ENHANCING MEDICAL IMAGING: CT TO MRI CONVERSION VIA GAN-CNN FUSION

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GROUP MEMBERS:

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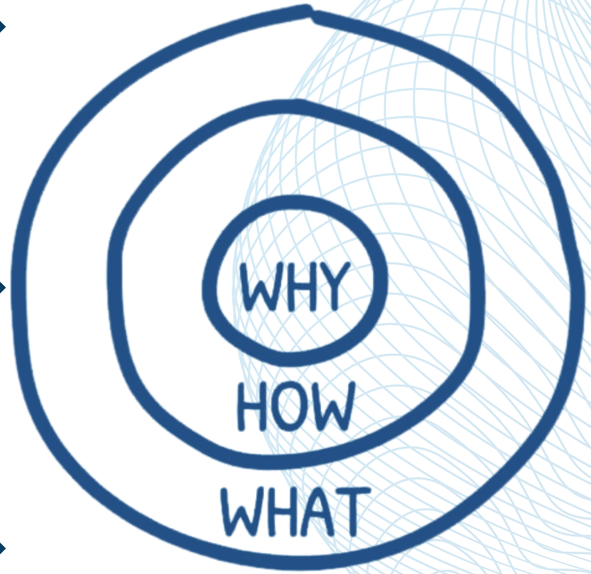
PRESENTATION OVERVIEW

1 Introduction

2 SDGs

3 Software Part



4 Hardware Part

5 Results

6 Future Work

INTRODUCTION

VISION

- To make MRI widely availabale.

- To make MRI like scans less expensive

MISSION:

- Synthesize MRI images from CT scans using Pix2Pix.

- Deploy on TMS320DM6437 DSP kit for low-power processing.

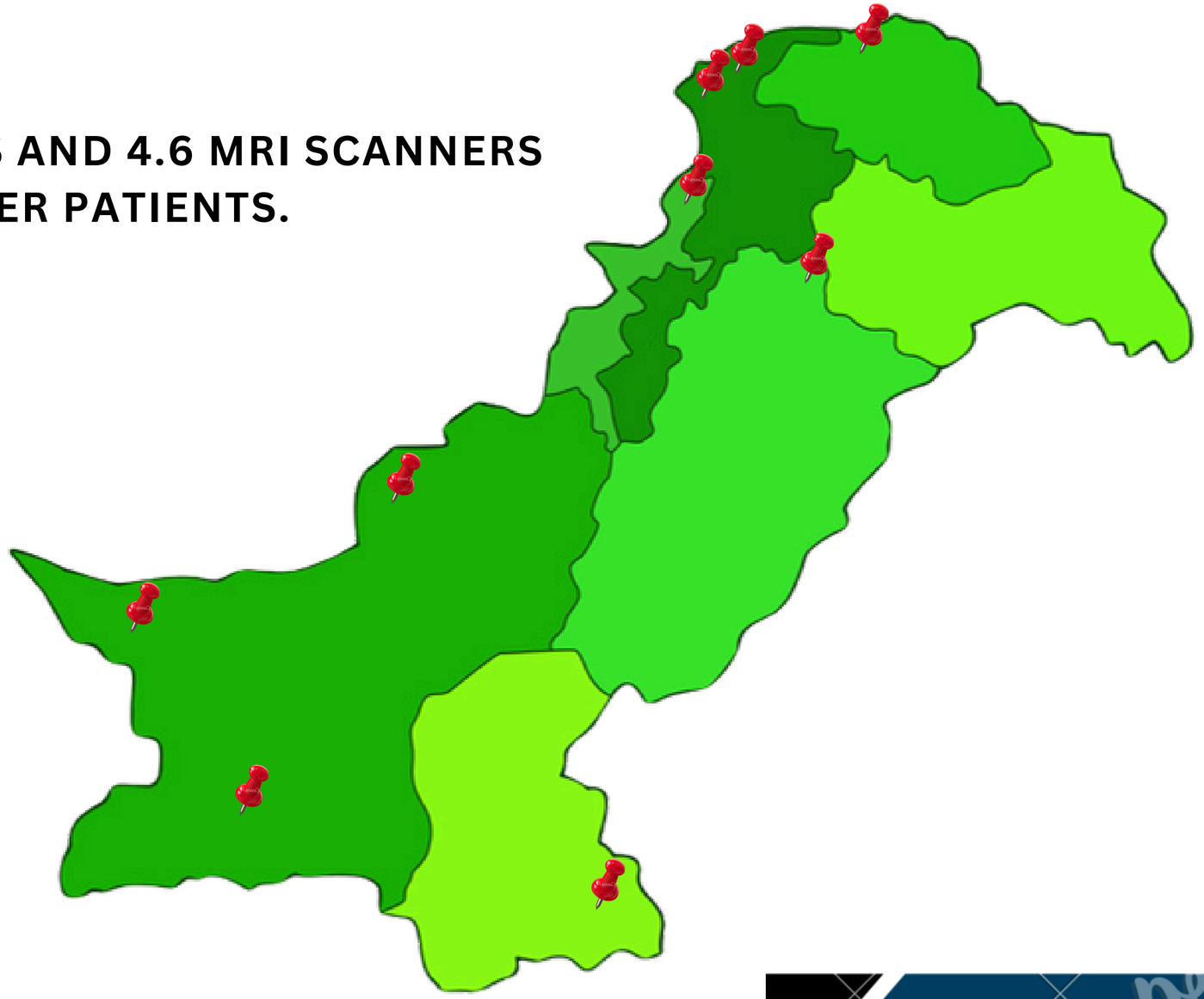
APPROACH:

- Utilize Pix2Pix, a conditional GAN, to synthesize T1-weighted MRI images from CT scans.

