Wild Animals Detection and Alerting using X-Band Doppler Radar for Crop Protection

Chaitra.R[#1],Manasa.M[#1], Sanjana.K[#1], Thejaswini.L[#1], Dr.Parmeshachari.B.D[#2]
[2]HOD, Department of TCE, GSSSIETW, Mysuru, Karnataka, India,
[1]Students, BE,Department of TCE, GSSSIETW, Mysuru, Karnataka, India

***Abstract* - In this project, an ultra-sensitive compact portable microwave life-detection device is introduced and implemented with promising results. By utilizing Doppler effect-based systems, vital signs such as heartbeats and breathing can be detected and can be used for finding animals behind trees, crops etc. This device is tested in both simulated and realistic situations, and it can accurately detect crucial signs of life through highly dense construction materials of about 1.5m thick and standard density materials of about 10m while operating at 10.5 GHz center frequency in x-band.**

In the world the economy of many countries is dependent upon agriculture . Traditional methods have been widely applied depending on the kinds of produce and imperilling animals .One such method electric fence is being used in our country to protect the crops in farm land from wild animals. s electric fence is more costlier for larger farm land , so farmers cannot afford. Fire hazards are more with electric fence. Due to which there will be loss of animal life and very dangerous to human being also. In order to overcome the disadavntages of electric fence , an effective method has to be developed.

INTRODUCTION

Farmers attempt to protect their crops from wildlife by increasing the risks faced by potential predators. These defense strategies were designed to exploit an animal's tendency to avoid foraging in risky areas by employing stimuli that increase an animal's fear of the places where crops are planted. The fearprovoking stimuli consisted of objects with visual, auditory, or gustatory olfactory characteristics that increased an animal's wariness or fear In some areas, divine intervention was invoked by farmers. In north-eastern Nigeria, farmers used fetish charms to protect their farms from wildlife (Ezealor& Giles, 1997). Knight (2004) reported that Japanese villagers used wolf charms (ofuda) obtained from wolf shrines and placed these in the local shrine or buried them in the fields to protect crops from forest herbivores. Knight (2004) further observed that Japanese farmers' preoccupation with safeguarding these fields, their means of subsistence, formed the basis for their representation of the wolf as a guardian spirit.

1. *SOME PRESENT METHODS USED TO SCARE ANIMAL ARE AS FOLLOWS:*

1.1.1 Mounting Plastic Papers on Wooden Sticks This method involved tying pieces of plastic paper of diverse colors to wooden branches and mounting them on the cultivated parts of farms to deter birds, Cape hares, and antelopes from raiding crops. This method uses both sight and sound to discourage wildlife from raiding crops. The vibration of the plastic papers produces a sound that is meant to frighten antelopes, and the sight of vibrating plastic papers is intended to scare birds.

1.1.2 Scarecrows, crude effigies of persons, were erected on the farms by the residents to scare birds and antelopes. The scarecrows served to frighten wildlife but were not, in themselves, dangerous. Seven farmers erected scarecrows on their farms. However, the scarecrows had limited effect. I personally observed bean plants located immediately beneath the scarecrows being raided by wildlife.

1.1.3 Use of Compact and Videocassette Tapes Old cassette tapes and videocassette tapes were tied across farms to deter birds. The wind-induced vibrations of these tapes deterred birds from raid crops, as the vibrating tapes frightened the birds. The success of this method varied from farm to farm. On some farms, crops were not raided, whereas others were raided despite the presence of the tapes.

1.1.4 Sheathing Maturing Maize to protect maturing maize, two farmers sheathed the maize with socks, cattle horns, and plastic papers. On one farm, the maize was not attacked by wildlife, but it rotted. On the other farm, the maize was not attacked by other species, but elephants consumed the maize along with the sheaths.

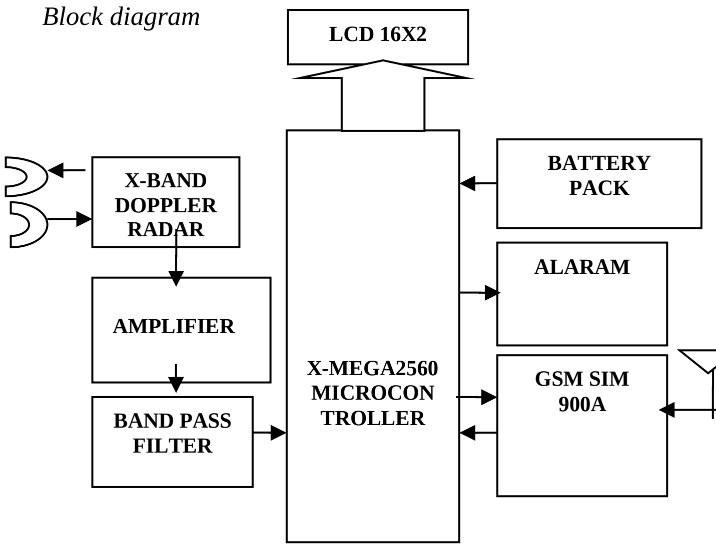
1.1.5 Displaying Dead Animal Parts

Parts of dead animals were placed on farms to serve as warnings to conspecifics: "this is what happened to your colleague." I observed parts of an elephant killed in the village by Kenya Wildlife Service (KWS) in June 2004

In all these methods a person need to be present or corresponding item must be displayed which can stop the animal by entering in to field or may not able to stop.

