

Preliminary Study on Determining Stem Diameter Variations of Sympodial Orchid

N.M Khairi, M.I. Naimah, M.S.B. Shah Rizam, M.T. Nooritawati and Z.A. Husna

Abstract—Changes in stem diameter of orchid plants were investigated in a control growing climate. Previous studies have focused on stem diameter in relation to plant water on terrestrial plants in order to schedule the irrigation. The objective of this work was to evaluate the ability of the strain gauges to capture changes in the epiphytes plant stem. Experiments were carried out by using the sympodial orchid, *Dendrobium Sonia* in a stressed condition. From the findings, the sensor can detect changes in the plant stem and the result can easily be used as a reference for further studies for the development of a proper watering system.

Keywords—Strain gauge, stem diameter, *Dendrobium Sonia*, epiphyte, terrestrial

I. INTRODUCTION

STEM diameter changes have been proven to be a reference parameter to indicate the water content of the apple [1], olive [2], plum [3] and peach trees [4] to schedule their irrigation [5]. All studies on stem diameter variations of terrestrial plants have given some information that may be useful to analyze the performance of terrestrial plant growth too [6].

Multiple sensors and instrumentations have been used to measure the stem diameter like tapes or caliper, linear motion potentiometer, dendrometer, dendrograph, linear variable differential transformer, strain gauge, laser, and micro wave [5].

The main purpose of this study, to identify the changes of sympodial orchid stems diameter and evaluate the ability of strain gauges as a sensor to detect the changes. Hence, findings will trigger for further investigations in development of a proper watering system for orchid farms in Malaysia.

II. MATERIALS AND METHODS

This study consists of a simple signal conditioning development because the main focus is to evaluate the ability of strain gauge as a sensor by implementing the Wheatstone bridge concept. Results from this study will serve as a

N.M. Khairi is with MARA University of Technology, now on leave for MSc in Electrical Engineering in UiTM, Shah Alam, Malaysia. (e-mail: khairimhd@yahoo.com.sg).

M.I. Naimah is with the MARA University of Technology, Shah Alam, Malaysia (phone: 603-55211897; e-mail: naimah5732@salam.uitm.edu.my).

M.S.B. Shah Rizam is a professor with the Electrical Engineering Department, MARA University of Technology, Shah Alam, Malaysia. (e-mail: sharizam@salam.uitm.edu.my).

M.T.Nooritawati is with the MARA University of Technology, Shah Alam, Malaysia (e-mail: noori425@salam.uitm.edu.my).

Z.A.Husna is with the MARA University of Technology, Shah Alam, Malaysia (e-mail: husnaza@salam.uitm.edu.my).

reference for further investigations in measurement of stem diameter in epiphytic plants.

In this experiment, a *Dendrobium Sonia* as a sympodial orchid plant was chosen because it was among the top in popularity as a cut flower in Malaysian floriculture industry. The experiment was conducted in Control Laboratory,UiTM Shah Alam, Malaysia. This place was chosen because it has constant temperature, humidity and light control of air-conditioning system and lighting features, respectively.

During the measurement process, the plant was in a stressed condition in order to ensure the rate of shrinking has occurred. The stressed condition was carried out by withholding any watering to the plant [7]. Fig. 1 shows the block diagram of the system.

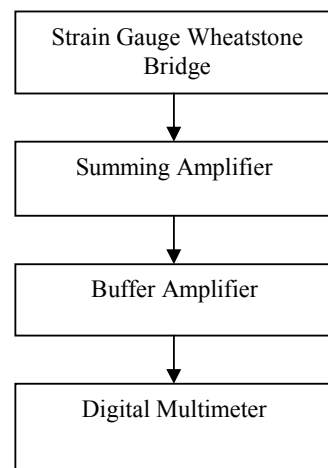


Fig. 1 The block diagram of the measurement system

A. Strain Gauge

Strain gauge sensor is used to measure voltage at the stem of the plants. The type of strain gauge used is copper nickel alloy; size 5mm, with gauge factor 2 and its resistance at 120 Ω . Klepper et al. [8][9] has successfully used strain gauges to measure growth stress in the terrestrial tree trunk and the diurnal changes of its stem. However, the output signal (volt/amp) strain gauge are small and weak and mostly of the order of 10⁻³ or less. Direct measurement of these signals is inappropriate to draw meaningful conclusions.