- Deploy the trained Pix2Pix generator on the TMS320DM6437 DSP kit for low-power processing.

PROBLEM

17.2 CT SCANNERS AND 4.6 MRI SCANNERS PER 10,000 CANCER PATIENTS.



SOLUTION

- CREATES MRI-LIKE IMAGES FROM WIDELY AVAILABLE CT SCANS, NO MRI MACHINE NEEDED.
- ENABLES FASTER DIAGNOSIS IN RURAL AREAS, SAVING LIVES AND REDUCING DELAYS.
- LOW-COST DEVICE, IDEAL FOR RESOURCE-LIMITED SETTINGS.

LITERATURE REVIEW

- Isola, P., Zhu, J.Y., Zhou, T. and Efros, A.A., 2017. **PIX2PIX ARCHITECTURE**

- Wolterink, J.M., Dinkla, A.M., Savenije, M.H.F., Seevinck, P.R., van den Berg, C.A.T. and Isgum, I., 2017. **CT TO MRI SYNTHESIS USING DEEP LEARNING**

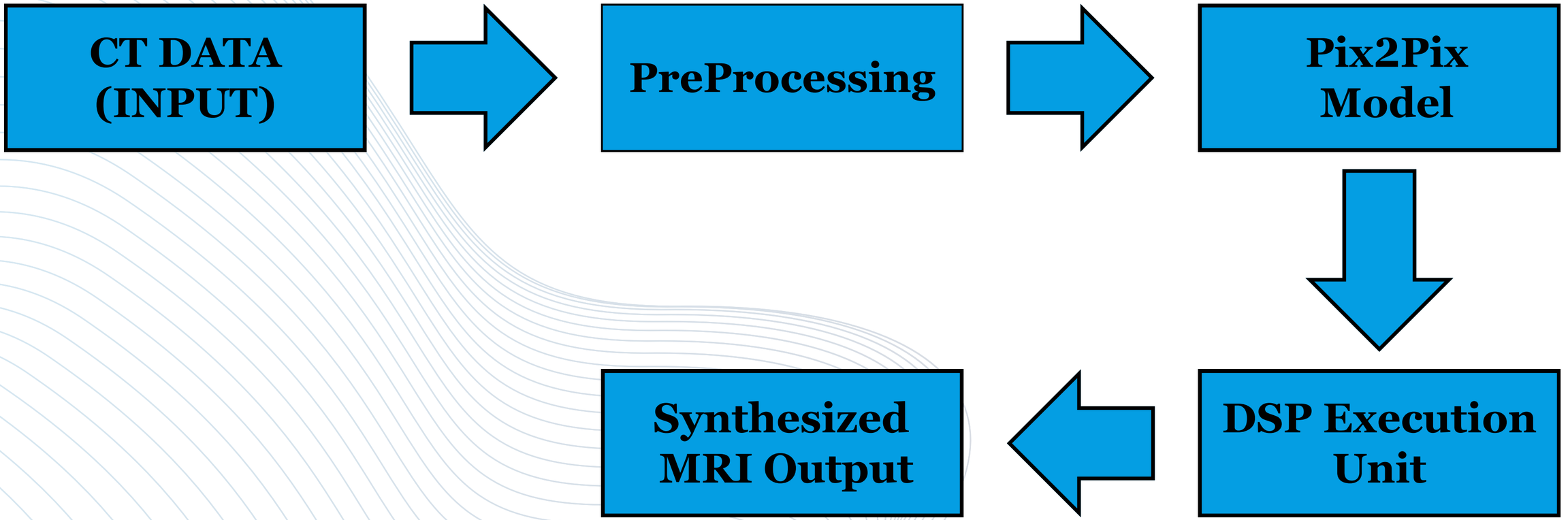
SDGs


10
REDUCED INEQUALITIES


3
GOOD HEALTH AND WELL-BEING


9
INDUSTRY, INNOVATION AND INFRASTRUCTURE

BLOCK DIAGRAM



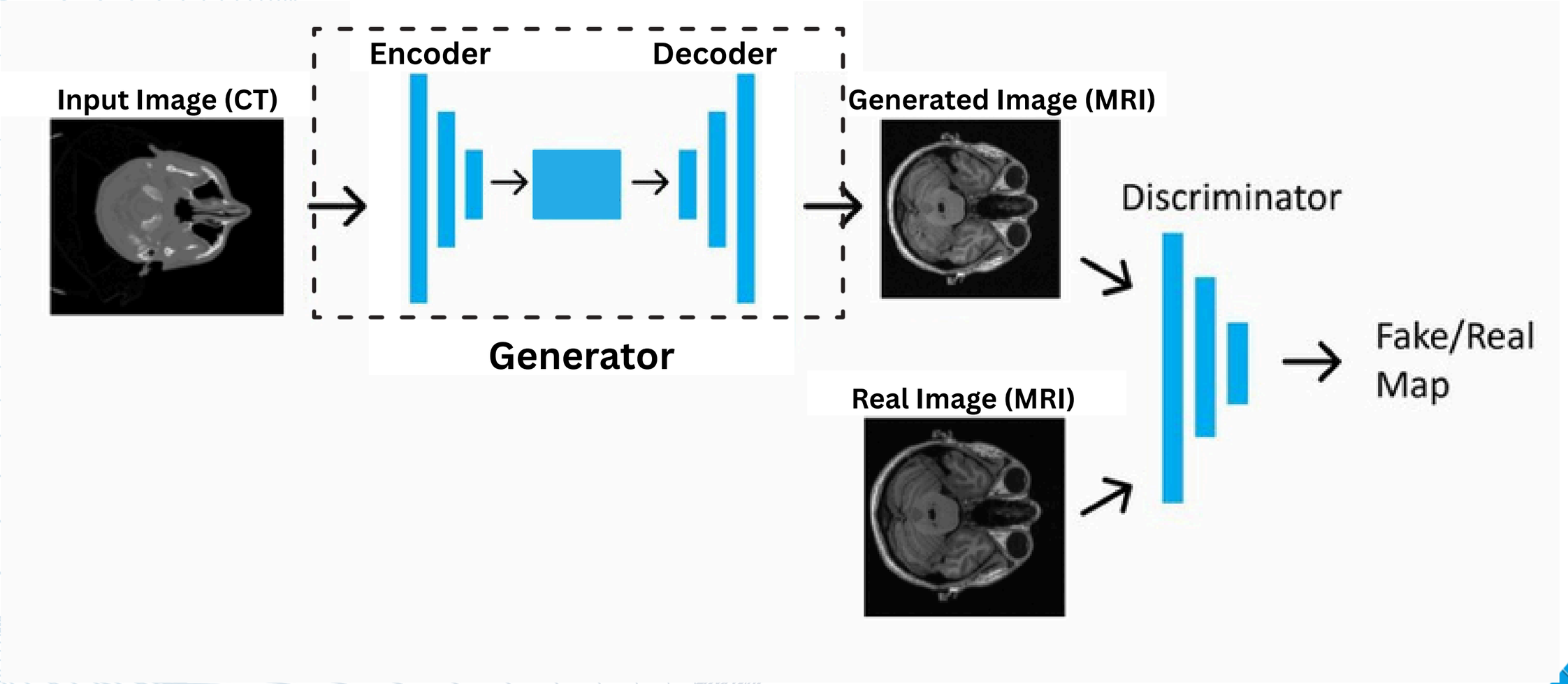
DATASET

1. DATASET WAS SOURCED FROM THE CERMEP-IDB-MRXFDG DATABASE.
2. CONTAINS PAIRED CT AND T1-MRI BRAIN SCANS FROM 37 HEALTHY ADULTS.
3. DATA IS PROVIDED IN DICOM FORMAT.

PREPROCESSING

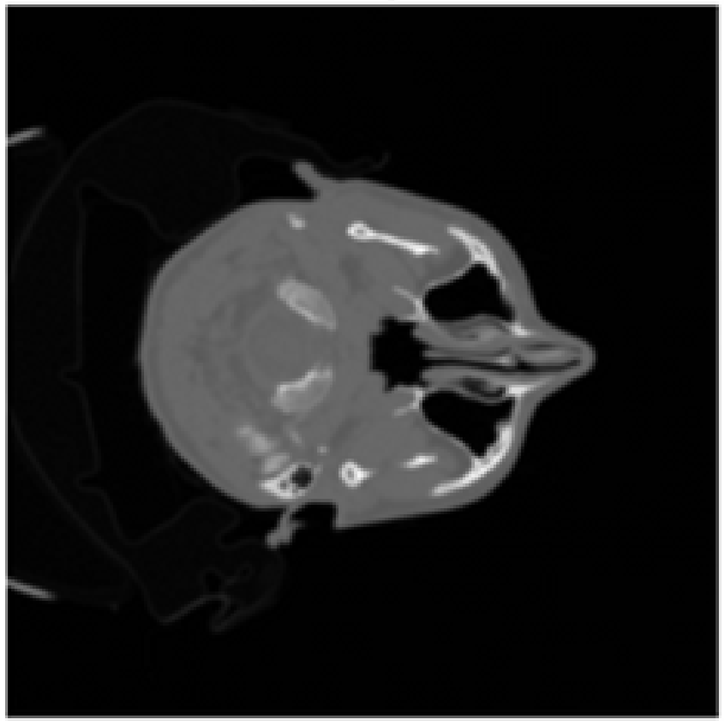
1. NORMALIZED ALL THE T1 MRI AND CT SCANS TO THE RANGE [-1,1].
2. RESIZED THE INPUT CT SCANS TO 256X256.
3. CONVERTED 37 INPUT 3D CT SCANS INTO 3700 SLICES.
4. TRAINING SET: 2600 SLICES, TESTING SLICES: 1100 SLICES

