A Novel Framework G-DANs for HADR (Kadai Section)

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1. Introduction

Typhoons are formed when the ocean surface heats up, evaporates and form clouds that can translate to strong winds and heavy rain under the right environmental conditions. Typhoon becomes destructive when it enters populated land. We proposed a novel framework the Generative Destructive Adversarial Networks (G-DANs), a rapid analysis and prediction method on satellite imagery built upon CycleGAN to simulate the aftermath of typhoon at landfall and predict destruction hotspots. This information will allow non-governmental organizations the equipment required for debris removal to search for survivors after the disaster.

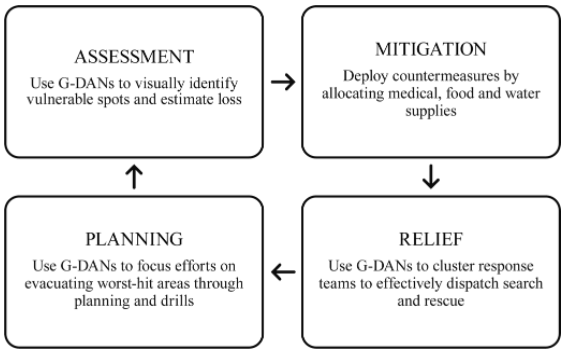

Fig. 1 Humanitarian assistance and disaster relief management (HADR) using G-DANs

2. Methodology

Our novel framework G-DANs built upon a deep learning neural network model CycleGan, which is an extension of Generative Adversarial Networks (GAN). GAN works by pitting 2 neural network systems against each other to improve the quality of their results.

To train the model for G-DANs, we process before and after satellite images from the worst-hit city of Tacloban in the Philippines during Typhoon Haiyan (Fig. 2a and 2b). The model extracted unique characteristics from unpaired pre-typhoon and post-typhoon images for image translation. To improve the robustness of our model, we input other satellite images of destruction sites with a 1:2 ratio where we had 100+ post-typhoon images and nearly 300 pre-typhoon images. We trained the model until the loss curve had converged and the images generated became more representative of a typhoon destruction path after almost a hundred epochs.

3. Observations

G-DANs training satellite images taken from the Philippines, Tacloban in 2013(Fig. 2a and 2b). Evaluation with the use of satellite images from Singapore, Choa Chu Kang as the input to G-DANs (Fig. 2c) The generated image (Fig. 2d) depicts the simulated destruction hotspots and aftermath.

(a) Ground truth – Before (b) Ground truth – After

(c) Input - Before (d) Generated - After

Fig. 2 Training and Testing images of before typhoon landfall and after typhoon landfall

4. System Diagram

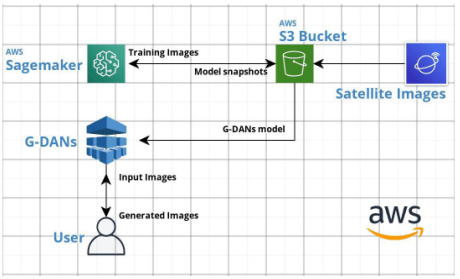

Fig. 3 Utilising cloud computing to train G-DANs

5. Roadmap and Improvements

Our novel framework G-DANs received constructive feedback from the personnel from Changi Regional HADR Coordination Centre (RHCC), Defence Science & Technology Agency (DSTA), Airbus and Singapore Space and Technology Association (SSTA). We intend to tune the model with more satellite images from different regions and to add in additional parameters such as typhoon direction and wind speed to improve the accuracy of the model's predictions. G-DANs is open-sourced, and accessible through: https://github.com/Jasperabez/G-DANs.