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Fabrication of a Model to Identify RPW Existence Using Voice Board and MEMS Accelerometer.

Betty Martin*, Godwin Premi MS, Jerry Alexander T , and Khamar Basha Shaik.

Sathyabama University, Rajiv Gandhi Nagar, Chennai-119, Tamil Nadu, India.

ABSTRACT

Additional study done on the research towards detection of red palm weevil is focused on the micro machined accelerometer. An acoustic recorder is placed on the area of infestation to capture the sound obtained from the pest. This test can be performed by placing the MEMS accelerometer on the same board of acoustic capture. When the accelerometer senses the movement of the weevil, the deflection sensed in its structure is measured. The output obtained is in terms of analog voltage and is directly proportional to acceleration.

Keywords- accelerometer; voice board; microcontroller; RPW (red palm weevil).

Corresponding author

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INTRODUCTION

Implementation of non-destructive methods in an interest to spot RPW in infested trees has always continued to be a challenge for farmers of coconut groves in India. Though most damage of RPW is on palms the recent research work here takes into consideration palms which deal with coconut trees. Of all the technologies available for detection of RPW, acoustic means prove to be better and has great potential to enable early detection of RPW on infested palms.

The RPW takes into effortless access to palm trunk and creates tunnels deteriorating the tree structure. This reduces transport of nutrients and water between root system and crown. It continues its continued existence hidden and undetected until they source considerable damage. Once the severity is experienced the tree is in every respect dead and its existence in the grove makes it poorer since the adjacent trees get effortlessly contaminated. Acoustic techniques have not come into bursting use mainly due to instrumentations costs, training needs, and traditional agricultural practices[4-5]. Different techniques have been functional to become aware of the initial infestation of this pest inside palm they are preventive, physical chemical and biological treatments that are still under research. Infra-red spectroscopy has not provided good results, moreover cannot be adopted on palms. Though computer aided tomography based on x-ray has been successfully implemented for detection purposes of insects, these methods are too expensive and impractical when inspection on entire tree has to be finished.

Hence acoustic concepts deals with capturing sounds of RPW produced owing to eating, biting of palm tissue and crawling. Therefore a prototype is introduced which involves MEMS accelerometer, microcontroller, acoustic sensor and a GSM powered by a solar panel as seen in figure 1.

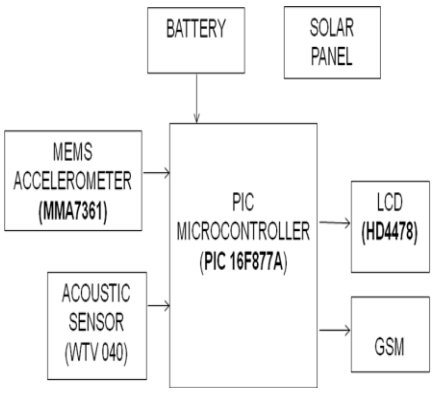

Figure I: Overview of the System

MEMS accelerometer senses acceleration in X,Y and Z axes. It is a low power complete 3 axis accelerometer with signal conditioned voltage outputs all on a single monolithic IC. This MEMS accelerometer is able to measure the static acceleration of gravity in tilt sensing application as well as dynamic acceleration resulting from motion, shock or vibration. The key benefit of microcontroller PIC 16F877A is it has inbuilt ADC, self-programmable code protection and in circuit debugging. An acoustic sensor is a microphone which has acceleration to electrical transducer converting sound to electrical signal. These microphones have numerous applications like telephones, tape recorders system, hearing aids, motion picture production, radio and TV broadcasting and in computer for recording voice and speech recognition etc.GSM is an open, digital cellular technology used for transmitting mobile voice and data services. This helps in voice communication, short message service, fax, voicemail and other services as call forwarding and caller id. The solar panel is used as a component of a layer photovoltaic system to generate and supply electricity in commercial and residential applications. They use light energy from sun to generate electricity through photovoltaic effect.

