPIO19	D7	35	X	X	36	D14/A5	GPIO16	PWM 1
Digital I/O	GPIO26	D8	37	X	X	38	D15/A6	GPIO20	Digital I/O
	GND		39	X	X	40	D16/A7	GPIO21	Digital I/O

Fig (2): Raspberry Pi3 and GPIO pins

4.1 Features

CPU: Quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz

GPU: 400MHz Videocore IV multimedia

Memory**:** 1GB LPDDR2-900 SDRAM (i.e. 900MHz)

USB ports: 4

Video outputs: HDMI, composite video (PAL and NTSC) via 3.5 mm jack

Network**:** 10/100Mbps Ethernet and 802.11n Wireless LAN

Peripherals**:** 17 GPIO plus specific functions, and HAT ID bus

Bluetooth: 4.1

Power source**:** 5 V via Micro USB or GPIO header

Size: 85.60mm × 56.5mm

Weight**:** 45g (1.6 oz)

5. RASPBERRY PI-3 AND CAMERA MODULE INTERFACE

Pi Camera module is a camera which can be used to take pictures and high definition video. Raspberry Pi Board has CSI (Camera Serial Interface) interface to which we can attach Pi Camera module directly. This Pi Camera module can attach to the Raspberry Pi's CSI port using 15-pin ribbon cable. In this night vision camera is used for security purposes. Night vision is the ability to see in low light conditions. Night vision is made possible by a combination of two approaches: sufficient spectral range and sufficient intensity range. Humans have poor night vision compared to animals, in part because the human eyes lack a tapetum lucidum. Here the night useful spectral range techniques can sense radiations that are invisible to a human observer. Human vision is confined to a small portion of the electromagnetic spectrum called visible light. The enhanced spectral range allows the viewer to take advantage of non-visible sources of electromagnetic radiations. The enhanced intensity range is achieved via technological means through the use of an image intensifier, gain multiplication CCD, or other very low-noise and a high-sensitivity array of photo detectors.

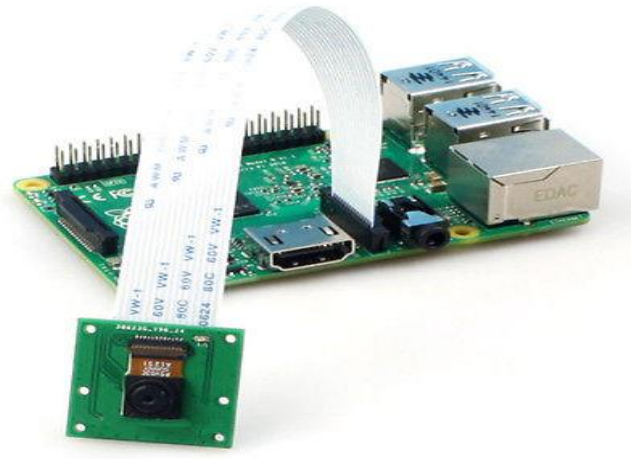


Fig (3): Raspberry Pi-3 with Camera interface.

5.1. Features

1. Resolution – 5 MP
2. HD Video recording – 1080p @30fps, 720p @60fps, 960p @45fps and so on.
3. It Can capture wide, still (motionless) images of resolution 2592x1944 pixels
4. CSI Interface enabled.

6. NOAA SATELLITE

Using SDR receiver and antenna we can receive the satellite images transmitted by orbiting satellites over the circumference of the globe. Here, the focus is on the satellites directed from NOAA. There are 4 operational satellites of NOAA in orbit NOAA-15, NOAA-16, NOAA-17 and NOAA-18. The satellite uses cameras to scan the visible spectrum as well as the infrared spectrum and take strips of images that would span approximately 3000 km. By repeated process we can make a continuous image. These weather satellites deal with two categories of image services, a digital high resolution data (HRPT) and an analogical lower resolution data (APT). In this paper, the focus is on the reception of the Automatic Picture Transmission (APT) weather satellites pictures. Where, this image is transmitted at 137 MHz and received at the ground station. This signal can be received through the antenna while the satellite is overhead. The VHF ground plane antenna is suitable to this system. The radio receiver demodulates the FM carrier and leaves an AM sub-carrier data signal that is processed to display an image. NOAA satellite imagery is done with the help of a VHF ground plane antenna and the Dongle SDR. The antenna is fixed in a particular position for getting better signal reception from the satellite. The SDR receiver is tuned to the frequency of the satellite with the help of interface software. The spectrum analysis is done with the SDR program and the signal from the satellite is recorded as WAV files. Also, the waterfall display of SDR shows the signal intensity in the tuned frequency. As the satellite passes, a direct image recording is done with the help WXtoImg software.

7. ANTENNA

An antenna is an electrical device which converts radio waves into electric current or vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter applies an oscillating radio frequency electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified. An antenna can be used for both transmitting and receiving. Antennas can be designed to transmit or receive radio waves in one direction or all directions. Antennas that can receive or transmit radio waves in all directions are called as omnidirectional antennas and in one direction are called as unidirectional antennas. The antenna for the APT (Automatic Picture Transmission) satellite system should be omnidirectional and circularly polarized beam. In this paper we have used VHF ground plane antenna. This antenna operates at approximately 140MHz resonant frequency. VHF ground plane antenna is use with SDR receiver for receiving NOAA satellite images.

