

## ABSTRAK

**Latar Belakang:** Meningkatnya prevalensi gangguan otot rangka pada pekerja kantoran akibat penggunaan komputer jangka panjang dengan pengaturan area kerja yang tidak ergonomis menjadi isu krusial dalam keselamatan dan kesehatan kerja. Asesmen ergonomi konvensional yang bergantung pada observasi manual pakar memiliki keterbatasan: subjektivitas tinggi, ketergantungan pada penilai, variabilitas hasil, potensi bias, biaya pelatihan tinggi, ketidaknyamanan penggunaan alat, sulitnya standarisasi dan konsistensi asesmen. Untuk mengatasi masalah ini, penelitian ini memperkenalkan pendekatan inovatif dengan mengembangkan prototipe perangkat lunak berbasis kecerdasan buatan yang memanfaatkan model *YOLOv11-pose* untuk analisis otomatis postur kerja melalui deteksi objek dan estimasi pose dari citra lingkungan kerja nyata.

**Metode:** Penelitian menggunakan metode *Research and Development* (R&D) Borg & Gall hingga tahap uji lapangan awal (*Preliminary Field Testing*). Prototipe ini mengklasifikasikan tiga parameter *Work Surface Checklist* dari *Computer Workstation Ergonomics: Self-Assessment* milik National Institutes of Health: posisi monitor, tinggi monitor, dan jarak pandang ke monitor. Data primer sebanyak 2.928 citra kerja nyata dikumpulkan menggunakan kamera smartphone dengan sudut pandang lateral dan superior. Sebanyak 2.204 citra digunakan untuk pelatihan model, sedangkan 473 citra digunakan untuk uji validitas dan uji reliabilitas. Asesmen manual oleh pakar ergonomi digunakan sebagai *gold standard*. Model *YOLOv11-pose* dilatih dengan teknik augmentasi guna meningkatkan generalisasi. Uji validitas prototipe diukur dengan *Mean Absolute Error* (MAE) yang membandingkan hasil klasifikasi prototipe dengan *gold standard* pada tiga variabel: posisi, tinggi, dan jarak monitor. Uji reliabilitas *intra-rater* dinilai dengan *Intraclass Correlation Coefficient* (ICC) untuk konsistensi pengukuran ulang oleh prototipe

**Hasil:** Uji validitas menunjukkan nilai MAE sebesar 0,1500 untuk posisi monitor, 0,0200 untuk tinggi monitor, dan 0,1992 untuk jarak monitor. Hasil uji reliabilitas *intra-rater* dilakukan dengan metode pengukuran ulang setelah jeda 24 jam oleh peneliti yang sama menggunakan perangkat keras dan versi perangkat lunak yang identik. Hasil ICC menunjukkan nilai 0,926 (95% CI: 0,904–0,943) untuk posisi monitor, serta 1,000 untuk tinggi dan jarak monitor.

**Kesimpulan:** Prototipe ini menginovasi dalam mendigitalisas asesmen ergonomi lingkungan kerja komputer dengan mengintegrasikan teknologi kecerdasan buatan pada praktik K3. Sistem ini dapat memberikan analisis awal terhadap konfigurasi *work surface* komputer, dan membuka peluang asesmen ergonomi yang lebih objektif, praktis, dan *real-time*. Penelitian selanjutnya disarankan memperluas pengambilan data ke berbagai institusi, menggunakan video untuk analisis postur dinamis. Pengumpulan citra perlu ditingkatkan dengan variasi sudut pengambilan, termasuk sudut yang kurang ideal. Ambang deviasi perlu diuji kembali secara eksperimen. Proses validasi juga sebaiknya melibatkan lebih dari satu pakar ergonomi untuk meningkatkan akurasi hasil.

**Kata Kunci:** Kecerdasan Buatan, *YOLOv11-pose*, Ergonomi, Asesmen Ergonomi, Keselamatan dan Kesehatan Kerja.

## ABSTRACT

**Background:** The increasing prevalence of musculoskeletal disorders among office workers due to prolonged computer use and non-ergonomic workstation setups has become a critical issue in occupational health and safety. Conventional ergonomic assessments, which rely on expert manual observation, have several limitations, including high subjectivity, assessor dependency, result variability, potential bias, high training costs, discomfort from assessment tools, and challenges in standardization and consistency. To address these challenges, this study introduces an AI-based software prototype using the YOLOv11-pose model to automate ergonomic assessments through object detection and pose estimation from real-world workstation images.

**Methods:** This study employed the Research and Development (R&D) approach following Borg & Gall's model, reaching the stage of preliminary field testing. The prototype classifies three ergonomic parameters from the Work Surface Checklist of the Computer Workstation Ergonomics: Self-Assessment by the National Institutes of Health: monitor position, monitor height, and viewing distance. A total of 2,928 real-world images were collected using smartphone cameras from lateral and superior angles. Of these, 2,204 images were used for model training, while 473 were reserved for validity and reliability testing. Manual assessments conducted by an ergonomics expert served as the gold standard. The YOLOv11-pose model was trained with image augmentation techniques to improve generalization. Validity was evaluated by calculating the Mean Absolute Error (MAE) between the prototype's classifications and expert assessments across the three ergonomic parameters. Intra-rater reliability was assessed using the Intraclass Correlation Coefficient (ICC), based on repeated measurements by the prototype after a 24-hour interval.

**Results:** The MAE values were 0.1500 for monitor position, 0.0200 for monitor height, and 0.1992 for viewing distance, indicating low average error between the system and the gold standard. The ICC results showed excellent intra-rater reliability, with a score of 0.926 (95% CI: 0.904–0.943) for monitor position, and 1.000 for both monitor height and viewing distance. These measurements were obtained using the same researcher, hardware, and software configuration, ensuring that the results reflected the system's internal consistency.

**Conclusion:** This prototype represents a promising step toward digitizing ergonomic assessments for computer-based workstations by integrating artificial intelligence into occupational health practice. The system may serve as an initial screening tool, supporting self-evaluation and assisting institutions in identifying ergonomic risk factors. Further studies are recommended to expand data collection across institutions, explore dynamic posture analysis via video, test various camera angles—including suboptimal ones—and reassess threshold values empirically. Involving multiple experts in the validation process is also advised to enhance result accuracy.

**Keywords:** Artificial Intelligence, YOLOv11-pose, Ergonomics, Ergonomic Assessment, Occupational Safety and Health.