

ABSTRAK

Uroflowmetry merupakan metode pemeriksaan noninvasif yang digunakan untuk mengevaluasi fungsi saluran kemih bagian bawah melalui pengukuran volume urine, *flow rate*, Qmax, dan waktu miksi. Oleh karena itu, diperlukan pengembangan sistem monitoring *Uroflowmetry* yang mampu menampilkan hasil pengukuran secara *real-time* serta memberikan informasi tambahan mengenai warna urine guna meningkatkan efektivitas pemantauan dan mendukung evaluasi kondisi pasien. Penelitian ini bertujuan untuk mengembangkan sistem monitoring *Uroflowmetry* Digital berbasis ESP32 dengan metode interpretasi otomatis parameter aliran dan warna urine berbasis *Internet of Things* (IoT). Sistem dirancang menggunakan sensor *load cell* dan modul HX711 untuk mengukur volume serta *flow rate* urine, sedangkan sensor warna TCS3200 digunakan untuk mengidentifikasi warna urine berdasarkan nilai RGB sebagai indikator tingkat hidrasi. Data hasil pengukuran diproses oleh mikrokontroler ESP32, ditampilkan pada LCD, dan dikirim melalui jaringan Wi-Fi ke dashboard monitoring sehingga dapat dipantau secara *real-time*. Hasil penelitian menunjukkan bahwa sistem berhasil melakukan pengukuran volume urine, *flow rate*, Qmax, dan waktu miksi secara otomatis sesuai dengan rancangan. Sensor TCS3200 mampu mengklasifikasikan warna urine berdasarkan rentang nilai RGB yang telah ditentukan, meskipun masih memiliki keterbatasan dalam membedakan kategori dehidrasi berat. Implementasi teknologi IoT memungkinkan hasil pengukuran ditampilkan secara *real-time*, sehingga meningkatkan kemudahan dan efisiensi proses monitoring. Dengan demikian, sistem yang dikembangkan mampu menjalankan fungsi utama sebagai alat monitoring *Uroflowmetry* Digital yang terintegrasi serta mendukung pemantauan parameter urine secara *real-time*.

Kata kunci: ESP32, *flow rate*, HX711, *Internet of Things* (IoT), *load cell*, TCS3200, *Uroflowmetry*, volume urine, warna urine.

ABSTRACT

Uroflowmetry is a non-invasive diagnostic method used to evaluate lower urinary tract function by measuring urine volume, flow rate, maximum flow rate (Q_{max}), and voiding time. Therefore, the development of a Uroflowmetry monitoring system capable of displaying measurement results in real-time and providing additional information on urine color is necessary to improve monitoring effectiveness and support patient condition assessment. This study aimed to develop an ESP32-based digital Uroflowmetry monitoring system with an automatic interpretation feature for urine flow parameters and urine color using the Internet of Things (IoT). The system was designed using a load cell sensor integrated with the HX711 module to measure urine volume and flow rate, while the TCS3200 color sensor was employed to identify urine color based on RGB values as an indicator of hydration status. The measurement data were processed by the ESP32 microcontroller, displayed on an LCD, and transmitted via a Wi-Fi network to a monitoring dashboard for real-time observation. The results demonstrated that the system successfully measured urine volume, flow rate, Q_{max} , and voiding time automatically in accordance with the intended design. The TCS3200 sensor was able to classify urine color based on predefined RGB ranges, although it still exhibited limitations in distinguishing severe dehydration categories. Furthermore, the implementation of IoT technology enabled real-time data monitoring, thereby improving the convenience and efficiency of the monitoring process. In conclusion, the developed system successfully performed its primary function as an integrated digital Uroflowmetry monitoring device and supported real-time monitoring of urinary parameters.

Keywords: ESP32, flow rate, HX711, Internet of Things (IoT), load cell, TCS3200, Uroflowmetry, urine color, urine volume.