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Research paper

Acoustic Identification of snail for Pest Control in Agriculture

Adeline Sneha J[1], Rekha Chakravarthi[2], Mokhtar Harun[3], You Kok Yeow[4]

[1] Department of EIE, Sathyabama Institute of Science and Technology, Chennai, India Nor Hisham Khamis
[2]Department of ETCE, Universiti Teknologi Malaysia, Chennai, India
[3]Communication Engineering Department , Universiti Teknologi Malaysia, Johur Bahru, Malaysia
[4]Communication Engineering Department , Universiti Teknologi Malaysia , Johur Bahru, Malaysia

Abstract

snails are harmless creatures; however, they can cause heavy losses to the agriculture industry. The Giant African snails are the natural enemies for the farmers which could cause massive damages to vegetation. These snails possess high reproductive ability, devouring good quality of meals, loss of quarantine facilities which makes this snail to have detrimental impact in destruction of the fields. The farmers apply molluscicides of their fields often which will guard the crops from snails. The alternative approach has been practiced with the aid of the farmers are capturing the snails all over the farm and killing it with boiling water. This all happens because of the shortage of initial identity of snails within the fields. This paper describes about the snails affecting the fields and modern-day technology to govern the snail by means of applying molluscicides only to the infected crop now not to the complete area. The suggested acoustic identification identifies the presence of snail with its sounds. The various features of the signals are extracted and the frequency is determined which has been continued with the neural network classification for automatic identification. This technology identifies the snail in its initial stage so that the effective control action has been taken without damaging the environment and field.

Keywords: *African Snail, Control Methodologies, Molluscicides, Agricultural Pests.*

1. Introduction

The African Snail (Achatina fulica) is one of the common pests in agricultural plantations. Land molluscs (snails and slugs), including Monacha cantiana, are very harmful pests to fruit trees, vegetables, field crops, ornamentals and ecosystem [1,2]. They are known for destructive nature on cultivated plants. They are the world's largest and most damaging land snail pests[3]. The African snail has been reported for the first time causing damages to ornamental plants and vegetables in Bangalore [4]. It can also cause severe damages to mulberry, betel vine, capsicum, areca, banana, tomato crops [5]. Slugs and snail damages are characterizing by holes and slimy trails over the foliage of cauliflower [6]. Snails can also release parasites which spreads Schistosomiasis japonica disease to human being. Estimates show that at least 206.5 million people required preventive treatment in 2016, out of which more than 88 million people were reported to have been treated[7]. Fascioliasis is also a disease caused by the fresh water snails. WHO estimates that at least 2.4 million people are infected in more than 70 countries worldwide, with several million at risk. No continent is free from fascioliasis, and it is likely that where animal cases are reported, human cases also exist [8]. Due to the high reproductive potential, a single snail can multiply into the field and it's difficult to control. During day time these creatures found shelter in a moisty shady places, but during night they come out from the habitat and damages the crops in a bunch. It has been a challenging task for the farmers to identify the snail in its initial stage. There is a symptom of impact has been identified by the farmer without proper inspection of the fields molluscicides are applied to the whole field to safeguard the crops from snail attack. Niclosamide is used in Asia and Africa to eradicate snails [9]. The World Health Organization has tested thousands of synthetic compounds for the eradication of snails. Though effective, these pesticides have so far not proved themselves to be entirely satisfactory [10]. Henceforth its necessary to develop a smart system for the identification and control of snails in the field. There are so many control techniques like cultural control, biological control, chemical control etc. that are available in the market for controlling the snails, but all these methods have some drawbacks like affecting the environment, time consuming, and lagging in initial identification of pest. The acoustic form of pest identification and control is suggested in this paper for initial identification of pest. This method is a non-destructive form of snail identification in the fields. The giant African snail is used in this work. A medium sized snail is chosen for this work. The length of the snail is 6.2 cm and the breadth of the snail is 3.2 cm. The weight of the snail is measured as 27.28 grams. The shell of this snail is light brown in color with pale yellow vertical markings in its shell. The snail chosen for the analysis is feed with vegetables. Different behavior of the snail's like eating, moving, retraction movement, and biting are recorded and analysed. The signals are generated from the matlab programming; and the statistical features are estimated. More than 15 statistical features are extracted from the signal. The behavior of the snail has been studied with the acoustic environment and the open environment. The Fast Fourier Transform is applied to the signals in order to find the frequency of the signal. The feature extraction and the classification of snail is done for the identification of snails in the fields. The snail used in this work is shown in the fig.1.