Acoustic methods have been developed to detect insects in concealed habitats, larvae in plant stems by Mankin (2004)[1] ,termites by shade (1993)[2], adults and larvae of food grains and insects in soil by Mankin

(2000)[1]. Almanie and Alkanhal (2005)[3] have developed hand held device to detect RPW in date palms which is connected to portable pc and has to be carried in fields for data acquisition. This method was hence practically not viable in large fields.

This research aimed to widen an efficient and portable acoustic device that could be used to detect RPW infested palms in field.

MATERIALS AND METHODS

The methodology used in this research comprises of MEMS accelerometer, voice recorder, microcontroller GSM modem and LCD display. Each part of the prototype will be explained in detail. The circuit diagram of the trial product shown in figure II explains the process pictorially. To deal with the hardware part of prototype it is essential to understand the structure and function of each block separately.

MEMS MMA7361

MEMS operate in low voltage 2.2V-3.6V with excellent temperature stability. It has fast turn on time approximately 0.5ms and is noted for its high shock survivability. The current consumption is low. This accelerometer is capable of sensing X,Y and Z axis vibrations. It can measure static as well as dynamic acceleration[11].

Microphones

The acoustic sensor used at this juncture is the microphone. These microphones are referred by their transducer principle. The one which utilizes capacitance change is condenser microphone and when electromagnetic induction principle is followed it is named as dynamic microphone. They often use piezoelectric generation or light modulation to produce an electrical voltage signal from mechanical vibration. Wireless microphone employs a radio transmitter.

Voice Recorder WTV040

Voice recorder records sounds sensed by acoustic sensor. This functions with 8 switches. The first three switches are used to record the sound, play the recorded sound and delete the recorded sound respectively. The fifth to eighth switches function as memory locations of voice recorder. The recorded sound is sent to ADC for conversion into digital form.

Microcontroller PIC16F877A

Microcontroller PIC16f877a is self-programmable under software control. The forty pins craft it easier to be used as peripherals and also decide what external devices to attach without worrying too much since it has numerous pins. The main benefit is that each pin is shared between two or three functions. It has an inbuilt ADC.

Solar Panel

Photons in sunlight strike the solar panel and are captivated by semiconducting materials such as silicon. Electrons are knocked from their atoms causing electric potential. Differential current starts flowing through material to cancel the potential and thus electricity is created. Due to special composition of solar cells, electrons move unidirectional. An array of solar cells converts solar energy into usable amount of direct current electricity. Hence they work on the principle of photovoltaic cell.

GSM

This is serially connected with microcontroller. GSM gets the information from MEMS accelerometer and microcontroller thereby alerting the concerned person whose mobile number is stored in microcontroller.

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RESULTS AND DISCUSSION

To begin with this section, the perception of detection is discussed in detail. The accelerometer is clamped to the tree on the place of suspicion. It senses vibration and produces voltage in form of analog signals. The out signal is given out along X,Y Z axes. This is fed to the microcontroller. The microcontroller compares the values against the threshold X,Y,Z axes values predefined in it. The voice board is activated and the mic records the sound. It stores the present values of X,YZ axes. As already discussed voice board has the capability to play, record erase address etc. The coding in the controller is embedded in such a way that sound will be recorded for few minutes. According to severity level of the RPW sound recorded, the coding displays high, Low and medium. Here GSM is used to communicate to mobile with the help of data given from controller. The transmitted data is by wireless means. The mobile receives the information within few secs and warns the grove owner about infestation. The data is also displayed in the LCD provided in prototype. Depending on severity level any action or destruction due to RPW can be commenced.

