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Multi-Level Pixel-Aligned Implicit Function for High-Resolution 3D Human Digitization

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***Abstract:** Current strides of image dependent 3 dimension human outline estimation have progressed due to remarkable strides in depiction capabilities facilitated by deep NN. Despite the strides made in real-world applications, existing methods still fall short in generating reconstructions that match the intricate details often found in the original images. We posit that this deficiency primarily arises from the clash between two competing demands: accurate predictions necessitate extensive contextual information, while precise predictions hinge on higher resolutions. Owing to the limitations in current hardware memory, prior techniques have leaned towards utilizing low-resolution images to encompass broader spatial context, resulting in less precise or lower-resolution 3D estimations.*

To overcome this hurdle, we have devised multi layered algorithm that undergoes endwise training. At rough level, model comprehensively processes the entire image at a reduced resolution, emphasizing holistic reasoning. This coarse level furnishes essential context to a finer level, which focuses on estimating highly intricate geometries by scrutinizing higher-resolution images. Our research demonstrates a substantial enhancement in performance compared to prior methodologies, showcasing the superior capabilities of our approach.

***Keywords:** 3D Human Digitization, Multi-Garment Net, Image Processing, Intelligent Remote Sensing.*

1. INTRODUCTION

Accurate and detailed digitization of the human form holds the key to unlocking numerous applications, ranging from medical imaging to advancements in virtual reality experiences.

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Despite advancements in achieving precise and metrically accurate reconstructions through multi-view systems, widespread accessibility has been limited due to its dependency on specialized capture setups that impose strict environmental conditions (such as a high number of cameras and controlled lighting). These professional systems are not only prohibitively expensive but also cumbersome to deploy. There has been a growing shift within the community towards leveraging high-capacity deep learning models as an alternative. These models show considerable promise in generating reconstructions even from a single image, offering a more accessible avenue for digitization. However, it's worth noting that the performance of these methods currently lags behind what professional capture systems can achieve, albeit showcasing significant potential for further advancements.

Figure1: Good resolution picture of person

The aim of proposed research is accomplishment of high reliability 3-dimension rebuilding of dressed individuals using solitary image, achieving resolution that captures intricate details like facial characteristics, clothing pleats. Assessment reveals that existing methods underutilize the potential of high-resolution (e.g., 1k or higher) human imagery, readily accessible through standard sensors in mobile devices. This limitation arises from past techniques relying on holistic approaches, mapping the 2D appearance of photographed humans to their 3D shape. However, practical constraints often lead to the use of down sampled pictures because of memory limitations, restricting the full utilization of high-resolution inputs. Despite the valuable information embedded in local image patches for thorough 3-dimension rebuilding, these cues are seldom harnessed within complete good resolution ideas, primaily because of memory constraints inherent in present model.

Literature Review

This seminar work introduced the concept of SCAPE, utilizing a deformable model based on statistical shape space to complete and animate human shapes. It presented a method for capturing a extensive range of human postures along with shapes using low-dimensional linear subspace representation. [1]

The paper introduces a method called "Multi-Garment Net" that focuses on dressing 3D human models realistically from images. The goal is to learn a model that can accurately infer

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clothing shapes and textures onto 3-dimension humanoid representations from 2 dimensional images. "Multi-Garment Net" proposed in this paper is designed to address the challenge of realistically clothing 3 dimensional humanoid representations dependent on 2 dimensional images. Paper "Multi-Garment Net: Learning to Dress 3D People from Images" presents an innovative approach to address the challenge of realistically clothing 3D human body models from 2D images. By leveraging neural networks and a data-driven approach, the method demonstrates promising results in synthesizing clothing variations and textures onto 3D human body models, contributing to advancements in computer vision and graphics for requests in virtual try-on, fashion, entertainment industries. [2]

The paper titled "Keep it SMPL: Automatic Estimation of 3D Human Pose and Shape from a Single Image" by F. Bogo et. al. focuses on involuntary estimation of 3-dimensional human posture, shape using solitary image. [3] Paper introduces SMPL, a method for involuntary estimation of 3-dimensional human posture, shape using solitary image. SMPL is designed to accurately capture human body shape and pose variations, enabling applications in computer vision, graphics, and human-computer interaction.

