Using satellite images and computer vision to study the evolution and effects of spatial apartheid in South Africa

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1 Introduction and Motivation

- One of the main problems in South Africa is removing many of the legacies of apartheid.
- For example, Figures 1 and 2 show some aerial images taken by photographer Johnny Miller, depicting completely segregated neighbourhoods of townships next to gated wealthy neighbourhoods that have largely remained unaffected by the ending of apartheid[1].
- Studying changes in the demographic makeup of different neighborhoods could help implement policies to desegregate them.
- Our project proposes using satellite imagery to study the effects of spatial apartheid.
- We are particularly interested in understanding the current state of neighbourhoods and how they evolve over time.

Figure 1, 2: Aerial images showing some of the legacy of spatial apartheid in Cape town, South Africa[1]

2 Objectives

The specific questions we would like to answer are:

1. Can we automatically identify clusters of townships and wealthy neighborhoods using computer vision?
2. Can we measure the sizes of these clusters, and how they are changing over time?
3. Can we build a vision system which can be used to infer socio-economic information about areas not present in the available datasets?
   a. These will include both new and older neighbourhoods which are outside of the data collection period.

3 Data

Our work uses 3 datasets depicting South Africa from 2006-2016:

- High resolution satellite images

Figure 3: President park suburb(left) & Tembisa township(right) 2014

- Shapefile data of geographically labeled coordinates of all buildings and polygons of all neighbourhoods in the country

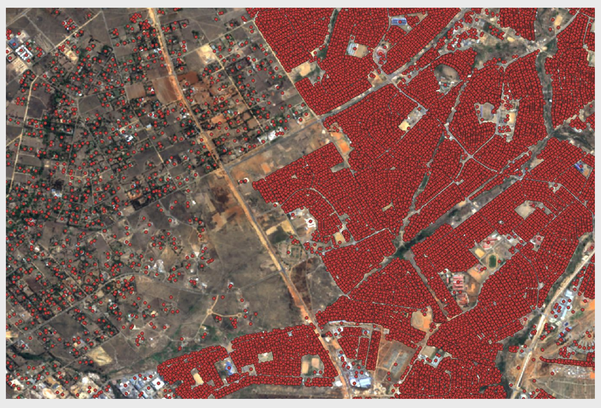

Figure 4: Shapefile data of President park suburb(left) & Tembisa township(right) 2014

- Household income data for every neigbourhood in the country (from 2011)
  - Income data on sub-sections within neighbourhoods as well

4 Methods

Our next step is to build a semantic segmentation model [2,3] for neighbourhoods which will learn to detect and classify clusters of townships and wealthy areas.

Features

- Shapefile neighbourhood polygons from the neighbourhood dataset
- Overlay them onto the satellite images to create masks for our training data

Labels

- Categorise the household income data into various classes: township, suburb, informal settlement, village, etc
- Classifications will be used as proxies to label the detected neighbourhoods

Model

- Build and train a semantic segmentation model to auto detect and classify neighbourhoods

Further steps

- Apply it to the ~5 million images in our test set
- Use class appearance models and saliency maps to understand which image attributes the model deems important for classification

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