Once the acoustic pattern of the red palm weevil is confirmed the waveform clearly explains the acceleration experienced by the MEMS accelerometer due to the pest. It exhibited positive and negative acceleration according to the deflection experienced in structure. Figure III shows the analog value of acceleration on X,Y and Z axes obtained on an infested tree. The concept of measuring acceleration along the three axes can be explained as follows. The accelerometer gives outputs as acceleration on each axis as an analog voltage between 0-5V. This gives the measure of the 3axis acceleration. When a 5V supply is given to this accelerometer sensor it gives the three axis acceleration values in three terminals (X, Y, and Z) as 0-5V. This analog voltage is directly proportional to the acceleration. When sensor is placed in horizontal position, it shows the value of acceleration in analog form.

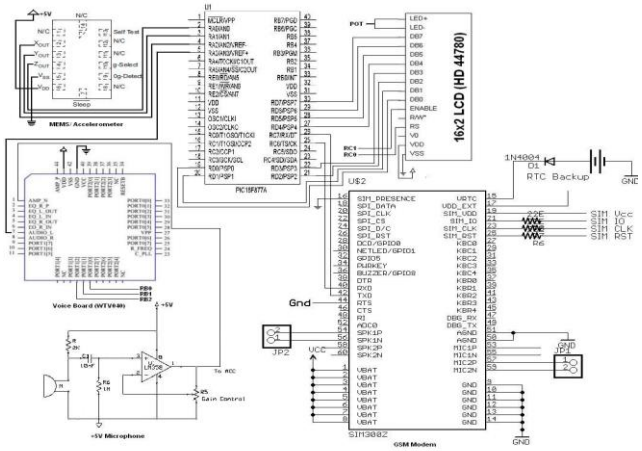

Figure II: The Circuit Diagram of the Model

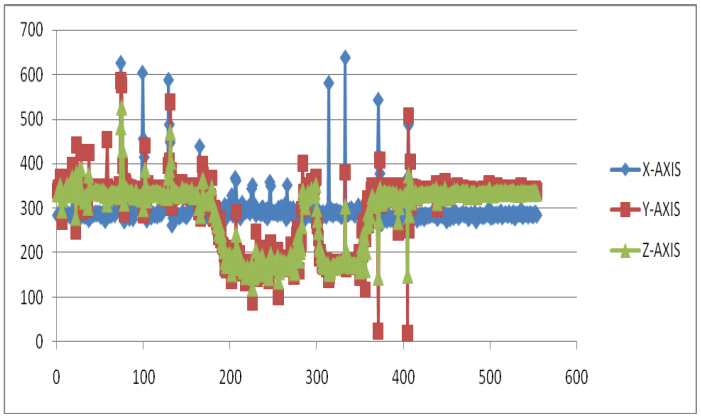

Figure III: Graph Indicating Infestation Along the Three Axes

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The value obtained is around 300 and this is a 10 bit equivalent analog voltage. Now when the sensor moves towards left vertical the obtained value is reduced to about 150 and again when sensor moves from horizontal to right vertical, the voltage obtained is 600. So when the sensor is moved in one direction, it reads from 150-600 and when moved in another direction the sensor reads 600-150. When fast movement is established, the sensor keeps on varying from150 -600 with 300 as base[9].

The prototype integrating the accelerometer, processor and the display unit is battery operated and carried throughout the field and inspected for infested as well as noninfested trees. Usually the voice board model as shown in figure IV was placed on a location which had some symptoms of brown oozing liquid. But this farm exhibited no such symptoms, since the trees were in the young stages of development. The voice board was focused on suspected trees on the trunk of the affected part. The sound files were recorded for different durations ranging from 42- 60 mins[10]. The display readings of X,Y,Z values were noted. Results obtained from voice board were analyzed. The sound files when played back had blank sounds, sound patterns of chewing and crawling and human whispers etc. Figure V pictures adult weevil with its grub. It contained readings of X,Y,Z values for affected as well as nonaffected trees[9]. The setup without any infestation was also recorded. The display showed variations in values for affected and nonaffected trees.