This paper focuses on semantic image segmentation using deep CNN combined with A convolution with wholly linked CRFs. Paper introduces DeepLab, an approach for semantic image separation that associates deep CNN with atrous convolution with wholly linked CRFs. DeepLab achieves good superiority pixel level semantic segmentation of pictures. "DeepLab: Semantic Image Segmentation with Deep Convolutional Nets, Atrous Convolution, and Fully Connected CRFs" presents an innovative approach to semantic image segmentation by leveraging atrous convolution, ASPP modules, and fully connected CRFs. The method demonstrates significant improvements in accurately segmenting images into semantic categories while preserving object boundaries and achieving advanced presentation on target datasets. Its efficiency with accuracy forms it a promising solution for several computer vision targets requiring pixel-level semantic segmentation.

Components Requirement

Software Requirement

1. 3D Scanning Software:
This software is used to capture the physical appearance of a human subject and convert it into a digital 3D model. It may involve the use of depth sensors, structured light systems, or other scanning technologies.

2. Mesh Processing Tools:
Once a 3D scan is obtained, mesh processing software is often used to clean up and optimize the mesh data. This can include removing noise, filling holes, and refining the surface details.

3. Implicit Function Generation:
If the paper focuses on implicit functions, there may be software components involved in generating and manipulating these functions. This could include algorithms for creating implicit surfaces based on the acquired 3D data.

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4. Pixel Alignment Algorithms:
Pixel alignment is crucial for maintaining high resolution in 3D human digitization. Software components involved in aligning pixels accurately could include algorithms for registration and alignment of multiple data sources.

5. High-Resolution Rendering Software:
For visualization purposes, high-resolution rendering software may be used to display the 3D human model accurately. This could involve realistic rendering techniques, shading algorithms, and other graphics-related components.

Flow Graph:

2. METHODOLOGY

1. Data Acquisition
Describe the methods used for capturing 3D data of human subjects. This could involve detailing the hardware (e.g., 3D scanners, cameras) and any specific techniques employed.

2. Preprocessing
Explain how the acquired data was processed before further analysis. This may include steps such as noise reduction, mesh cleaning, or other preprocessing techniques.

3. Implicit Function Generation
If the paper focuses on implicit functions, describe the process of generating these functions from the 3D data. Include details about the algorithms or mathematical techniques used.

4. Pixel Alignment
Explain the procedures and algorithms used for pixel alignment in the context of high-resolution 3D human digitization. This might involve techniques for accurate registration and alignment of pixels.

5. Integration of Multi-Level Information
If the paper discusses multi-level information, provide details on how different levels of data or features are integrated into the digitization process.

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6. Resolution Enhancement Techniques
If the methodology includes techniques for achieving high resolution, describe the specific approaches used to enhance the resolution of the 3D human models.

7. Validation and Testing
Detail the methods used to validate the results of the digitization process. This could involve comparisons with ground truth data, quantitative metrics, or other validation techniques.

8. Software and Tools
List the specific software tools, libraries, or frameworks used in the implementation of the methodology.

9. Ethical Considerations
If relevant, discuss any ethical considerations in the data acquisition process, especially when dealing with human subjects.

Final Model of Project

3. RESULTS

Datasets. For the acquisition of good fidelity 3-dimensional geometry with corresponding pictures, our approach involves utilizing the Render People dataset, which comprises 500 commercially existing good resolution photogrammetry images. This dataset is divided into