PIX2PIX MODEL

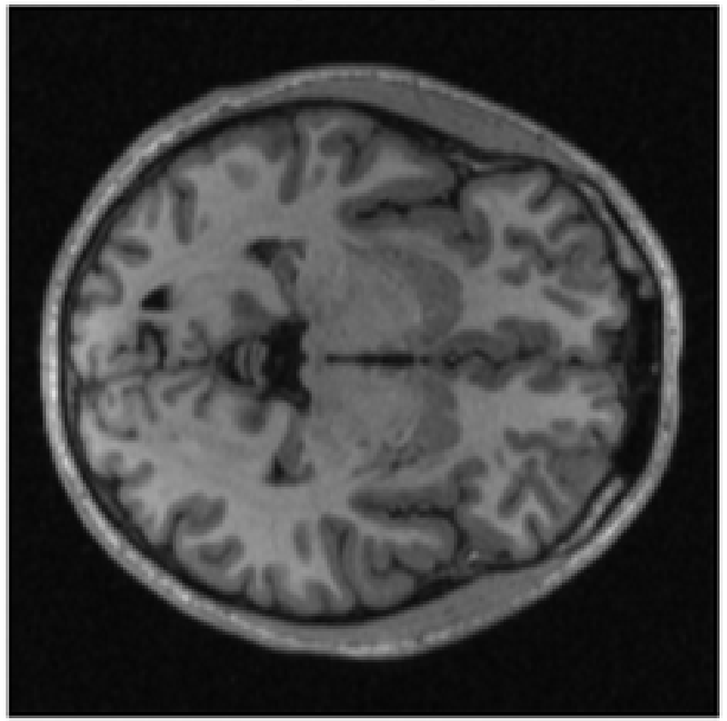


PIX2PIX MODEL

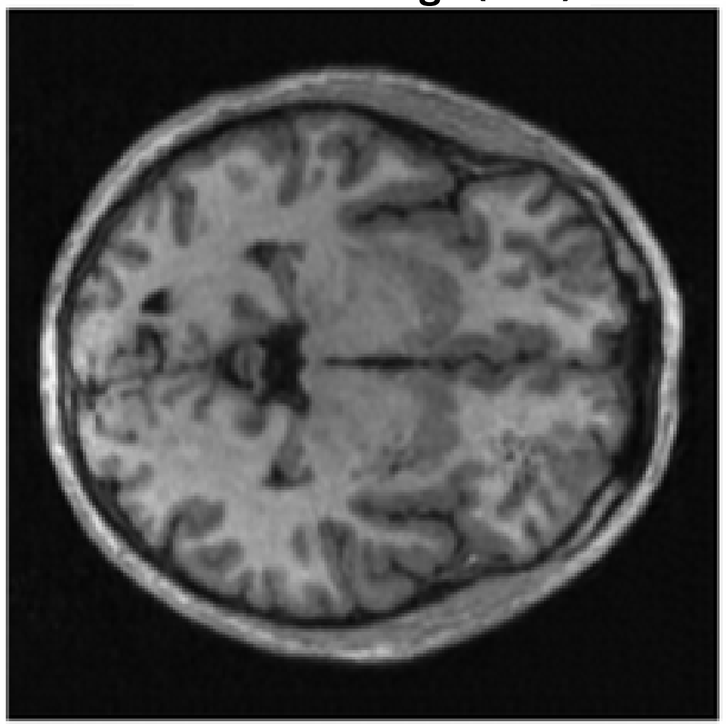
Input Image (CT)