2. DETAILED DESIGN

Block diagram



3. CONCEPTIAL DESIGN

Methodology

The proposed system consists of three microwave UWB Doppler Radar in X-band operating at 10GHz frequency to transmit from patch antenna. Proximity signals received by pairs of patch antenna and same signal is passed into the mixer for further processing.

The signal from the Doppler Radar will be in the form of pulse repetition frequency. The obtained pulse repetition frequency need to be converted into voltage, will be in microvolt which cannot be applied for processing as it needs at least milli volts. To amplify micro volts to milli volts 2 KHz PRF amplifier has been designed with considerable gain. After amplification, signal must be passed through a limited bandwidth using bandpass filter. After this, process signal is fed to microcontroller to do the processing with respect to Doppler repetition equation.

doppler equation

Where,

$$F_d = 2V\left(\frac{F_t}{c}\right)\cos\theta$$

F_d = Doppler frequency

V = Velocity of the Target.

F_t = Transmit frequency.

C = Speed of light (3×10^8 m/sec).

θ = The angle between the target moving direction and the

Fd =19.49 V (Velocity in km/hr) or 31.36 v (v in mile per hour) is the simplified output for formula when target is coming towards radar (Ft = 10.525 GHz).

Frequency to Voltage conversion

Doppler module consists of internal oscillator which gives the source signal as transmitted frequency then the signal received will be heterodyne by mixing up with this signal set and the output is obtained in the format of sinusoidal which contains frequency difference between signal received at its output of the receiver. By using microcontroller corresponding values can be read and recorded in a need way. Microcontroller reads the data from its internal analog channel when it is at DC level. Hence frequency to voltage circuit is necessary. LM358 dual opamp is configured with specific set for output data for known frequency range with voltage range obtained from the module. The equation to do this is as shown below-

$$\Delta f = \frac{2 * v}{\lambda}$$

$$\lambda = \frac{c}{f_o}$$

Where,

C = Speed of light.

f_o= signal frequency.

v = speed of value to the application

To form a High-Pass Filter, the output from HB100's is connected to P1 and C4/(R4&R2&R1). Due to this high-pass filter, the signal at the opamp A positive input (IN+A) is centered at Vcc/2 and voltage divider made by R1 and R2. Hence opamp A, R5, C5, R6 and C6 form a non-inverting band-pass filter as shown in figure 4.2. It amplifies the signal at IN+A by 100(R6/R5) between 3.4Hz (1/2 x π x R5 x C5) and 72Hz (1/2 x π x R6 x C6). The gain is 1 outside these frequencies, so the opamp A's output is centered around Vcc/2.

Circuit diagram of Amplifier and Band Pass Filter

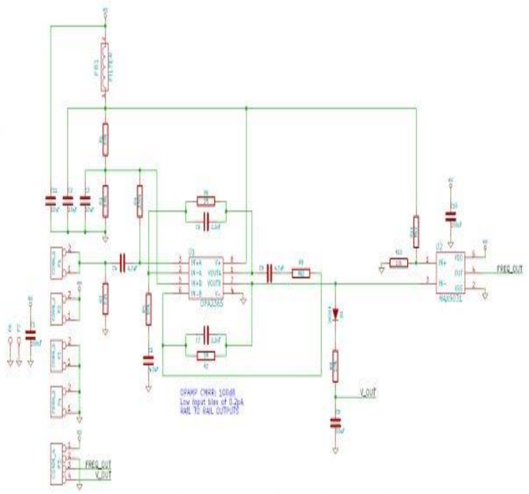


Figure 4.2: Circuit Diagram

The signal is then passed through an inverting band-pass filter circuit. The gain is 121 (R7/R8) between 4.1Hz (1/2*pi*C8*R8) and 72Hz (1/2*pi*C7*R7). The gain is 0 outside these frequencies, but the opamp B's output is also centered around Vcc/2 because Vcc/2 is present at IN+B.The lower cut off frequency at last amplifying stages is slightly higher than the previous which avoids amplifying the DC component as the band-pass filter is not ideal. Hence HB100 signal is amplified by 100*121=12100 which leads amplification of noises and also the opamps chosen will have a high common mode rejection ratio (CMRR).