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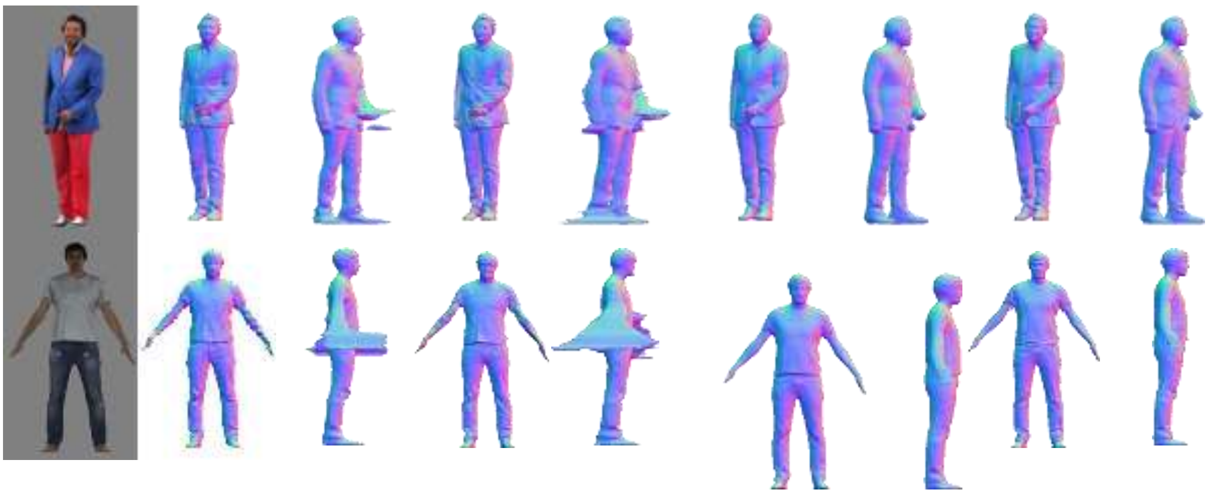
two subsets: training set containing 450 themes with separate trial set comprising 50 themes. Employing precomputed radiance transfer, we render meshes utilizing 163 2nd order spherical harmonics from HDRI Haven1. Separate individual within the dataset is rendered from various viewpoints across the yaw axis, maintaining a fixed elevation of 0 degrees.
In contrast to methods necessitating clean segmentation masks, our approach involves augmenting arbitrary background pictures using the COCO dataset. This augmentation process removes the requirement for a segmentation step, streamlining the workflow.

Implementation Details
Picture encoders at poor resolution as well as good resolution levels employ weighted hourglass system, comprising 4 loads for former and 1 stack for the latter. To enhance performance, we adopted suggested modifications and replaced batch normalization with group normalization within these networks. Notably, well picture encoder omits single down sampling process, thereby preserving larger feature surrounding resolution. Feature extents include 128x128x256 for the coarse level and 512x512x16 for the fine level.



(a)I/P (b) Good module (c) Good module with Global feature (d) 1-level PIF (e) Multi-level PIFu

In terms of the multi-layer perceptron (MLP) configuration, the coarse-level image encoder comprises layers with specific neuron counts. Meanwhile, the fine-level image encoder incorporates an MLP structure with a neuron count sequence of (272, 512, 256, 128, 1), incorporating hop influences at the 2nd and 3rd layers for enhanced connectivity and information flow.

4. CONCLUSIONS

We introduce a multi-level framework designed to engage in comprehensive reasoning that combines both global and local information, enabling the generation of good resolution 3 dimension restorations of dressed individuals using solitary picture, without requiring extra

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further processing steps or additional data. In this approach, the multi layered PAIF, progressively conveys global context across scale pyramid, constructing implicit three dimension implanting. This strategy bypasses early decisions on clear geometry, a limitation in previous methodologies.

Our empirical evaluations underscore the significance of integrating such Three Dimension aware setting for achieving both detailed and exact reconstructions. Additionally, it is illustrated that extenuating vagueness in image domain significantly enhances reliability of reconstructed details, particularly in obstructed areas.

Given that efficacy of our multi leyered approach hinges on successful extraction of three dimension embeddings in earlier stages, enhancing the resilience of reference point model is poised to unswervingly benefit our total reconstruction exactness. Upcoming research directions might involve integrating human precise priors, such as semantic separation, posture information, parametric three-dimension expression models. Moreover, incorporating two-dimension management of implied superficial could additional bolster provision for handling diverse real-world inputs.

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