PERANCANGAN *AUTOMATIC GROWTH CHAMBER* DENGAN FITUR *MULTI-CAMERA* UNTUK SISTEM *MONITORING* RITME SIRKADIAN BERDASARKAN PERGERAKAN TANAMAN

INTISARI

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Ritme sirkadian merupakan sebuah siklus biologis yang memiliki periode sekitar 24 jam. Ritme sirkadian pada tanaman banyak dipelajari untuk mengetahui kondisi tanaman. Tujuan dari penelitian ini adalah merancang *Automatic Growth Chamber* untuk sistem *monitoring* ritme sirkadian berbasis pergerakan tanaman secara otomatis. Sistem yang dirancang terdiri dari 2 ruang pertumbuhan (*chamber*) untuk mengamati keberadaan ritme sirkadian pada tanaman jeruk (*Citrus sp.)* kondisi normal dan terinveksi virus Tristeza. Masing-masing *chamber* dilengkapi dengan sensor *monitoring* lingkungan yang dapat membaca nilai suhu, kelembaban dan intensitas cahaya serta fitur *multi-camera* terintegrasi mikrokomputer (Raspberry Pi3 B+) yang dapat memonitor pergerakan tanaman berdasarkan proyeksi vertikal (*top-view projetion*) dan horizontal (*side-view projection*). Data citra tanaman diambil setiap 30 menit sekali sedangkan data kondisi lingkungan di diambil setiap 5 menit sekali dan akan dikirim ke *cloud-server*. Data hasil *monitoring* citra tanaman dari kedua jenis proyeksi kemudian dianalisis menggunakan metode *Optical Flow* menggunakan Library OpenCV dengan menerapkan algoritma Shi-Tomasi dan Lucas Kanade. Selanjutnya, ritme sirkadian diestimasi menggunakan metode FFT (*Fast Fourier Transform*) dengan bantuan *software* RStudio. Hasil analisis data citra digunakan sebagai parameter evaluasi kinerja fitur *multi-camera* yang digunakan, yaitu dengan membandingkan grafik *time series*, periode, amplitudo, fase dan beda fase dari ritme sirkadian yang didapat. Berdasarkan hasil analisis data, diketahui bahwa sudut proyeksi vertikal memiliki performa yang lebih baik dalam menangkap pergerakan tanaman. Pergerakan (*displacement*) tanaman yang dapat ditangkap melalui sudut proyeksi vertikal bernilai lebih besar pada masin-masing *chamber* yaitu 62,654 (*chamber1)* dan 18,76 (*chamber2)*. Adapun periode ritme sirkadian yang berhasil diidentifikasi berkisar antara 20 sampai 24 jam.

Kata kunci: *Automatic Growth Chamber*, *multi-camera*, sistem *monitoring* pergerakan tanaman, aliran optik.

DESIGN OF AUTOMATIC GROWTH CHAMBER WITH MULTI-CAMERA FEATURES FOR CIRCADIAN RHYTHM MONITORING SYSTEM BASED ON PLANT MOTION

ABSTRACT

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Circadian rhythm is a biological cycle that has a period of about 24 hours. Circadian rhythms in plants are usually studied to observe plant conditions. The objective of this study was to design an Automatic Growth Chamber for monitoring circadian rhythm based on plant motion. The system consists of 2 growth chambers to observe the existence of circadian rhythms in Citrus sp. under normal and infected (Tristeza virus) conditions. Each chamber is equipped with environmental sensors to monitor temperature, humidity, and light intensity and multi-camera features integrated microcomputer (Raspberry Pi3 B +) that can monitor plant motions based on top-view and side-view projections. The images data are captured every 30 minutes while data on environmental conditions are taken every 5 minutes and will be sent to the cloud server. The captured data from both types of projections were analyzed using the Optical Flow method using the OpenCV Library by applying Shi-Tomasi and Lucas Kanade algorithm. The circadian rhythm was estimated by applying the FFT method using Rstudio software. Furthermore, the multi-camera features were evaluated by comparing time-series graphs, periods, amplitudes, phases and phases-shift of the circadian rhythm obtained. Based on data analysis, it is known that the vertical projection angle has a better performance in capturing the motion of plants. The plant motion value observed through the top-view projection has a higher value of 62.654 in chamber 1 and 18.76 in chamber 2. Circadian rhythms that have been identified have a period value ranging from 20 to 24 hours.

Keyword: Automatic Growth Chamber, multi-camera, plant motion monitoring system, optical flow