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Fig.1: Giant African Snail

These snails are the natural enemies of the farmers. The sounds of snails at its different behaviors are recorded by the H1 recording device. The snails which are tested in the lab are collected from the soil, moisty places located in Malaysia with the duration of February 2018-April 2018. Snails were kept in plastic boxes with the room temperature of (28 ± 2^0C). The Snails are feeded only with vegetables cauliflower, tomatoes, cucumber, lettuce etc. The behavior of the snail is observed each day. Rather than a plastic boxes and soil, snails move fast in fresh water. Most of the snails move by gliding along on their muscular foot, which is lubricated with mucus. This motion is powered by succeeding waves of muscular contractions that move down the ventral of the foot. It uses slime for its easy moments of the muscles. The slime is an unpleasant thick and slipper liquid substance which supports the snail for easy gliding moment. The silvery mucous trails on the plants confirms the presence of snails not the earwigs, caterpillar or other chewing pest [11]. Most of the time the snail damages the crop during the night than the day time. These damages cause heavy agricultural losses to the farmers. Therefore, it necessitates the development of efficient technology to identify the snail in its initial invasion to the field and to control the spreading of snail throughout the field. The developed technology could support the farmers and to reduce the quantity of annual crop losses

2. Control of snails

Snails damages the plant seedlings, tubers, leaves and fruits. Damages caused by this snail sometimes causes the death of the plants, finally results in major production losses. Therefore, it's necessary to control the snail. Several groups of compounds present in various plants have been found toxic to snails. Thus saponins, tannis, miscellaneous alkaloids, alkenyl phenols, glycoalkaloids, flavonoids, sesquiterpenes lactones, torpedoed and phorbl. These chemicals are found to be poisonous to snail at the acceptable doses ranging from less than 1-100 ppm. Different Methods of Snail control is given in fig.2.

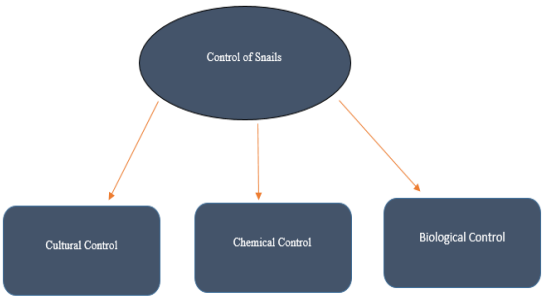

Fig. 2: Control of Snail

2.1. Cultural Control

Cultural Practices modifies the farm in such a way that reduces the pest investigation using plants which are used as the natural resistant of pests. The cultural practices may directly or indirectly affect the growth of pests, minimizing the attack of pest to the agricultural plantation and controlling the multiplication of pest. It's like prophylactic. Cultural practices that retain soil moisture and promote good plant growth also promotes slug and snail habitat[11].Weed control, good hygiene and good environment makes this method to prevent the attack of pest over longtime. As the pest no longer have the weeds for its shelter and food then its starts consuming the crops. The frequent observation is needed to gather information about the weedy fence line. The success of this control requires long term effective planning and careful timings, but still the complete control has not been achieved.

2.2 Chemical Control

Identify applicable funding agency here. If none, delete this text box.
The snails are eradicated with the chemicals, however these chemicals are harmful to the crops and the environment. Metaldehyde, Methiocarb and Iron EDTA are used as baits. These chemicals are used in Australia for snail control. A 50% solution of niclosamide ethanolamine salt (WPN) is widely used for snail control in China. However, WPN is costly and toxic to fish [12]. In the process of eradication of snails mollucicides are applied enormously into the fields to kill the snails, but it affects the birds which is the natural controller to manage the snails.