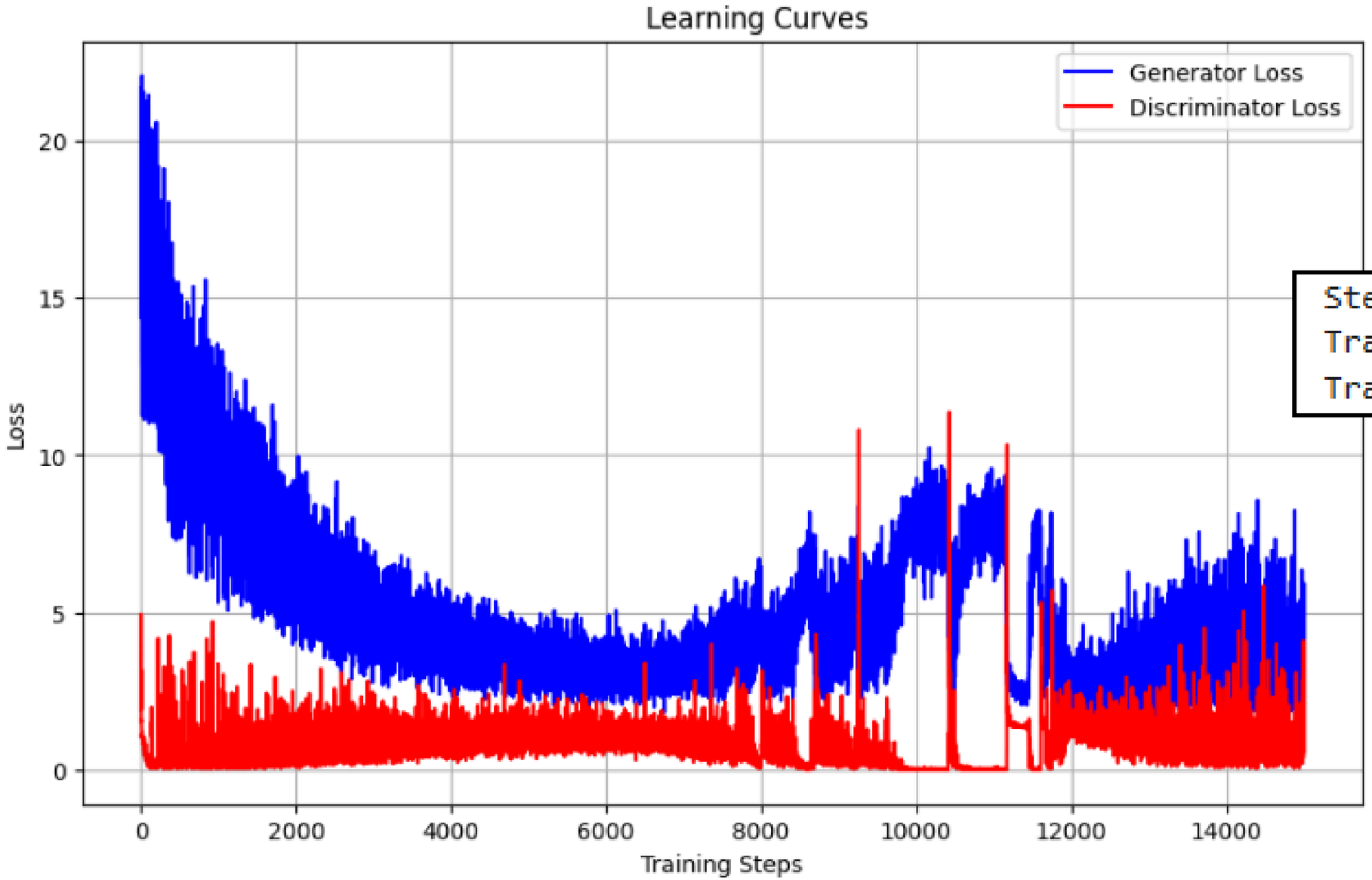
Real Target Image (T1w)



Generated Image (T1w)



