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Research Article

AUTOMATION OF MACHINERY FOR COLLAGEN BASED THIN SHEET OF WOUND DRESSING MATERIAL

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ABSTRACT

Objective: Smart, Intelligent, Novel machinery has been automated for large scale production of collagen sheets.

Methods: Collagen based wound dressing materials with required thickness in sheet form can be produced by the automated machinery. Moisture, pH, Temperature and IR sensors are interfaced with the ARM CORTEX microcontroller attached to the machinery. Low cost dryers are used to dry the wet sheet processed from the developed machinery. The use of social network like the GSM are also used in the machinery

Results: There is further improvement in the drying time of the paste to sheet form, compared to our earlier study. The drying time of the sheet from this process is 60 min and the sheets exhibit good tensile strength compared to our earlier study. The collagen sheets produced have a thickness of ≤ 1mm and a width of 250mm.

Conclusion: The operator is provided information of the pH, Moisture, and temperature of the sample paste. The machinery automatically notifies the operator about the completion of the process through GSM.

Keywords- Automated sheet forming machine, Collagen based wound dressing materials, GSM, Moisture Sensors, pH Sensor, Infrared Sensors, ARM Cortex Microcontroller.

INTRODUCTION

Biological dressings are comprised of Biomaterials that play a very active role in the process of wound healing and some time referred to as bio active dressing. The bioactive dressings include tissue engineered products derived from natural tissues or artificial sources. The materials derived from natural sources based on collagen can be prepared in various forms that is solution, gel, powder, fiber, film, sponge, tube, sheets [1].one such application of collagen is the regeneration of soft tissue using phytopharmaceuticals that appears to be promising in the field of medicine[2]. Our earlier study focused on processing of the biocomposites using machinery in sheet form [3]. The recent advancement in microcontroller based embedded system has paved way to develop systems for specific applications. The advantage of these systems is it helps in continuous monitoring and control over the process at remote locations through social network like the GSM [4]. Sensors are used to monitor the process and the need for a wireless sensor based control adds advantage in reduction of cost, power management in the system [5].These type of systems have been successfully implemented in applications such as control, security, monitoring and relative ease of maintenance. This paper extends our earlier work by expanding the scope of the application. It focuses on the automation of the developed machinery by interfacing with a microcontroller. We have introduced a system which monitors temperature, pH, and moisture through the sensors and sends information to the operator's mobile through GSM. The operator is also provided with the information of the number of sheets completed by the display for local indication and notified through mobile by GSM. The advantage of implementing such systems is, it saves much of the resources and time. To further reduce the drying time of the process, dryers are used in the process of drying these sheets and the system is interfaced with the ARM Cortex microcontroller.

MATERIALS AND METHODS

The aim of present study is to

- Automate the production of thin sheets of wound dressing materials.
- To measure the physical parameters namely the temperature, moisture, Ph of the paste.
- Effective pressing of the sheet material for excess removal of the moisture
- Use of social networks like the GSM for operator assistance.

The block diagram of the hardware implementation is shown in Fig. 1.

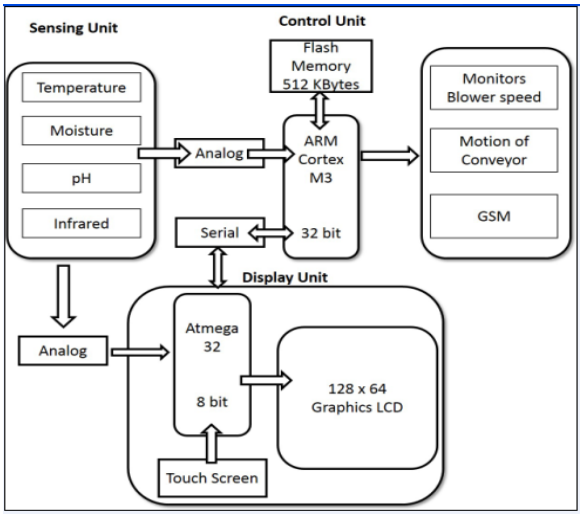

Fig. 1: Block diagram of interfacing of sensors, Display, blower, GSM with the ARM Cortex microcontroller.

The ARM Cortex M3 [6] is a 32-bit ARM core microcontroller. The specifications of the processor are it has 54 digital input/output pins, 12 analog inputs, 4 UARTs, 84 MHz clock, a reset button and an erase button.

Moisture Sensor and pH Sensor

Smart sensor platforms are developed to provide plug and play capability [7].Inside the storage tank, the moisture and pH sensor is fixed. These sensors monitor the moisture and pH content of the prepared collagen paste and display the output information to the graphic LCD.