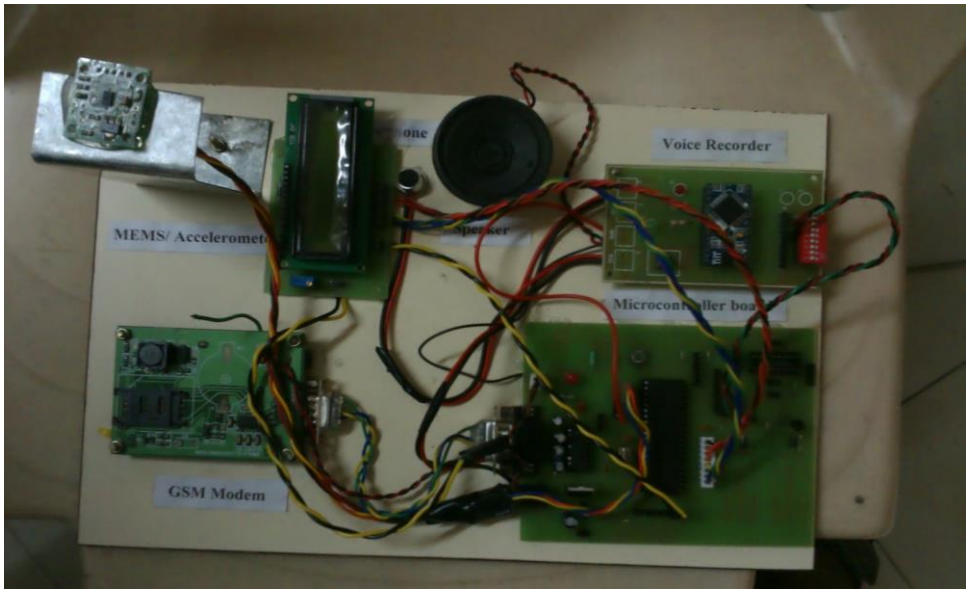

Figure IV: The Voice Board Model

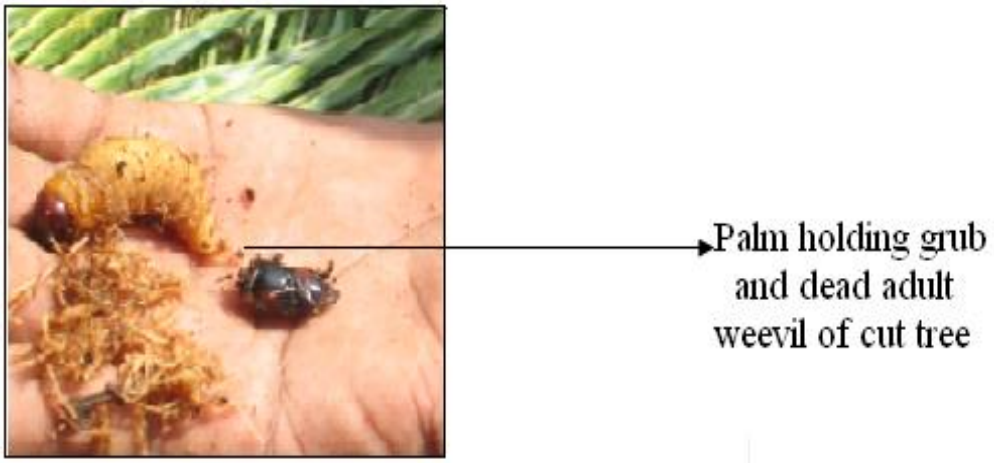

Figure V: The Adult Weevil with Grub

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CONCLUSION

To summarize, the accelerometer sensor along with the VOICE BOARD played a significant role in detecting the weevil. The established sensor with its merits had one demerit too. The VOICE BOARD had to be carried along with the accelerometer and placed in synchronization with each other. This problem raised during testing on fields and could be a future attempt to detect red palm weevil on palms [7-8].

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