Development of Latex Transducer for Rubber Tapping Process

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Abstract. There is a huge demand for rubber in India used in variety of products. Now a day’s people collect the latex from the rubber tree by manual or semi-automatic rubber tapping process. By collecting the latex, the cutting depth is fixing for an approximate value. For each and every tree the depth of the bark is varied and improper tapping damages the cambium layer of the tree. The proposed latex transducer contains two motors, embedded controller, current sensor, distance sensor, LCD display and power supply. One motor is used for drilling and other motor is for driving. The driving motor will drive the drilling motor. For driving, stepper motor is used and drilling operation brushed DC motor is used. The current sensor senses the current of drilling motor. Initially the current sensor sense the distance up to the tree surface, then the embedded controller will give the signal to the driving motor, the driving motor will drive the drilling motor up to the tree surface. Once the drilling motor reach the surface, the embedded controller initialize the distance and runs the drilling motor so the distance sensor sense the distance from the tree surface. To reach the inner wood the drilling motor takes more current, so the embedded controller will stop the drilling operation and give the signal to the LCD display. So easily find the depth of rubber tree up to the cambium layer.

Keywords: Cambium layer, latex vessels, sensing mechanism, driving mechanism.

1 Introduction

Rubber tapping process is a process of collecting latex from a rubber tree using a tapping tool. An incision in the tree’s bark is made to cut through the latex vessels and latex is collected in the collector. Incision timing is planned in the planting cycle to get the optimized latex yield. A worker taps hundreds of rubber trees in the early morning daily for a stipulated time and tapper scrapes away the choked latex and a thin layer of bark. The latex flows down in the tapped path spirally into a collector cup for two hours before the latex hardens and dries out the cut in the tree. The challenging problem in tapping with rubber trees is to take care in avoid damaging the inner bark of rubber tree. Tappers are trained for at least six months prior before
learning the proper technique and poor tapping may lead to damage and even kill many valuable trees.

The tree can be tapped when the circumference reaches 50 centimetres and tapping mark guide is marked at a height, of 1 meter from the ground, normally after 5 years from the plantation, the tapping can be done. A metal ribbon attached to a wooden lath 1.10 meters long is used to mark the position for tapping in the tree. This metal ribbon is at an angle of 30 degrees to the horizontal as shown in Fig 1.

![Fig. 1. Rubber tapping measurement](image)

Roll the metal ribbon round the tree. Using an awl, a sharp iron point, a cut was made along the metal ribbon. The cut ends all around the tree in the right direction for further tapping in the tree. The start of cut and the end of cut should be on the same vertical axis line. Using the awl, a vertical channel is made from the lower edge of the cut. The cut and the channel must be deepened. This is done with a gouge, a tool that is used by pushing it so as to remove bark. For the tapping process, the gouge is pushed several times along the cut to make a channel in removing a little bark every time for the latex to flow. The process is repeated for several times initially until the cut in the bark reaches close to the cambium layer but not to damage it. The tapping cut inclination should be maintained with around 6 millimetres thick in bark and 4.5 millimetres depth in bark for 25 centimetres vertical channel length. Gutter is placed at the lower end of the channel. At the end of the marking guide, a latex collecting cup is tied at the bottom end of the cut. The latex flows from the cut through the channel and finally collected in the latex cups.
The first latex flow at the starting of tapping is not good for harvesting initially. Over a period the tapping is done regularly without harvesting the latex from the rubber trees. Presently, manual tapping or semi-automatic tapping process is used in rubber tapping for collecting the latex. Rubber tree tapping is preferred with manual tapping. Manual tapping also has drawbacks like bark consumption and improper cutting depth when using a manual tapping knife. The bulging out of bark and wounds caused due to imperfect tapping which results in reduction of tapping cycle of rubber trees. Tapping is performed only once per day on the tree surface.

2 Background of the work

T. Jayanthi et al, [1], explains about the dielectric properties of natural rubber as an experimental study and function of dry rubber. The dry rubber content in the latex decides the quality and cost of rubber directly. The orientation of loosely bound water molecules decides the dielectric properties of Hevea latex in the tree. The experiment was carried out at room temperature in a dielectric liquid cell as natural rubber holder for the analysis. The study infers that the dry rubber content is inversely proportional to its dielectric constant. i.e. when the moisture content increases, the dielectric constant also increases. For larger values of moisture, the values of $\varepsilon$ are also high. Even though Hevea latex is a very complex material, it has a good relationship between dielectric properties and moisture content.

Ali Hamad Ali et al, [2], describes about the microwave antenna sensing technique for determination of moisture content in hevea latex from indian rubber tree. The computer-controlled Professional Network Analyzer (PNA) (model N5230A) and monopole antenna are used in measurement setup. The reflection coefficient magnitude and moisture content in hevea latex were tested over the bandwidth from 2.2 GHz to 2.7 GHz. The relationship between reflection coefficient magnitude and moisture content shows linear curve at 2.3 GHz. At this value, the moisture content, sensitivity and linearity of antenna were estimated. The results from the measurements have given better correlation between the predicted and measured values of moisture content in the latex of tree. The proposed method determines the moisture content in the latex liquid in a better way.