Automation of the Conveyor

The removal of the moisture from the paste is the primary requirement in our study. Two Infrared sensors are mounted on top of Roller 1 and Roller 3.These sensors are connected to the relay board and interfaced with the microcontroller. The purpose of these sensors is when the wet sheet passes and moves out of roller 2, the IR sensor mounted on roller 3 senses the wet sheet, activates the relay and sends the signal to the microcontroller to reverse the direction of the conveyor. The conveyor now moves in the opposite direction and sheet again passes through roller 2 and when it moves out of roller 1, the IR sensor mounted on top of roller 1 detects the sheet triggers the relay and the microcontroller again reverses the direction of the conveyor.This method of pressing the sheet repeatedly through the rollers, effectively reduces the moisture content of the sheet to a greater extent.

Temperature Sensors

In our study, to monitor the heat transferred to the sheet material from the dryer, temperature sensor is connected to the dryer that continuously monitors the heat from the dryer. The temperature sensor is interfaced with the arm cortex microcontroller. The software program for the microcontroller is written such that when the temperature reaches above 40°C, the sensor transfers the information to the microcontroller which triggers the relay and disconnects the dryer from the drying process. It automatically resumes its operation after the desired temperature of 40°C is reached thus avoiding the overheating of the collagen sheet material.

Global System for Mobile Communication (GSM)

The GSM modem is a highly flexible plug and play quad band.It supports features like voice, SMS, data/Fax, GPRS and integrated TCP/IP stack. Our study implements the interfacing of the GSM modem to the ARM Cortex microcontroller. The advantage of using this modem is it can accept any GSM network operator Subscriber Identity Module (SIM) card and act just like a mobile phone with its unique phone number. The advantage of using GSM in our study is, operator presence is always not necessary in the machine. The GSM alerts by sending a message to the operator's mobile about the sensor data attached to the process or completion of the process.

RESULTS AND DISCUSSIONS

The automated machinery for the preparation of thin sheets of wound dressing materials is developed. In our study we have placed 2 Kg of the prepared collagen paste in the storage tank [8, 9].The sample paste prepared is shown in Fig.2.

Fig. 2: Sample Collagen Paste

The moisture sensor, temperature sensor and pH sensor mounted inside the storage tank sense the moisture, temperature and pH of the sample paste and the output is displayed in the graphic display interfaced with Arm Cortex microcontroller shown in Fig.3.

When the motor is switched ON the conveyor starts moving and the paste is allowed to pass through the rollers. All the 3 rollers are adjusted manually for 3mm, 2mm and 1mm thickness of the output. when the paste passes through roller 1, there is a elongation in length to form a wet sheet with a thickness 3mm.During this process approximately 10% of the water present is drained and collected in the drain tray.

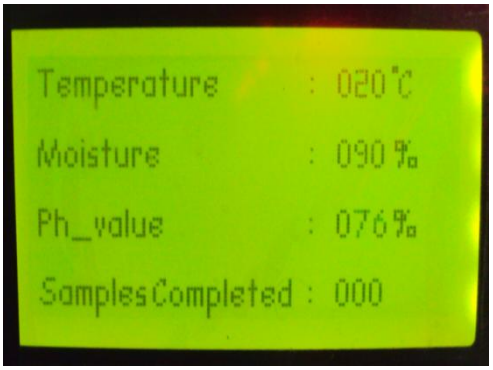

Fig. 3: Display of Temperature, Moisture and pH from the sensors

The sheet further goes through Roller 2 which gives an output thickness of 2mm.At the output of Roller 2, further approximately 20% of moisture content is eliminated in the wet sheet. The infrared sensor mounted on Roller 3 senses the wet sheet and reverses the direction of the conveyor. This method of repeatedly subjecting the wet sheet through rollers removes the moisture to approximately 60%. The number of iterations we have adopted for the conveyor to reverses its direction is 5 iterations. Fig.4 illustrates the mounting of the Infrared sensors over roller1 and roller 3.

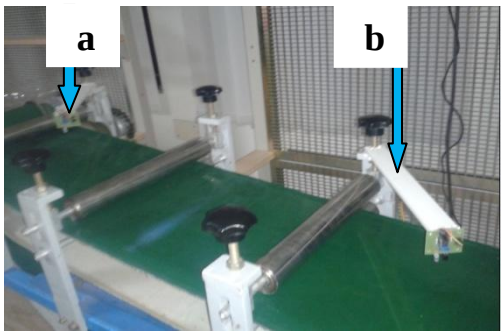

Fig. 4: Infrared sensors mounted on a, Roller 1 b, Roller 3.

The wet sheet finally moves through Roller 3 to produce an output of 1mm thickness with a moisture content of only 10%.The time taken for the removal of water content and formation of 1mm thickness of wet sheet is approximately 6 minutes. The length of the wet sheet formed is 30cm in length and this sheet is transferred to conveyor II and placed in a steel rack for drying.

Automation of the Dryer

The Infrared sensor attached to the dryer senses the wet sheet in the steel rack, triggers the dryer to start the drying process. The wet sheet is dried over the dryer. The interfacing circuit for the dryer arrangement is shown in Fig.5. The thin sheet obtained is approximately 30cm in length and the output of the sample sheet obtained from the automated machinery is shown in Fig.6.

Fig. 5: The Sample collagen sheet rolled out from the automated machinery.

