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Curated Data for Efficient Learning

PGcGAN: Pathological Gait-Conditioned GAN for Human Gait Synthesis

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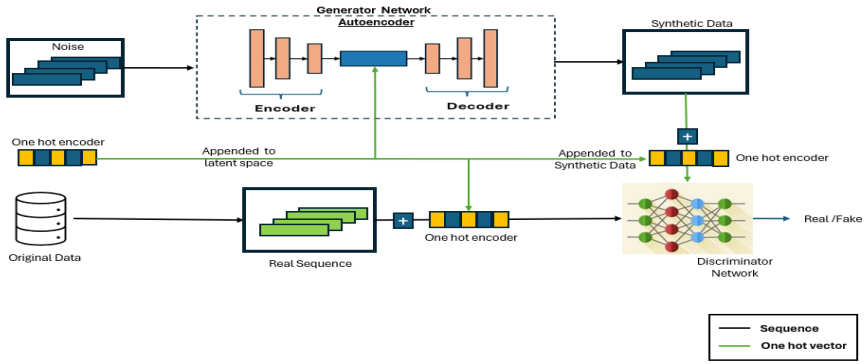
Motivation & Background

- Pathological gait analysis plays a central role in clinical analysis, rehabilitation and prothesis development
- Pathological gait datasets are limited in size and variability
- Generative modelling can augment data by learning the motion variability from observed gait sequences
- Objective: To synthesize pathology specific gait sequences that are structurally and temporally plausible and useful for downstream analysis

PGcGAN Framework



Key Contribution

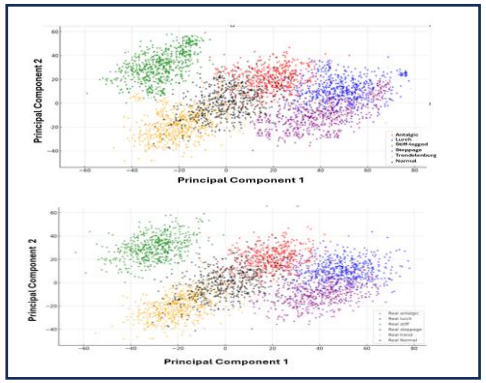
- Pathology-conditioned GAN for human gait synthesis, PGcGAN.
- Enabling controlled synthesis across six gait categories using one-hot encoded pathology labels
- A conditional autoencoder-based generator combines adversarial and reconstruction objectives.
- Synthetic gait data improves pathological gait recognition across GRU, LSTM, and CNN models.

Pathological Gait Dataset

- Public Pathological Gait Dataset [1]
- 3D pose keypoint trajectories
- 10 people x 6 gaits x 120 instances
  - Total 7200 sequences
- Six gait categories
  - Antalgic
  - Stiff Legged
  - Steppage
  - Lurching
  - Trendelenburg
  - Normal

Experimental Evaluation

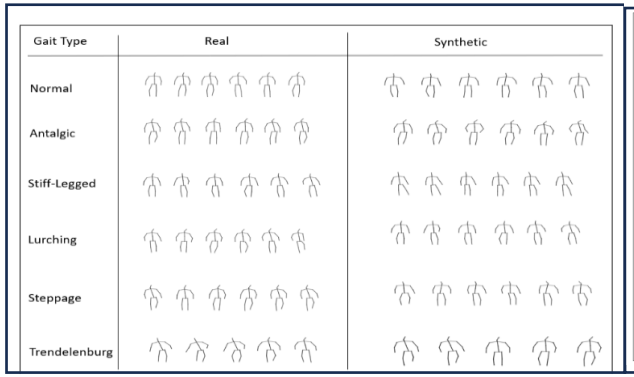
PCA Analysis of Joint Position Trajectories

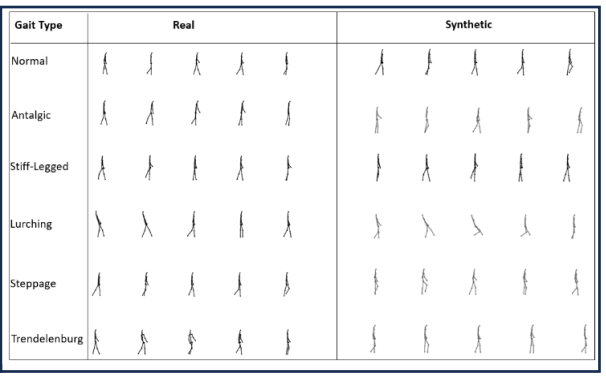


Classification Performance Class-based Performance Analysis

Class	Real (%)	Synthetic(%)	Real+Synthetic(%)
Steppage	97.08	83.58	96.33
Stiff-legged	88.58	**83.92**	95.42
Normal	88.75	90.08	97.08
Lurching	93.00	96.67	98.00
Antalgic	93.00	91.42	95.08
Trendelenburg	86.08	83.83	88.58
Overall	91.08	88.25	**95.08**

Visual Validation





Comparative Study

Study	Validation Approach	Mean R^2
Kim & Hargrove	Trajectory similarity and prosthetic control performance metrics	0.97
Our Study PGcGAN	Trajectory similarity metrics + visual kinematic envelope comparison	0.94

Conclusion

- PGcGAN synthesizes pathology-specific gait sequences from 3D pose trajectories using a conditional GAN
- Generated sequences preserve structural and temporal gait characteristics and inter-subject variability
- Synthetic data effectively augments clinical datasets and improves downstream gait recognition

Future Work

- Incorporate additional clinical conditions and larger datasets.
- Evaluate on real-world clinical workflows and applications.

References

1. K. Jun, Y. Lee, S. Lee, D. Lee and M. S. Kim, "Pathological Gait Classification Using Kinect v2 and Gated Recurrent Neural Networks," in IEEE Access, vol. 8, pp. 139881-139891, 2020, doi: 10.1109/ACCESS.2020.3013029.
2.] M. Kim and L. J. Hargrove, "Generating synthetic gait patterns based onbenchmark datasets for controlling prosthetic legs," Journal of NeuroEngineering andRehabilitation, vol. 20, no. 1, p. 115, 2023