Fig (4): VHF ground plane antenna.

8. SOFTWARE DEFINED RADIO (SDR)

A radio receiver practices the radio frequency signal from an antenna in order to produce operational information such as audio. There are many radio receivers available in the market. In order to make the system cost effective, we have tried with both FUN cube Dongle (FCD), RTL-SDR-2832. A software-defined radio receiver can be tuned to any frequency band and decode different modulations/encoding schemes across a large frequency spectrum by means of a programmable hardware, which is controlled by software. For a better reception, a good receiver is needed which has the correct IF bandwidth. The FCD is a fully integrated, wide band, high performance Software Defined Receiver with a greater potential. It is a simple USB receiver covering approximately 60MHz to 1,700MHz range of the frequency. The Dongle is designed to allow anyone to try their hand at reception of satellites like FUN cube anywhere on Earth as part of a global educational collaboration project collecting information from space. The FUN cube Dongle is similar to a USB TV Dongle. This can be simply connected to the computers USB port and thus it appears as a USB Audio Device running at full speed. In our computer, we can use various SDR interface software to adjust the parameters to our requirements.

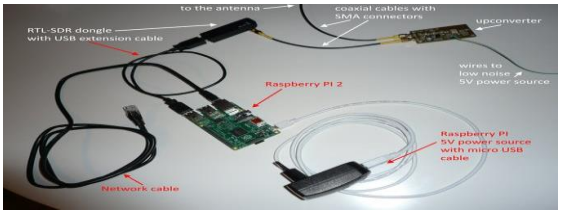


Fig (5): SDR connected to Raspberry Pi3.

9. WxtoImg SOFTWARE

High quality satellite image is decoded from the recorded wave file using WXtoImg. WXtoImg is a fully automated APT and WEFAX weather satellite (wxsat) decoder. The software supports recording, decoding, editing, and viewing on all versions of Windows, Linux, and Mac OS X. WXtoImg supports real-time decoding, map overlays, advanced colour enhancements, 3-D images, animations, multi-pass images, projection transformation, text overlays, automated web page creation, temperature display, GPS interfacing, wide-area composite image creation

and computer control for many weather satellite receivers, communications receivers, and scanners. WXtoImg makes use of the 16- bit sampling capabilities of soundcards to provide better decoding than is possible with expensive purpose-designed hardware decoders. WXtoImg comes in a basic freeware version that provides a large range of features. Improved automation, new enhancements, a wider variety of options, projection transformations and improved quality images from communications receivers and scanners are available by upgrading the software. WXtoImg is feature-laden program that decodes NOAA data in real-time, saving the raw data as WAV files. The program can be made to process these WAV files into images in a variety of projections, and can create a colour composite of numerous types. Output is in JPEG, PNG, BMP, PBM (PGM/PPM/PNM), or AVI format. WXtoImg software is used in this paper work. The direct recording of the satellite signals is possible with this software and thus we get images of the ground station location.

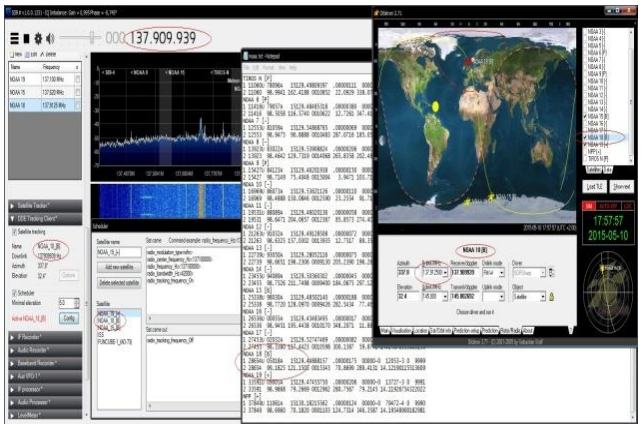


Fig (6): Wave file to JPEG conversion

10. CODING FOR VIDEO RECORDING

```
 import picamera
from time import sleep
 camera = picamera . PiCamera()
Camera . resolution = (640, 480)
 print()
# start recording using pi camera
camera.Start _ recording("/home/pi/demo.h264")
# wait  for video to record
Camera .wait _ recording(20)
# stop recording
Camera . stop_ recording()
Camera . close()
print("video recording stopped")
```

10.1. Program for capturing image

```
import picamera
from time import sleep
#create object for PiCamera class
camera = picamera.PiCamera()
#set resolution
camera.resolution = (1024, 768)
camera.brightness = 60
camera.start_preview()
#add text on image
camera.annotate_text = 'Hi Pi User'
sleep(5)
#store image
camera.capture('image1.jpeg')
camera.stop_preview()
```

11. CONCLUSION

In this paper Surveillance system with Raspberry pi-3 is done in such a way that field areas are monitored. It is related to the security basis. The implementation is low cost. Also predict the weather conditions using SDR receiver. Unaware about the weather condition is avoided. This paper is useful for rural areas, coastal areas, etc.

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