Abstract: Several Land Parcel Geometry issues in Indonesia's Land Registration Process, such as parcel overlapping, gaps between parcels, and incorrect parcel shapes and sizes, are currently being addressed through a block adjustment approach. One crucial aspect of the block adjustment process is determining control points that tie the parcel geometry to the land coordinate system. Detailed Observations and measurements of parcel points in the field and aerial photographs established these control or tie points. Rectifying land parcels requires many control points, requiring substantial time and effort. The automation phase is critical to expedite the control point identification process. This research uses artificial intelligence techniques to identify control points in very high-resolution orthophoto mosaics. The method employed for control point identification involves the Segment Anything Model (SAM) algorithm to segment parcel boundary indications accurately. Enhance the quality of segmentation results conducted by fine-tuning, followed by centerline extraction and refinement of the extracted data. Based on the segmentation, a SAM model capable of accurately segmenting building objects is attained. After the centerline extraction process and modifications to the existing geometric operations within the GIS Tool, at the edges of buildings, fences, and walls derived points. These points can serve as control point indications in the block adjustment process.

Keywords: orthophoto, control point, block adjustment, automation
Segmentation of Parcel Boundary Indications in Very High-Resolution Orthophoto Mosaics for Control Point Identification

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**Methods**

Pada penelitian ini, area yang digunakan adalah area yang terletak di kompleks Nusa Hijau Permai di Cimahi, yang menampilkan variasi berbagai jenis bangunan—regular, semi-regular, dan irregular. Pengolahan citra ortofoto menggunakan metode pembagian data dengan resolusi sangat tinggi, memungkinkan tekanan waktu yang signifikan dalam identifikasi titik kontrol terlepas dari metode data citra ortofoto atau citra satelit, atau dari titik pengukuran di lapangan. Pengukuran titik kontrol memerlukan pemahaman yang mendalam oleh operator/survei untuk memahami konsep titik kontrol ini.

Pengolahan otomatis titik kontrol dapat diwujudkan dengan memanfaatkan citra ortofoto dengan resolusi sangat tinggi, dan metode kecerdasan buatan. Citra ortofoto membawa data raster dengan resolusi sangat tinggi, memungkinkan proses otomatisasi melalui aplikasi kecerdasan buatan berbasis segmentasi [5]. Segmentation for land parcel boundaries using deep learning has been developed [6]. In this study, the latest deep learning technology, SAM [7], will be employed to perform automatic segmentation on orthophoto data. The goal of this research is to utilize deep learning technology to generate indicative control points used in the block adjustment process.

**Results**

In this research, Artificial Intelligence technology is employed for automatic segmentation, utilizing the Segment Anything Model. This foundational model is trained on 11 million photos and 1 billion masks, ensuring SAM produces highly accurate segmentation results. **Figure 2** illustrates the architecture design of the SAM model.

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**Figure 1. Adumanis workflow**

**Figure 2. Automation Workflow**
centerline data is in polyline form and serves as a reference for control point determination.

3. Simplification: Simplifies the centerline points for a neater form, employing the Douglas-Peucker method in the simplification process.

4. Point Extraction: Extracts control points from the endpoints of the centerline. The output of the point extraction is indicative control points used in the Adumanis control point determination stage.

Results And Discussions

The initial stage of the research involves the segmentation process using the SAM model. In the SAM model segmentation process, the first step is to input hyperparameter values. The hyperparameter values used in this study are presented in Table 1.

Table 1. Hyperparameter value in SAM

<table>
<thead>
<tr>
<th>Hyperparameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box_nm threshold</td>
<td>0.8</td>
</tr>
<tr>
<td>Point per batch</td>
<td>256</td>
</tr>
<tr>
<td>Stability score</td>
<td>0.9</td>
</tr>
<tr>
<td>Min-max region</td>
<td>250</td>
</tr>
<tr>
<td>Padding</td>
<td>256</td>
</tr>
</tbody>
</table>

The output from SAM is a vector representation of buildings, as depicted in Figure 4. The polygons generated by SAM are vector data with a zero-shot characteristic, meaning each segment of the building is segmented separately, such as the building and roof being segmented independently. In this study, there is no need for a polygon merging process to form buildings since the output consists of control points.

The next step is the process of extracting a centerline from the polygon gaps. In this process, the gaps formed from the SAM segmentation polygon are transformed into lines. In this study, before extracting the centerline, a buffer process is conducted with a value of -0.05 meters. This step is taken to create larger polygon gaps and minimize polygons that overlap. Figure 5 displays the centerline formed between the polygon gaps.

After obtaining the centerline, the next steps involve the simplification process and point extraction. In the point extraction process, the resulting points include both endpoints and intersections of each polyline. Therefore, point filtering is performed to select points indicating the ends of buildings. The filtering technique involves creating a guidance vector to determine the direction and distance of block translation. The selected control points meet criteria if a point is found within a 50 cm radius of the guidance vector’s end and has a degree of 3 in the segmentation processing from the previous stage. Figure 6 displays the output of control points after filtering.

From the generated points, the next step involves the block adjustment process. The image displays the results of the block adjustment. In the Adumanis outcome, there is a change in area with a difference of 4-6% from the initial area. Additionally, there is a shift of parcels towards the control points, resulting in parcels that now
have positions and shapes consistent with the actual conditions.

**Figure 5.** Control Point Indices from SAM segmentation

**Figure 6.** Before and after adumanis

**Conclusions**

Based on the research results, it is evident that utilizing SAM segmentation on very high-resolution orthophotos can yield accurate building object segmentation. To obtain indicative control points, the process involves creating a centerline, simplification, and point filtering, resulting in accurate indicative points. In this study, the generated control points are situated at the ends of the residential areas. After conducting the block adjustment process, referencing these control points, the adjusted parcels are obtained. Consequently, the parcels have positions and shapes in accordance with actual conditions, identifiable from the very high-resolution orthophotos. The block adjustment results reveal a change in area ranging from 4% to 6% compared to the previous area, still well within the tolerance of the required area change, which is below 10%.

**References**