2.3 Biological Control

Chickens are introduced into the fields since they can provide good control of snails and many insects. They also control the weeds in the fields. But sometimes vegetables and fruits fall as the food for chickens which will impact the production of crops. Though biological control may seem attractive, sometimes misguided attempts can terribly damage non-target, indigenous snails. biological control agents against *Achatina fulica* are highly dangerous from the perspective of the conservation of native snail species. [13].

3. Acoustic Identification of Snail

The acoustic identification of snail is the good solution to fit all the farmer's need unto protecting the crops from snails. In this work the identification of snail has been done with the sounds of snails.
The giant African snails are collected from different environment. The sounds of snail were recorded. This paper gives the analysis of single snail with multiple behaviors. Before recording the sounds from the snail, the possibility of sounds produced by the sounds are studied. Based on the studies the sound production in snail is classified into snail eating, snail moving, snail retraction of head, snail biting and moving head. The sounds of the snails are recorded from the acoustic environment and the open environment. In the open environment the impact of noise is very high than the original signal. But in the acoustic room the impact of noise is minimum. The H1 recorder is used for recording the sounds of the snail. The recorded sounds are present in the micro SD supports the capacity of 32 GB. Then with the proper interface the sounds are transferred to the Pc. The Matlab 2015 version is used for the generation of signals from the sounds of snail. In the open environment the sounds are collected with different interval of time and its analyzed. The Fig.3 represents the Time Domain Analysis of the Signal. This can also further have examined with Frequency Domain Analysis with the help of Fast Fourier Transform. The frequency of the signal is fixed. The various

statistical features are extracted from the signal for further classification. Similarly, the same procedure has been applied to the Acoustic Environment. The Sound Signals are given in Fig.4.

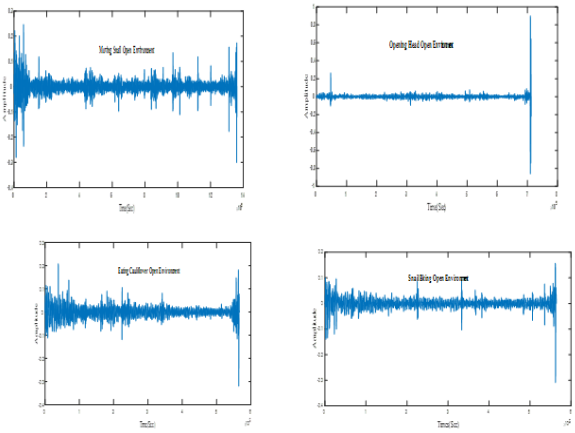

Fig. 3: Signals of Snail at Open Environment

The statistical features are extracted from the signal. Table 1 represents the feature extraction of signals obtained from the open environment.