K. M. Z. Hossain et al, [3], describes about the grafting of N-Butyl Acrylate with Natural Rubber Latex Film using gamma radiation. The mixture of Natural rubber latex (NRL) and n-butyl acrylate (n-BA) are irradiated under gamma radiations at various absorbed doses from Co-60 source at room temperature. Over a period of five weeks, the samples were analyzed for its chemical properties and stability of mixture. The values of swelling ratio, cross-link density of vulcanized rubber were measured for analysis. The results states that cross-link density is proportional and swelling ratio is inversely proportional to the chemical dose provided over the test period. 15kGy absorbed dose provides optimized results in blending and better crossing nature in the natural rubber. The cross linking reaction mechanism was
developed based on the cross linking properties of natural rubber from the optimized dose.

R. Roslim et al, [4], explains about the alternative compounding formulation for natural rubber (NR) latex foam. The proposed formula deals with the environmental control and health impacts of NR latex foam products. The NR latex foam formed have ultra-low protein allergen city (Type I) and chemical sensitivity (Type IV). The NR latex foam have typical physical properties than normal latex foams. The foam exhibit an open-cell structure based on the images obtained in Scanning Electron Microscopy (SEM). The biodegradability of the NR latex foam is tested using soil burial method and the natural degrading is occurring in promising rate.

Mohd zafran abdul aziz et al, [5], elaborates about the reflectance sensors based identification of automated rubber seed clones using PIC16F877A microcontroller. The best yielding rubber tree clones were selected for the recognition of tree clones using reflectance at their surface. The five types of indian rubber clones namely PB360, RRIM2009, RRIM2011, RRIM2016 and RRIM2025 seeds were collected as samples for analysis purpose. The QTR -1A reflector sensors of three numbers are used to collect reflection sensitivity at each 3D Coordinates. From the measured readings, it is evident that every crust of surface reflects light in different manner.

The proposed device measures the exact percentages of reflectance from the seed surfaces based on the provided light intensity. An average of 30 samples for 5 different clones reflectance values are taken and converted into light reflection wavelengths using MS Office Excel. From the analysis results, average voltage is generated from the data and inferred that there is exact finite differences in voltages for each clones. The brightness of brown color in the front surface of seed provides the clue for classification of clones and it provides better accuracy in identification using black surface.

From the above literature survey, there is no specific information related to sensors for sensing the raw latex from the cambium layer of rubber tree (Hevea brasiliensis). With the help of knowledge in capacitive transducer, the dielectric property of latex in liquid form increases with water content and it can be used as dielectric between the conducting plates of capacitor transducer.

3 Proposed methodology

The main purpose of this paper is to describe the measurement of the depth up to the cambium layer of a rubber tree. To measure the depth, we are using distance sensor with current sensor. Initially measure the distance, between the distance sensor to the surface of the rubber tree. Then, drilling motor moves towards the surface of the tree depends up on the signals from the distance sensor.
Embedded controller can drive the drilling motor and driving motor. The current sensor will sense the current of drilling motor and the distance sensor will measure the distance. When the current reaches to certain point, the embedded controller can stop the drilling operation. And display the depth of the distance up to the cambium layer. Fig.2 shows the block diagram of the proposed method.

![Block diagram of the proposed methodology](image)

**Figure 2.** Block diagram of the proposed methodology

## 4 Experimental Setup

Latex transducer is one of the device used to measure the depth up to the cambium layer of a rubber tree. The circuit consists of an embedded controller like Arduino. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB...
connection, a power jack, an ICSP header, and a reset button. The experimental setup is shown in figure 3.

![Figure 3. Latex transducer drive experimental setup](image)

Embedded controller can be interface with stepper motor, current sensor, distance sensor, stepper motor controller, LCD display and DC motor. The Pins can configured depends up on the program uploaded in the controller. The LCD display can be display the distance as well as current. The Current sensor, sense the current of the drilling motor and give the signal to embedded controller. The stepper motor controller is connected between embedded controller and stepper motor. Figure 4. shows the overall hardware setup of latex transducer.

![Figure 4. Latex Transducer hardware setup](image)

5 Hardware implementation
The operation of the Latex Transducer for Rubber Tapping Process is examined in the laboratory with the sample test bark of rubber tree. The Transducer can be determined the distance up to the cambium layer from the outer bark and measurements can be displayed in the LCD screen. By using this system, the damages on the surface of the rubber tree is avoided. The distance up to the cambium layer from the outer bark is to be varied depend up on the rubber tree. The all arrangement of ultra-smart latex transducer for rubber tapping process is carried out successfully. The transducer will sense the distance up to the cambium layer. The hardware results shows that, the sensing part is accurate. A wide variety of tree’s layer is to be possible to sense within a fraction of second. The harware setup in the laboratory measuring the cambium layer distance is shown in fig. 3 and the result is correlated with manual reading using caliper.

![Figure 5 Latex sensor Laboratory test result.](image)

6 Conclusion

The paper explains the method to measure the position of latex vessels in th cambium layer using the latex transducer. The setup is tested in the tree bark of RRI51 type Clone Heavea Brasiliensis commonly known as rubber tree. The cambium layer distance from outer bark is measured using digital vernier caliper showing the value ‘3.3’cm. The output of the latex transducer is shown in figure 5. In comparing the values from digital vernier caliper and LCD output from the latex transducer describes that the sensing part is accurate. The response of the system is quick. A wide variety of tree’s layer is to be possible to sense within a fraction of
second. The proposed method could be useful in future developments. The robustness of the system reduces the maintenance requirement and has good durability. The system also provides reliable to user for effectively use the system in real time applications.

The further improvements can be done by studying the yield period and tree shape and cut analysis using digital image processing and the monitoring of the cut and its yield may improve the livelihood of the proposed system for future usage and improvements of the system.

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