4. REFERENCES

[1] H. R. Chuang, H. C. Kuo, F. L. Lin, T. H. Huang, C. S. Kuo, and Y. W. Ou, "60 GHz Millimeter-Wave Life Detection System (MLDS) for Noncontact Human Vital- Signal Monitoring," IEEE Sensors Journal, vol. 12, no. 3, March 2012.

[2] J. C. Lin, "Microwave sensing of physiological movement and volume change: A review," *Bioelectromagn.*, vol. 13, pp. 557–565, 1992.

[3] K. M. Chen, D. Misra, H. Wang, H.-R. Chuang, and E. Postow, "An X-band microwave life-detection system," *IEEE Trans. Biomed. Eng.*, vol. 33, no. 7, pp. 697–702, Jul. 1986.

[4] H. R. Chuang, Y. F. Chen, and K. M. Chen, "Automatic clutter-canceller for microwave life-detection system," *IEEE Trans. Instrum. Meas.*, vol. 40, no. 4, pp. 747–750, Aug. 1991.

[5] K. M. Chen, Y. H. Huang, J. Zhang, and A. Norman, "Microwave life-detection systems for searching human subjects under earthquake rubble or behind barrier," *IEEE Trans. Biomed. Eng.*, vol. 27, no. 1, pp. 105–114, Jan. 2000.

[6] K. M. Chen, Y. Huang, A. Norman, and J. Zhang, "Microwave life-detection system for detecting human subjects through barriers," in *Proc. Progress in Electromagnetic Research Symp.*, Hong Kong, Hong Kong, Jan. 6–9, 1997.

[7] Q. Zhou, J. Liu, A. H. Madsen, O. B. Lubecke, V. Lubecke, "Detection of Multiple Heartbeats Using Doppler Radar," *ICASSP 2006 Proceedings*, vol. 2, pp. 1160-1163, May 2006.

[8] L. Chioukh, H. Boutayeb, D. Deslandes, K. Wu, "Noise and Sensitivity of Harmonic Radar Architecture for Remote Sensing and Detection of Vital Signs," *IEEE Transactions on Microwave Theory and Techniques*, vol. 62, no. 9, pp. 1847-1856, Sept. 2014.

[9] C. Li, and J. Lin, "Random Body Movement Cancellation in Doppler Radar Vital Sign Detection," *IEEE Transactions on Microwave Theory and Techniques*, vol. 56, no. 12, pp. 3143-3153, Dec. 2008.

[10] M. Ascione, A. Buonamo, M. D'Urso, L. Angrisani, and R. S. L. Moriello, "A New Measurement Method Based on Music Algorithm for Through the Wall Detection of Life Signs," *IEEE Transactions on Instrumentation and Measurement*, vol. 62, no. 1, pp. 13-27, Jan. 2013.

[11] C. Li, V. M. Lubecke, O. B. Lubecke, and J. Lin, "A Review on Recent Advances in Doppler Radar Sensors for Noncontact Healthcare Monitoring," *IEEE Transactions on Microwave Theory and Techniques*, vol. 61, no. 5, pp. 2046-2061, May 2013.

[12] W. Hu, Z. Zhao, Y. Wang, H. Zhang, and F. Lin, "Noncontact Accurate Measurement of Cardiopulmonary Activity Using a Compact Quadrature Doppler Radar Sensor," *IEEE Transactions on Biomedical Engineering*, vol. 61, no. 3, pp. 725-736, March 2014.

[13] Y. Hong, S. G. Kim, B. H. Kim, S. J. Ha, H. J. Lee, G. H. Yun, and J. G. Yook, "Noncontact Proximity Vital Sign Sensor Based on PLL for Sensitivity Enhancement," *IEEE Transactions on Biomedical Circuits and Systems*, vol. 8, no. 4, pp. 584-594, Aug. 2014.

[14] G. Wang, J. M. Ferreras, C. Gu, C. Li, and R. G. Garcia, "Application of Linear Frequency Modulated Continous- Wave (LFMCW) Radars for Tracking of Vital Signs," *IEEE Transactions on Microwave Theory and Techniques*, vol. 62, no. 6, pp. 1387-1400, June 2014.

[15] C. Li, J. Cummings, J. Lam, E. Graves, and W. Wu, "Radar Remote Monitoring of Vital Signs," *IEEE Microwave Magazine*, vol. 10, no. 1, pp. 47-56, Feb. 2009.

[16] Q. Aardal, Y. Paichard, S. Brovoll, T. Berger, T. S. Lande, and S. E. Harman, "Physical Working Principles of Medical Radar," *IEEE Transactions on Biomedical Engineering*, vol. 60, no. 4, pp. 1142-1150, Apr. 2013.