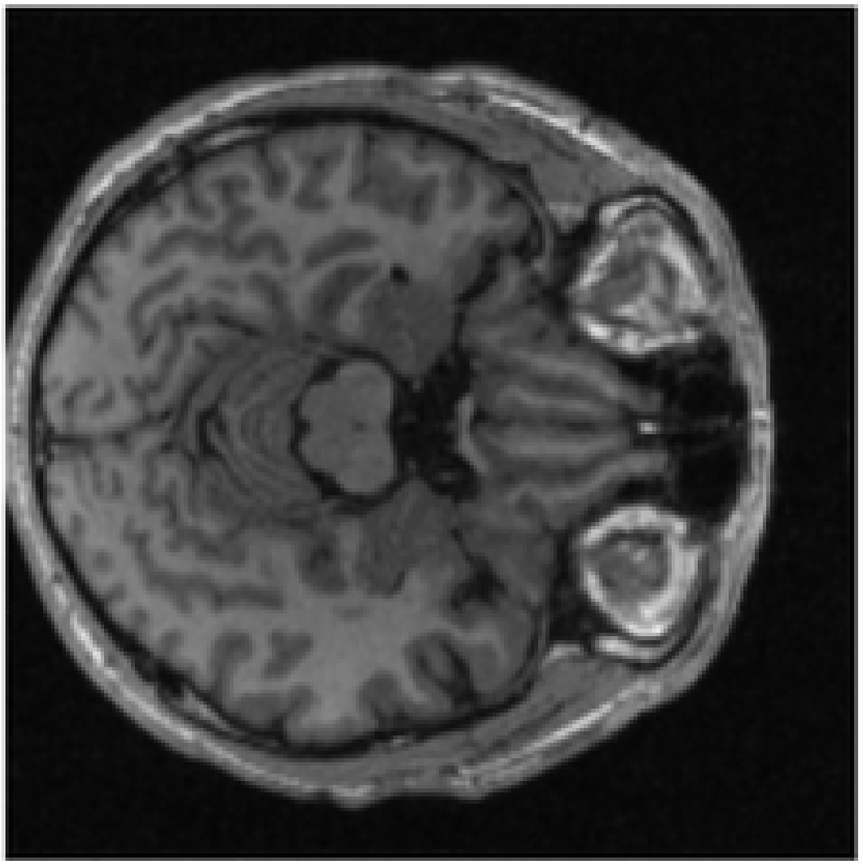
PIX2PIX MODEL



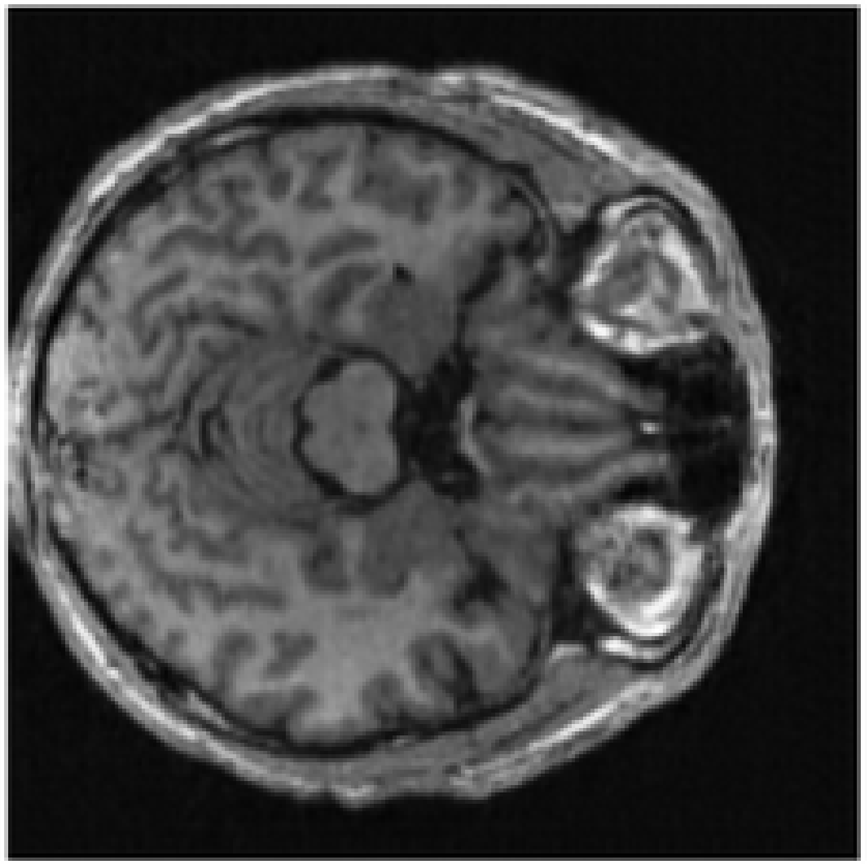
Step: 749
Training MSE: 0.0009
Training MAE: 0.0173

PIX2PIX MODEL

Real Target Image (T1w)



Generated Image (T1w)

