INTISARI

PENGEMBANGAN DOSIMETER *REAL-TIME WIRELESS* UNTUK SINAR-X DAN GAMMA BERBASIS GEIGER-MULLER

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Telah dilakukan penelitian pengembangan prototipe dosimeter real-time wireless berbasis sensor GM tipe M4011 yang terintegrasi dengan mikrokontroler Teensy 4.1 dan ESP32. Penelitian dilatarbelakangi oleh tingginya pemanfaatan radiasi sinar-X dan gamma di bidang medis dan industri serta risiko kesehatan akibat paparan radiasi berlebihan. Tujuan penelitian ini adalah menghasilkan sistem pemantauan dosis radiasi secara langsung untuk meningkatkan keselamatan pekerja. Prototipe dirancang portabel, praktis, dan mampu menampilkan dosis radiasi dalam satuan CPM (Cacah Per Menit), µSv, dan µSv/h melalui antarmuka berbasis Graphical User Interface (GUI). Metode penelitian meliputi perancangan perangkat keras dan perangkat lunak, kalibrasi sensor menggunakan Raysafe X2 (sinar-X) dan Radiation Alert Ranger (gamma), serta pengujian terhadap variasi jarak dan sumber radiasi seperti Cs-137, Co-60, dan pesawat sinar-X SF100BY. Hasil penelitian menunjukkan respons linier yang sangat baik dengan koefisien korelasi Pearson sebesar 0,997 untuk radiasi gamma dan 0,999 untuk sinar-X, serta tingkat akurasi sebesar 98,85% (gamma) dan 99,21% (sinar-X). Prototipe juga berhasil memvalidasi prinsip hukum kuadrat terbalik. Tegangan kerja optimal tabung GM adalah 380–440 V sesuai karakteristik plateau detektor. Penelitian ini menunjukkan potensi besar prototipe sebagai dosimeter aktif atau surveymeter untuk mendukung prinsip ALARA (As Low As Reasonably Achievable) dalam keselamatan radiasi.

Kata Kunci: Dosimeter *real-time wireless*, Geiger-Muller, monitoring radiasi, radiasi gamma, sinar-X, surveymeter.

ABSTRACT

DEVELOPMENT OF A REAL-TIME WIRELESS DOSIMETER FOR X-RAY AND GAMMA BASED ON GEIGER-MULLER

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A research study was conducted to develop a real-time wireless dosimeter prototype based on the GM tube type M4011, integrated with a Teensy 4.1 microcontroller and ESP32. The study was motivated by the extensive use of X-ray and gamma radiation in medical and industrial fields and the associated health risks due to excessive exposure. The objective was to create a real-time and wireless radiation dose monitoring system to ensure worker safety. The prototype is designed to be portable, user-friendly, and capable of displaying radiation dose measurements in CPM (Counts Per Minute), µSv, and µSv/h through a Graphical User Interface (GUI). The research methodology involved hardware and software design, sensor calibration using the Raysafe X2 (for X-ray) and Radiation Alert Ranger (for gamma radiation), and testing under various distances and radiation sources such as Cs-137, Co-60, and the SF100BY X-ray machine. The results demonstrated a highly linear response with Pearson correlation coefficients of 0.997 for gamma radiation and 0.999 for X-rays, and measurement accuracies of 98.85% and 99.21%, respectively. The prototype also successfully validated the inverse square law principle. The optimal operating voltage of the GM tube was found to be within the 380–440 V range, consistent with the plateau characteristics of the detector. These findings indicate the prototype's strong potential as an active dosimeter or survey meter supporting the ALARA (As Low As Reasonably Achievable) principle in radiation safety management.

Keywords: Wireless real-time dosimeter, Geiger-Muller, radiation monitoring, gamma radiation, X-rays, surveymeter.