INTISARI

KARAKTERISASI SISTEM *PHOTOACOUSTIC IMAGING* BERBASIS LASER DIODA DAN MIKROFON *CONDENSER* UNTUK MENCITRAKAN STRUKTUR ANATOMI GIGI

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Pada penelitian ini sistem pencitraan fotoakustik berbasis laser dioda dan mikrofon kondenser digunakan untuk sampel struktur anatomi gigi. Sampel gigi dibuat dengan permukaan tipis dan dilapisi *dental wax*. Permukaan gigi disinari oleh pulsa laser dengan panjang gelombang 532 nm. Laser dan detektor diatur dalam posisi statis dan meja scan bergerak dengan arah X-Y *stage*. Sistem pengambilan data menggunakan mikrofon (detektor) diperkuat dengan *soundcard* Behringer. Karakterisasi terhadap sistem yaitu mikrofon dan meja *scan* dilakukan sehingga diperoleh pengaturan sistem yang sesuai. Metode *contrast limited adaptive histogram equalization* (CLAHE) diterapkan sebagai solusi dalam peningkatan kualitas citra fotoakustik gigi. Sampel dipindai pada frekuensi 17 kHz-20 kHz serta *duty cycle* (DC) 30%-50% untuk mendapatkan frekuensi dan DC optimal yang akan digunakan pada pengambilan data selanjutnya. Hasil yang diperoleh untuk pengaturan frekuensi optimal adalah 19 kHz dan DC optimal 50%. Sehingga telah didapatkan hasil citra interpolasi yang cukup baik untuk membedakan struktur anatomi gigi dengan nilai taraf intensitas maksimum rata-rata untuk email -71.8363 dB, dentin -70.7671 dB, dan pulpa sebesar -70.4895 dB. Nilai taraf intensitas minimum rata-rata email ialah -71.9900 dB, dentin adalah -70.8588 dB, and pulpa sebesar -70.6045 dB dengan angka ketidakpastian ± 0,0001. Analisis data nilai PSNR dan RMSE terbaik diperoleh oleh citra dengan variasi nilai 50 pada *block size* CLAHE. Dengan demikian, pencitraan fotoakustik telah mampu menampilkan hasil citra yang sesuai dengan area pemindaian dimana proses pencitraan dilakukan pada objek jaringan keras gigi. Hasil penelitian menunjukkan sistem pencitraan fotoakustik dapat dikembangkan lebih lanjut untuk menghasilkan citra struktur gigi yang memiliki karies.

Kata kunci: pencitraan fotoakustik, struktur anatomi gigi, intensitas akustik, laser dioda, mikrofon kondenser, *contrast limited adaptive histogram equalization* (CLAHE), PSNR, dan RMSE

ABSTRACT

CHARACTERIZATION OF PHOTOACOUSTIC IMAGING SYSTEM BASED ON DIODA LASER AND MICROFON CONDENSER FOR DENTAL ANATOMY STRUCTURE

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The feasibility of a laser diode and condenser microphone-based photoacoustic imaging system to see the characterization of the dental anatomy is examined. A tooth is prepared to get the finest tooth surface. The tooth was given for treatments as covered with dental wax. The tooth's surface is illuminated with a laser pulse with a wavelength of 532 nm. The radiation sources and detector is set in a static position, while the object table moves in the X-Y direction. The data retrieval system using a microphone (detector) that is amplified by soundcard Behringer. Characterization is performed on the system, which is the microphone, scanning table, and laser carried out so that the appropriate system settings are obtained. The contrast limited adaptive histogram equalization (CLAHE) technique is applied as a solution in improving the quality of dental photoacoustic images. The sample is scanning at frequencies of 17 kHz - 20 kHz and the duty cycle is 30%-50% to obtain the optimal frequency and DC that will be used in subsequent data collection. The optimal frequency arrangements in this study are 19 kHz and the duty cycle is 50%. The result shows that the interpolation image has been obtained good enough to distinguish three anatomical structures of teeth with maximum average intensity for enamel is -71.8363 dB, dentin of -70.7671 dB, and pulp of -70.4895 dB. The minimum average intensity level of enamel is -71.9900 dB, dentin is -70.8588 dB, and pulp is -70.6045 dB with measurement uncertainty ± 0,0001. The best PSNR and RMSE data analysis was obtained by the image with a variation of 50 in the CLAHE block size. Photoacoustic imaging system based on diode laser 532 nm and condenser microphone has been able to show the results of the image corresponding to the scanning area. The process is carried out on the object-imaging hardtissues such as the surface tooth. The results indicate if the photoacoustic imaging system will be developed further in the next research is a more promising way to generate images of tooth surface structures that have caries or more severe problems.

Keywords: Photoacoustic imaging, dental anatomy, acoustic intensity, diode laser, condenser microphone, *contrast limited adaptive histogram equalization* (CLAHE), PSNR, and RMSE