PUSHPIN

Highest-accuracy, fastest turnaround, lowest cost parcel change detection
OVERVIEW

WHO ARE WE?

WHAT MAKES US BETTER?

DEMONSTRATION

NEXT STEPS
COMPANY

FOUNDED IN 2015

BASED IN MINNEAPOLIS

24-PERSON COMPANY

• 3 principals, 3 consultants, and 18 analysts

FLAGSHIP PRODUCT IS PUSHPIN PLATFORM

• Stems from map challenges at founder’s previous company
• Deep learning applied to aerial imagery
• Human + machine symbiosis
• Two pending patents; more in the pipeline
PRINCIPALS

RANDY MILBERT  
Founder and President
Graduated from MIT in 2000; founded Primordial in 2002; secured $15M in government contracts for Ground Guidance off-road route planning software; sold government-wide Ground Guidance license in 2012; sold company to Polaris Industries (NYSE:PII) in 2013

ANDREAS ROBINSON  
Chief Technology Officer
Graduated from the University of Minnesota in 2004 with master’s in computer science; joined Primordial in 2006; led multimillion dollar Army, Air Force, and DARPA projects; developed machine learning algorithms for extracting features from satellite imagery

GRADY HANNAH  
VP Business Development
Technology sales and business development veteran; spent 15 years in senior roles in tech-forward Silicon Valley companies; sold ground-based image capture technology to assessor market at Facet Technologies; responsible for Pushpin sales and marketing
WHAT MAKES US BETTER?

COMPETITION

OUTLINE OLD BUILDINGS
OUTLINE NEW BUILDINGS
COMPARE OUTLINES
REVIEW RESULTS

Manual
Automated

ADVANTAGES

ALL PARCEL CHANGES
Pushpin recognizes all parcel changes, not just main structure changes

CATEGORIZED RESULTS
Pushpin classifies changes into 10 categories, facilitating prioritization

< 4 WEEK TURNAROUND
Pushpin is 10X faster, completing countywide projects in weeks

15¢ PER PARCEL
Pushpin is 5X cheaper, charging just 15¢ per parcel with no setup fees

PUSHPIN

SPLIT PROJECT INTO BATCHES
AUTOMATICALLY CLASSIFY BATCHES
REVIEW BATCHES

MANUALLY CLASSIFY ANY REJECTED BATCHES
AUTOMATIC CLASSIFIER

1. **START WITH A CUSTOM NEURAL NETWORK BASED ON RESNET 50**
   - ResNet 50 is the 50-layer residual network that won the ImageNet Large Scale Visual Recognition Competition (ILSVRC) in 2015
   - Pushpin customized this network for parcel change detection (e.g. supporting two input images)

2. **PRETRAIN USING IMAGENET DATASET**
   - Pushpin pretrained the network using the ImageNet dataset
   - This dataset includes 1.2 million images of everyday objects manually classified into 1,000 categories

3. **TRAIN USING PUSHPIN PARCEL DATASET**
   - Pushpin further trained the network using 100K image pairs manually classified as changed or unchanged
   - Changed parcels also include one or change type (addition, construction, deck, demolished, flatwork, garage, new, other, pool, shed)
# Change Heatmaps

<table>
<thead>
<tr>
<th>OLD</th>
<th>NEW</th>
<th>CHANGED</th>
<th>UNCHANGED</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Old Image" /></td>
<td><img src="image" alt="New Image" /></td>
<td><img src="image" alt="Change Heatmap" /></td>
<td><img src="image" alt="Unchanged Heatmap" /></td>
</tr>
<tr>
<td><img src="image" alt="Old Image" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Output</th>
<th>Output</th>
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<tr>
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</table>
UNITED STATES PROVISIONAL PATENT APPLICATION

INVENTORS: Randy Milbert and Andreas Robinson

FILED: September 21, 2017

ABSTRACT:
The present disclosure is a computer-implemented method for identifying property changes by analyzing differences between old and new imagery. An administrator begins by providing links to old imagery, new imagery, and a parcel file. The application then divides the project into batches and automatically classifies each batch. Analysts review these batches and reject those that are insufficiently accurate. Analysts manually classify rejected batches. Once all batches are accepted, the administrator can download a change report. The change report includes overall project statistics, a breakdown of changes by type, a heatmap showing areas of rapid change, and an estimated tax impact. The application also divides the results into geographic sectors to facilitate fieldwork.
ADDITIONAL SERVICES

IMPERVIOUS SURFACE EXTRACTION
- We deliver outlines and areas of impervious surfaces in residential or commercial parcels
- Useful for calculating storm water runoff fees
- 25¢ per residential parcel

BUILDING OUTLINE EXTRACTION
- We deliver outlines and areas of structures on residential or commercial parcels
- Useful for GIS applications
- 25¢ per residential parcel
<table>
<thead>
<tr>
<th>PAYING</th>
<th>TRIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MARICOPA COUNTY, AZ</td>
<td>HARRIS COUNTY, TX</td>
</tr>
<tr>
<td>LEE COUNTY, FL</td>
<td>SCOTT COUNTY, IA</td>
</tr>
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<td>TRAVIS COUNTY, TX</td>
<td>DUVAL COUNTY, FL</td>
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<tr>
<td>CARSON CITY, NV</td>
<td>SUMTER COUNTY, FL</td>
</tr>
<tr>
<td>HILLSBOROUGH COUNTY, FL</td>
<td>ATCHISON COUNTY, KS</td>
</tr>
</tbody>
</table>
“Pushpin is applying to real property assessment the same kind of artificial intelligence algorithms that Google uses in its autonomous cars. Our testbed was a set of four areas of the county, each of which presents a different challenge for change detection via aerial photography. After we examined these small pilot areas with this constantly learning technology, we believe our office has a new opportunity to improve the accuracy, turnaround time, and cost for detecting a variety of changes.”

**ERIC BAILS**  
Chief Technology Officer, Maricopa County Assessor, Arizona

“We fly new aerial photographs of Lee County every year to help with our parcel inspection and valuation process. Pushpin allows us to leverage that investment by identifying changes in parcels without costly on-site inspections. Having a full accounting of new construction, additions and demolitions is important in developing a fair and equitable tax roll for everyone. Pushpin is a great new tool we plan on utilizing to increase the accuracy of our data collection process.”

**KEN WILKINSON**  
Property Appraiser, Lee County, Florida

“Pushpin enabled us to analyze our zone 3 properties in a fraction of the time and cost that was previously possible. We performed a careful review of the results and were so pleased that we asked Pushpin to analyze our zone 4 properties in the next fiscal year. We enjoy working with innovative partners like Pushpin that enable us to lower costs and increase efficiency.”

**BOB HENRIQUEZ**  
Property Appraiser, Hillsborough County, Florida
DEMONSTRATION

• Review change detection case studies
• Review sample change report
NEXT STEPS

START A FREE TRIAL

• We will analyze 1,000 parcels in your county for free
• We will deliver a detailed change report plus a spreadsheet highlighting changes
• We will complete the project within 5 business days

CONSIDER USING US FOR YOUR ENTIRE COUNTY

• If the trial goes well, hire us to perform change detection for your entire county
• We have the highest accuracy, fastest turnaround, lowest cost solution