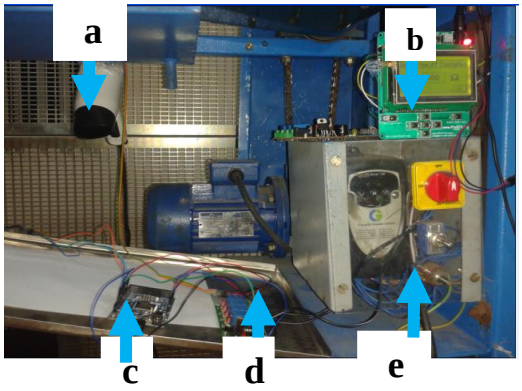

Fig. 6 : The labeled parts for the drying process shown by arrows: a blower; b Graphic Display; c ARM Cortex Microcontroller; d Relay ; e switch control.

The mechanical properties of the thin film of collagen sheets obtained using the automated machinery developed is summarized in Table 1.

Table 1: Mechanical Properties of Thin film of collagen sheets obtained from the Developed Machinery.

Sample	Thickness(mm)	Tensile Strength(Mpa)	Elongation at break (%)
1	0.15	31.14 ±2.5	6.06 ± 0.8
2	0.11	30.48 ± 3.52	6.00 ±0.6
3	0.12	31.25 ± 1.99	5.52 ± 0.7

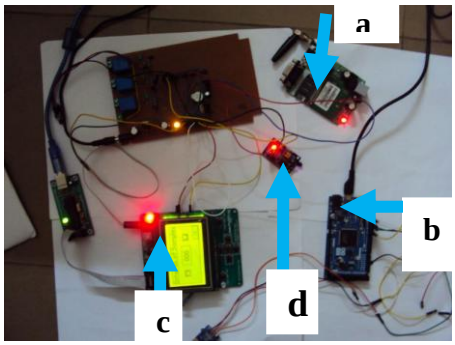

Fig. 7: The labeled parts for automation of the machinery shown by arrows: a GSM module; b ARM Cortex Microcontroller; c Graphical Display; d Temperature Sensor

This machinery is completely automated by interfacing sensors, GSM with the microcontroller, thus eliminating the need for operator's assistance at all times.Fig.6 illustrates the interfacing of GSM module with the Arm cortex microcontroller.

The results show that the three thin collagen sheets produced using this machine exhibited good tensile strength with thickness of ≤ 1mm (Table 1).This study further focuses that there is a very great improvement in drying time of the wet sheet.In our present study we have reduced the time required to dry the wet collagen sheets to 60 min compared to our earlier result of 180 min.

CONCLUSION

With the new advancement in embedded technology applications for multidisciplinary research has significantly improved to develop and automate machinery for specific applications. This novel automated machinery developed finds its application in the automatic preparation of thin sheets of wound dressing material based on collagen used for wound management purpose.

The machinery is automated by interfacing sensors, PC and GSM technology to the microcontroller adds more intelligence to the developed machinery. The automated machinery is relatively low in cost and can be used in laboratory as well as for the production of large scale of wound dressing materials.

REFERENCES

1. Joshua Boateng S, Kerr Matthews H, Howard Stevens NE, Gillian Eccleston M Wound Healing Dressings and Drug Delivery Systems. Journal of pharmaceutical sciences 2008; 97: 2892–2923.
2. Kirubanandan S, Swethkamal K and Renganathan S.Activities of triphala towards promoting collagen synthesis at wound site and inhibiting methicillin-resistant *staphylococcus aureus* and its enzymes. International journal of Pharmacy and Pharmaceutical Sciences 2013; 5(2): 54-62.
3. Sumathi V, Sastry TP, Senthil R, Shanthi C Fabrication Of Machinery For Continuous Formation Of Thin Sheet Of Wound Dressing Material. International journal of Pharmacy and Pharmaceutical Sciences 2014;6(supp1):(in press)
4. Wolfgang Gerstacker, Robert Schober, Raimund Meyer, and Frank Bernosterer, Michael Ruder, Hans Kalveram, GSM/EDGE: A mobile communications system determined to stay. International Journal of Electronics and Communications 2011; 65: 694-700
5. Ramamurthy H, Prabhu BS, Gadh R, Madni A, Wireless Industrial Monitoring and
6. Control using a Smart Sensor Platform IEEE Sensor Journal 2007; 7(5): 611- 618.
7. "Arduino microcontroller", [online:] http://Arduino.cc
8. Wynn R, Plug-and-play sensors, Machine Design 2003;75(10): S10
9. Ramnath V, Sekar S, Sankar S, Sankaranarayanan C and Sastry TP. Preparation and evaluation of biocomposites as wound dressing material. Journal of Material Science Mater Med 2012; 23: 3083-3095.
10. Pandima Devi M, Sekar M,Chamundeswari M, Moorthy A, Krithiga G Selva Murugan N and Sastry TP Bull. Mater Sci (2012); 7:1157–1163.