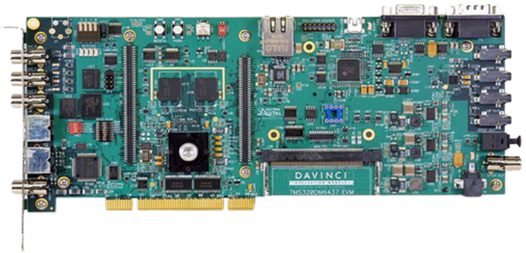


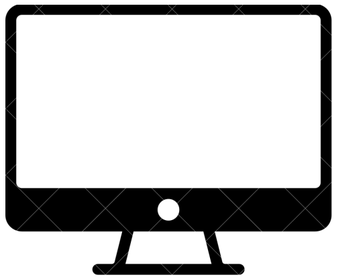
Average SSIM: 0.9598043614323907

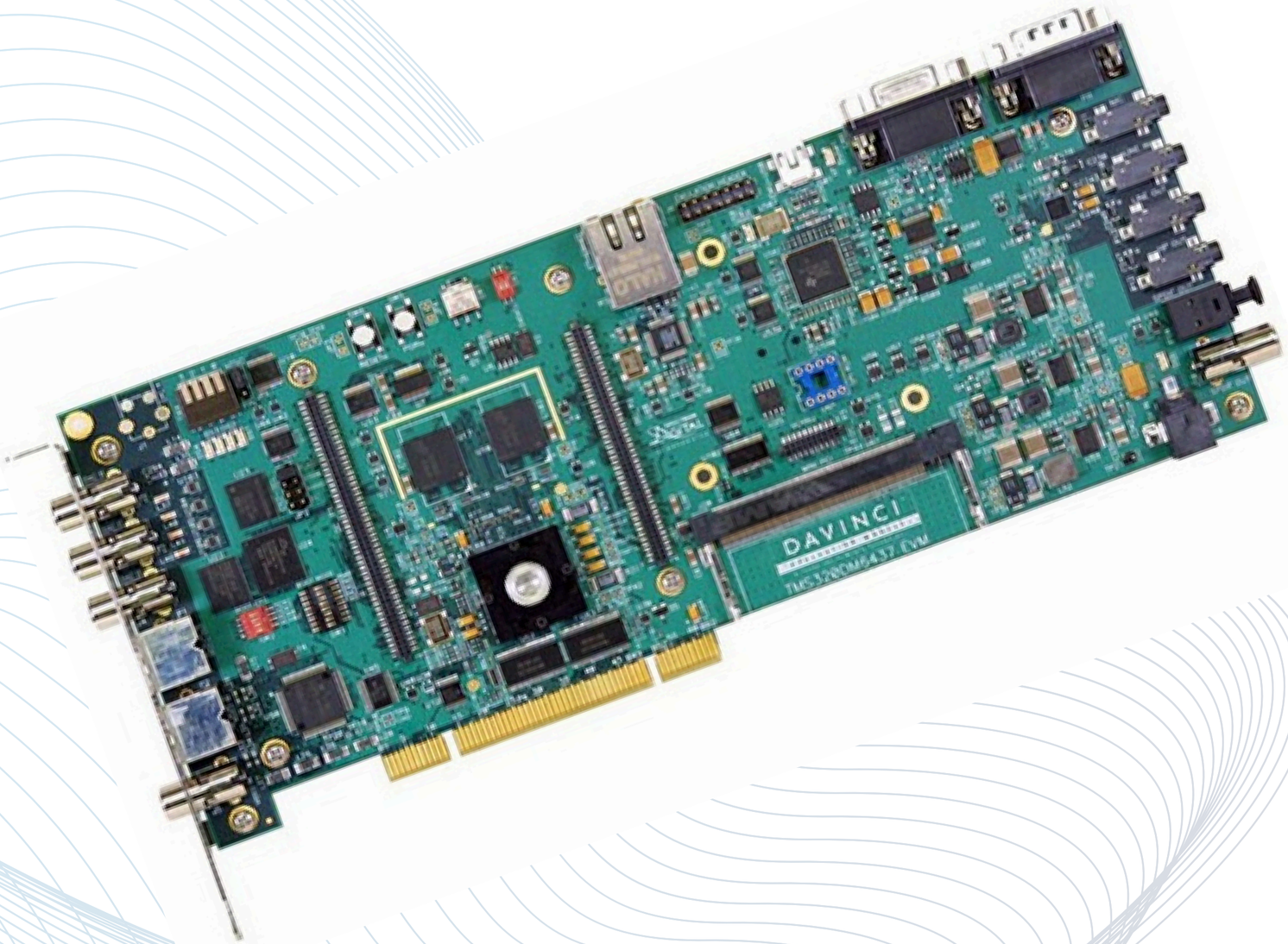
Average PSNR (dB): 36.22919218746142

HARDWARE PART

1. OBJECTIVE: RUN THE TRAINED PIX2PIX MODEL DIRECTLY ON A DSP KIT FOR MEDICAL IMAGE TRANSLATION (CT → MRI).
2. MOTIVATION: TO DO COST-EFFECTIVE MRI GENERATION WITHOUT HIGH-END GPU INFRASTRUCTURE.
3. KEY CHALLENGE: PURE C CODE AND EMBEDDED MEMORY LIMITATIONS.
4. HARDWARE PLATFORM: TI DSP KIT + LCD DISPLAY FOR ON-DEVICE PROCESSING AND VISUALIZATION.