Table.1: Feature Extraction of Signals in the Open Environment

Pest Behaviour	Mean	standard deviation	Skewness	Kurthosis	Entropy	Peaktopeak	Maximum	Signal to Noise Ratio
Snail Moving1	0.01	0.02	-0.19	22.52	2.40	0.55	0.25	-9.45
Snail Moving2	0.01	0.02	0.52	31.14	1.95	0.41	0.20	-15.52
SnailMoving3	0.01	0.03	-2.12	303.72	2.10	1.90	0.90	-15.00
SnailMoving4	0.01	0.03	3.89	154.51	2.37	1.19	0.76	-16.60
SnailMoving5	0.01	0.02	-3.15	117.43	2.02	0.74	0.24	-11.45
SnailMoving6	0.01	0.02	-0.06	13.95	2.29	0.34	0.18	-11.12
Opening head1	0.01	0.03	3.78	314.05	2.22	1.76	0.90	-9.56
Opening head2	0.01	0.03	-2.47	78.97	2.26	0.93	0.30	-13.93
Opening head3	0.01	0.01	-1.90	93.38	1.63	0.42	0.20	-11.62
Opening head4	0.01	0.01	-18.21	694.21	1.52	0.72	0.19	-10.68
Eating Cauli1	0.02	0.02	-0.49	21.98	2.49	0.53	0.21	-8.79
Eating Cauli2	0.01	0.02	0.69	47.03	2.20	0.56	0.29	-10.69
Eating Cauli3	0.01	0.02	3.28	64.99	2.22	0.47	0.35	-6.60
Eating Cauli4	0.01	0.02	1.17	46.82	2.25	0.60	0.37	-11.31
Snail Biting1	0.01	0.02	-2.01	32.70	2.34	0.47	0.16	-13.37
Snail Biting2	0.01	0.02	-0.14	15.18	2.12	0.29	0.15	-6.38
Snail Biting3	0.00	0.01	6.33	162.98	1.41	0.27	0.20	-8.86
Snail Biting4	0.01	0.02	0.16	6.63	2.29	0.23	0.12	-15.18

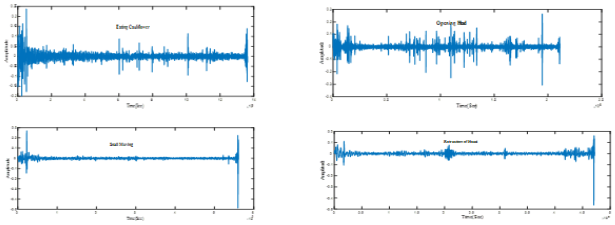

Fig. 3: Signals of Snail at Acoustic Environment

Table 2: Feature Extraction of Signals in the Acoustic Environment

Pest Behaviour	Mean	standard deviation	Skewness	Kurthosis	Entropy	Peaktopeak	Maximum	Signal to Noise Ratio
Eatingcauli1	0.01	0.02	-0.36	31.20	2.01	0.44	0.24	-13.83
Eatingcauli2	0.01	0.01	-0.49	166.64	1.93	0.91	0.53	-13.72
Eatingcauli3	0.02	0.03	-1.04	18.87	2.59	0.50	0.18	-6.89
Eatingcauli4	0.01	0.02	0.15	32.96	2.40	0.85	0.41	-20.03
Openinghead1	0.01	0.02	-0.50	32.13	2.05	0.57	0.26	-15.91
Openinghead2	0.01	0.03	-0.32	73.19	2.30	1.08	0.50	-13.37
Openinghead3	0.01	0.02	-0.99	79.95	2.24	0.99	0.49	-13.25
Openinghead4	0.01	0.01	-2.10	45.59	1.86	0.32	0.12	-11.36
Moving Snail1	0.01	0.02	-4.10	238.98	1.68	0.76	0.27	-5.50
Moving Snail2	0.02	0.03	0.22	23.05	2.42	0.72	0.32	-12.08
Moving Snail3	0.01	0.03	-4.15	291.88	2.18	1.61	0.61	-9.18
Moving Snail4	0.01	0.02	0.10	18.08	2.23	0.42	0.28	-9.52
Retraction of Head1	0.01	0.02	-7.16	201.69	1.95	0.63	0.16	-11.00
Retraction of Head2	0.01	0.02	0.01	9.71	2.29	0.31	0.19	-7.41
Retraction of Head3	0.01	0.03	-1.60	85.63	2.18	0.97	0.42	-14.32
Retraction of Head4	0.01	0.02	-1.57	28.52	2.18	0.43	0.19	-8.20

4. Conclusion

The Acoustic Identification of Snail is the nondestructive form of identification. Unless like the other technologies the acoustic form of identification of snail identifies the presence of snail in its initial stage which can avoid the spreading of snails throughout the fields. Thereby the loss has been minimized. This work has been enhanced with neural network for further classification. This Technology is easier and user friendly, but sometimes affected by environmental noise.

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