B. Wheatstone bridge

Two 120 Ω fixed resistors and a 250 Ω variable resistors are connected to the strain gauge to form a Wheatstone bridge. The zero adjustment was done by adjusting the variable resistor to the closest zero output value.

C. Sympodial orchids

A *Dendrobium Sonia* is chosen as a sample of sympodial orchids in this study. The plant was in blooming size and well grown in 6 inch plastic pot with the broken brick and charcoal as its media.

D. Measurement

After determine the strain gauge characteristic, the strain gauge was attached on the orchid stem to measure the output. The output was measured by using a digital multimeter in every 15 minutes.

III. RESULT AND DISCUSSION

Based on the experimental analysis, firstly, the strain gauge was bent about 0.5mm from -3 to 3mm and measured the voltage output using micrometer in order to obtain its characteristic. Figure 2 shows the gauge characteristic (mv) versus distance (mm). As seen from Figure 2, the correlation coefficient between sensor output and micrometer displacement, R^2 is good as at 97.89%.

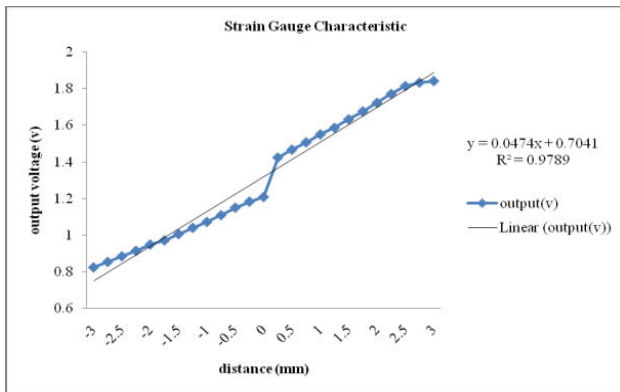


Fig. 2 The strain gauge characteristic

Pattern of the stem variations was observed and it produced the same response as in terrestrial plant [10] as show in Figure 3, Figure 4 and Figure 5. The stem has decrease at maximum value during the midday time.

As comparison, the stem diameter variations rate can be seen as in Figure 6 and Figure 7. The stem observed in decrement phase [2] due to the severe water stress occurred in the epiphyte plant cells.

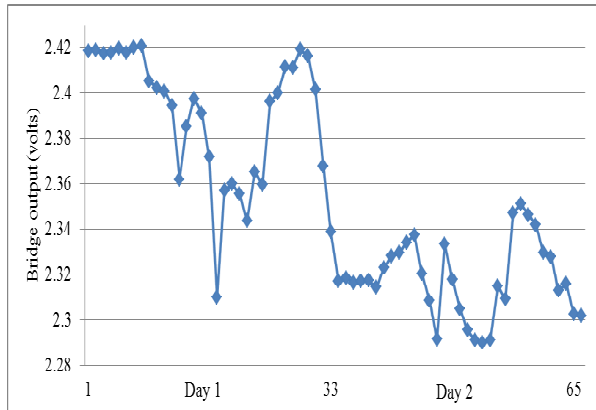


Fig. 3 Comparison of stem variations for Day 1 and Day 2

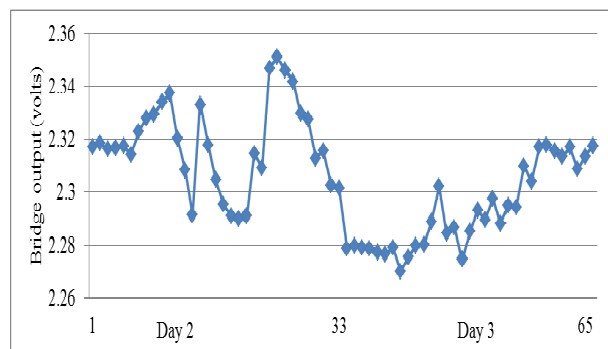


Fig. 4 Comparison of stem variations for Day 2 and Day 3

Even in the water stressed condition, the orchid plant still can do the recovery response. It may occur from the ability of epiphyte plant to absorb water in the air. This response can be observed at number of measurement of 22 until 31 in Figure 6 during the day of experiment.