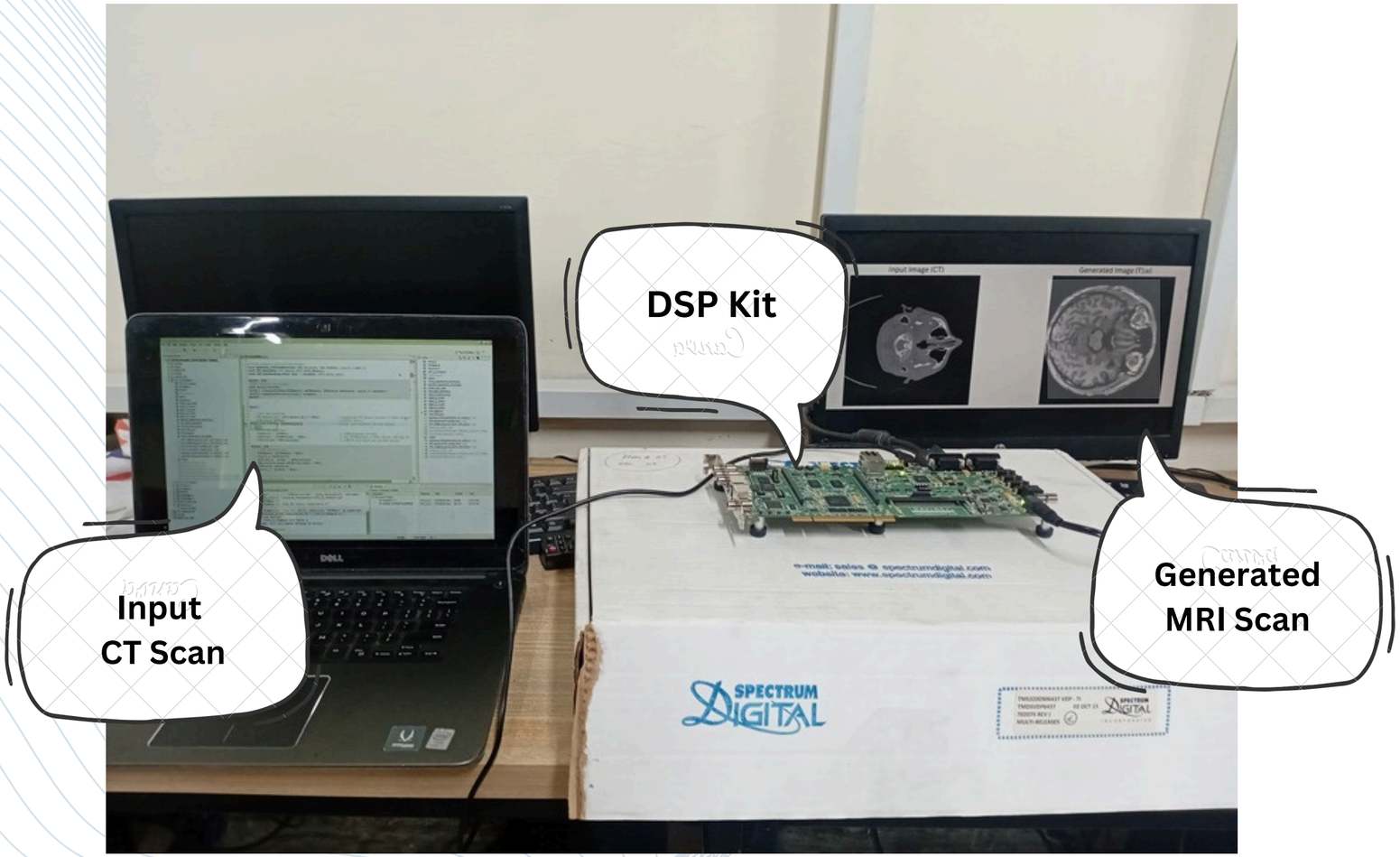




DSP Kit Specifications

- **Processor**
  32-bit fixed point DSP
  Up to 600 MHz
- **Memory**
  256KB SRAM
- **Storage**
  SPI Flash up to 64MB
- **Power**
  ~1.8 W to 2.5 W (at 600 MHz)

HARDWARE LAYOUT



Embedded Deployment

1. ORIGINAL MODEL TRAINED USING .H5 FORMAT.
2. CONVERTED MODEL WEIGHTS TO .NPY, THEN TO .H HEADER FILES.
3. MODEL LOGIC EXPORTED FROM PYTHON (.TXT) AND CONVERTED TO C-STYLE HEADERS.
4. ENSURES COMPLETE INDEPENDENCE ON DSP HARDWARE.

Preparing CT Images for Inference

1. **INPUT CT IMAGES ORIGINALLY IN .NII MEDICAL FORMATS.**
2. **TRANSFORMED TO C-STYLE .H FILES.**
3. **STANDARDIZED IMAGE RESOLUTION: 256 × 256.**
4. **READY TO BE FED DIRECTLY INTO THE DSP'S INFERENCE PIPELINE.**

Running Inference on the DSP Kit

1. C CODE IMPLEMENTS PIX2PIX GENERATOR ON THE DSP KIT.
2. USES EMBEDDED .H FILES FOR NUMPY AND MODEL LOGIC.
3. PROCESSES INPUT CT .H ARRAY AND PRODUCES MRI-LIKE .H OUTPUT.
4. NO OS, NO DYNAMIC MEMORY.

Conclusion

1. THE PIX2PIX IS SUCCESSFULLY SYNTHESIZING MRI - LIKE IMAGES.
2. THE LOSSES ARE STABLE AND GENERATED IMAGES HAVE A HIGH SSIM.
3. THIS LEADS US TO CONCLUDE THAT IT IS IN FACT POSSIBLE TO GENERATE MRI-LIKE SCANS FROM CT DATA ALONE.

Future Work

1. ADD REAL-TIME PROCESSING SO RESULTS APPEAR INSTANTLY AFTER CT IMAGE INPUT.
2. USE FASTER HARDWARE (LIKE AN FPGA) TO IMPROVE SPEED AND PERFORMANCE.
3. DESIGN A SMALL DEVICE THAT CONNECTS DIRECTLY TO A CT SCANNER FOR ON-THE-SPOT MRI-LIKE IMAGE GENERATION.
4. MAKE THE SYSTEM SMALLER AND MORE EFFICIENT FOR USE IN HOSPITALS OR MOBILE UNITS.

REFERENCES

1. Isola, P., Zhu, J.Y., Zhou, T. and Efros, A.A., 2017. Image-to-image translation with conditional adversarial networks. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pp.1125-1134.
2. Wolterink, J.M., Dinkla, A.M., Savenije, M.H.F., Seevinck, P.R., van den Berg, C.A.T. and Isgum, I., 2017. Deep MR to CT synthesis using unpaired data. In International Workshop on Simulation and Synthesis in Medical Imaging. Springer, pp.14-23.
3. Armanious, K., Jiang, C., Fischer, M., Küstner, T., Hepp, T., Nikolaou, K., Gatidis, S. and Yang, B., 2020. MedGAN: Medical Image Translation using GANs. Computerized Medical Imaging and Graphics, 79, p.101684.

Thank you

Q/A