

## INTISARI

### **SISTEM DETEKSI DAN ESTIMASI KEPADATAN KERUMUNAN BERBASIS CLOUD MENGGUNAKAN DETR DENGAN INFERENSI CITRA TUNGGAL**

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Peningkatan kepadatan penduduk di ruang publik seperti area transportasi, pusat perbelanjaan, dan kegiatan berskala besar menuntut adanya sistem pemantauan yang mampu mendeteksi dan menghitung jumlah individu secara otomatis dan akurat. Metode konvensional berbasis pengawasan manual memiliki keterbatasan dalam hal akurasi, efisiensi, dan skalabilitas, sehingga diperlukan pendekatan berbasis *deep learning* yang terintegrasi dalam sistem layanan berbasis jaringan. Penelitian ini bertujuan untuk mengembangkan dan mengimplementasikan sistem deteksi individu serta estimasi jumlah kerumunan berbasis Detection Transformer (DETR) yang terintegrasi dalam layanan berbasis web dan diimplementasikan pada lingkungan *cloud* berbasis VPS pada studi kasus fasilitas publik semi-terbuka. Model dilatih menggunakan *dataset* CrowdHuman dalam format COCO selama 50 *epoch*, dengan *checkpoint* terbaik diperoleh pada *epoch* ke-35. Evaluasi kinerja model dilakukan menggunakan metrik *mean Average Recall* (mAR), *precision*, *recall*, serta F1-score, Hasil pengujian menunjukkan bahwa model memperoleh nilai *recall* sebesar 73,52% pada ambang IoU 0,5. Tiga *endpoint* utama (`/infer/json`, `/infer/image`, dan `/infer/image/preview`) berfungsi dengan baik pada seluruh lingkungan pengujian. Selain itu, pengujian *Quality of Service* (QoS) menunjukkan bahwa layanan mampu berjalan secara stabil melalui jaringan, dengan nilai rata-rata *latency* dan *throughput* berturut-turut sebesar 26892,3 ms dan 276,775 bps. Secara keseluruhan, penelitian ini berhasil menghasilkan sistem *crowd counting* dan *density estimation* berbasis DETR yang valid secara algoritmik dan berhasil diimplementasikan sebagai layanan berbasis *cloud*.

Kata kunci: *crowd counting*, *density estimation*, DETR, API, Docker, *cloud computing*, VPS, *Quality of Service* (QoS)

***ABSTRACT***

***CLOUD-BASED CROWD DENSITY DETECTION AND ESTIMATION SYSTEM  
USING DETR WITH SINGLE IMAGE INFERENCE***

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*The increasing population density in public spaces such as transportation areas, shopping centers, and large-scale events requires monitoring systems capable of automatically and accurately detecting and counting individuals. Conventional manual surveillance methods have limitations in terms of accuracy, efficiency, and scalability, thereby necessitating a deep learning-based approach integrated into network-based service systems. This study aims to develop and implement an individual detection and crowd counting system based on the Detection Transformer (DETR), integrated into a web-based service and deployed in a VPS-based cloud environment, with a case study in a semi-open public facility. The model was trained using the CrowdHuman dataset in COCO format for 50 epochs, with the best checkpoint obtained at epoch 35. Model performance was evaluated using mean Average Recall (mAR), precision, recall, and F1-score metrics. The evaluation results indicate that the model achieved a recall of 73,52% at an IoU threshold of 0,5. Three main endpoints (/infer/json, /infer/image, and /infer/image/preview) functioned properly across all testing environments. Furthermore, Quality of Service (QoS) testing demonstrated that the service operated stably over the network, with average latency and throughput scores of 26892,3 ms and 276,775 bps, respectively. Overall, this research successfully developed a DETR-based crowd counting and density estimation system that is algorithmically valid and successfully deployed as a cloud-based service.*

*Keywords: crowd counting, density estimation, DETR, API, Docker, cloud computing, VPS, Quality of Service (QoS)*