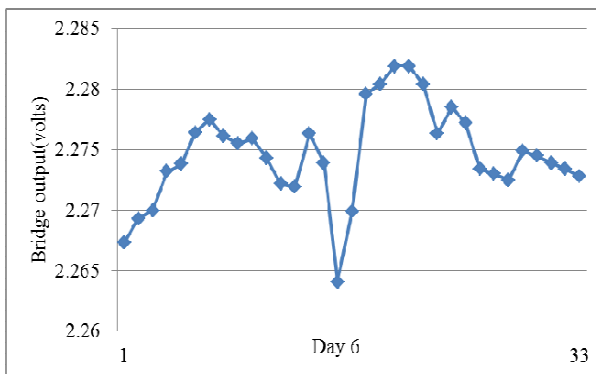


Fig. 5 The stem variation for Day 6

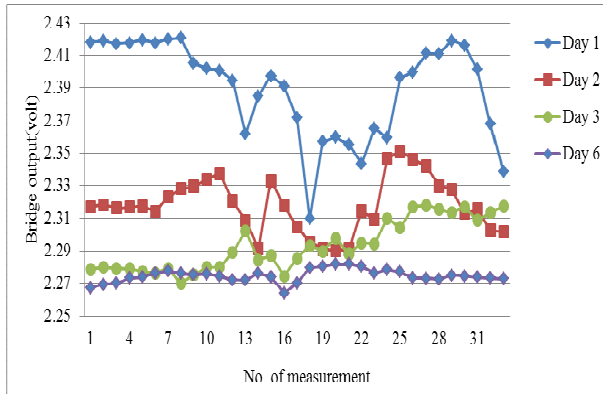


Fig. 6 Comparisons of stem variations for the 6 days

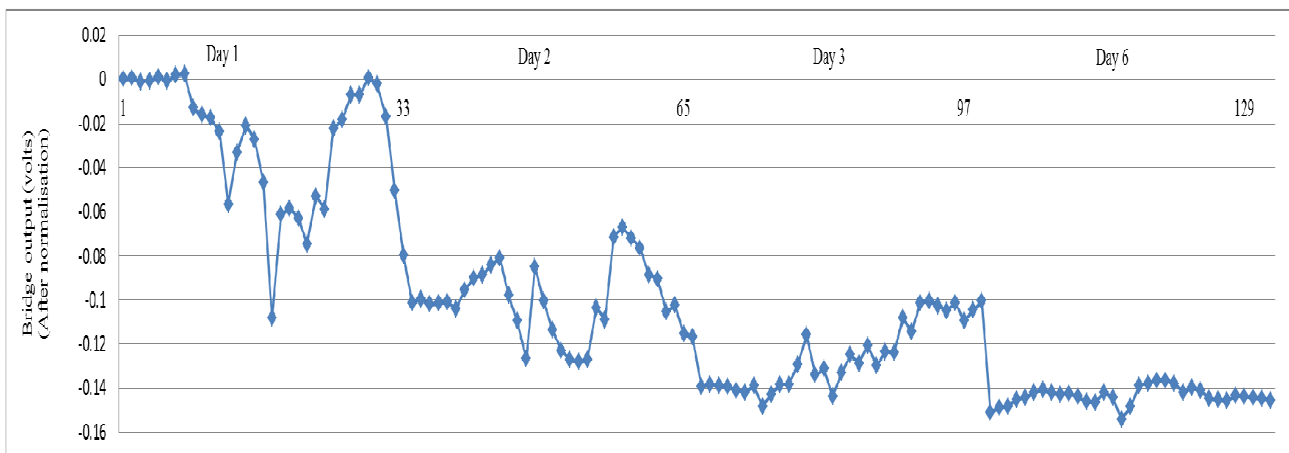


Fig. 7 The continuous stem response for 6 days

IV. CONCLUSION

From the experiment, it can be concluded that the strain gauge can detect the stem water content in orchid plant. With instrumentation enhancement and other parameters consideration that may affect the water content in plant, the stem diameter in orchid can be manipulated to schedule the watering.

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