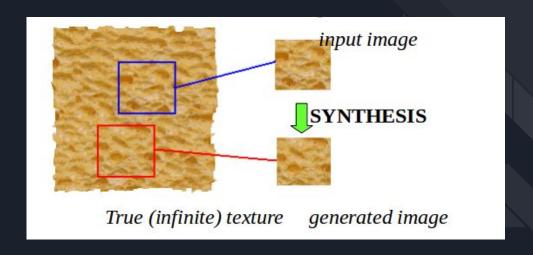


Team Name TheArtAdda Project ID 44

Members |

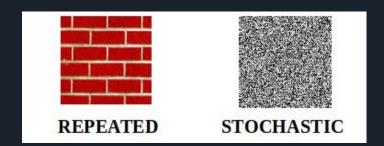
Anvesh Chaturvedi 2016109**4**Yudhik Agrawal 2016109**3**

Goal Of Texture Synthesis



Given a finite sample of some texture, the goal is to synthesize other samples from that same texture.

Challenges



- Modelling the whole spectrum from repeated to stochastic textures.
- Texture Analysis: Getting an idea of the texture structure for correctness of texture synthesis.
- Finding the nature of the image and adjusting the parameters of the algorithms accordingly.
- Multiple varieties of textures [Without any pattern].

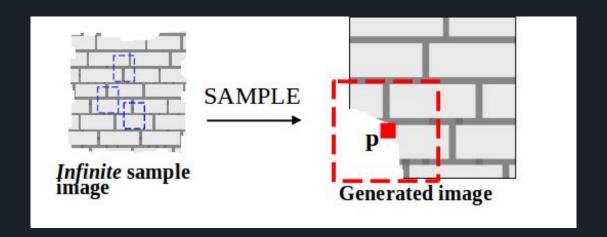
Texture Synthesis by Non-parametric Sampling

Efros & Leung, 1999

Approach

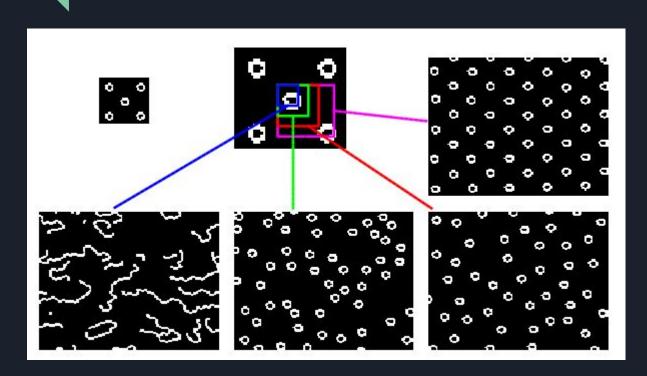
- The main goal of the texture synthesis algorithm is to preserve local structure at all stages of the algorithm.
- We need to fulfill certain constraints at each stage to ensure robustness of the results.
- One pixel at a time. Our algorithm "grows" texture, pixel by pixel, outward from an initial seed.
- The neighborhood of a pixel is **modelled** as a square window around that pixel. The size of the window is a free parameter that **specifies how stochastic** the user believes this texture to be.

Synthesizing One Pixel



- We assume the Markov property to be true where we can find the conditional probability distribution of any point 'P' given that we have its neighbourhood.
- We find the best match using SSD error (weighted by a Gaussian to emphasize local structure), and consider all samples in some range of distance from that match.

Randomness Parameter - The Window Size



The size of the neighbourhood window is a parameter that specifies how stochastic the user believes this texture to be. Different outputs are observed as we go on changing the window size.

Image: <u>Fence</u>
Window
Size - **21**



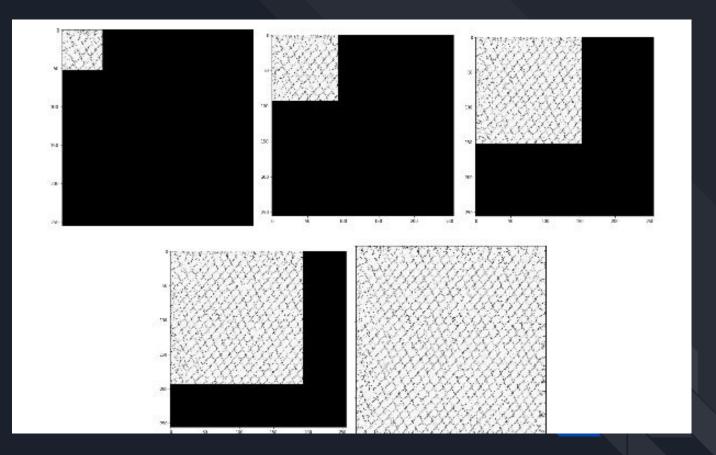


Image: <u>Fence</u>
Window
Size - **23**



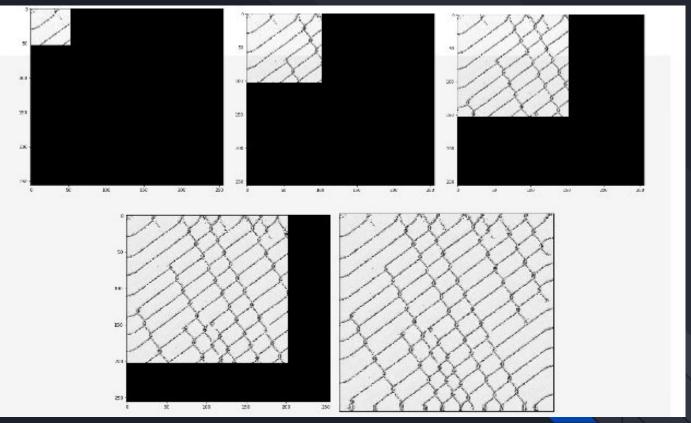
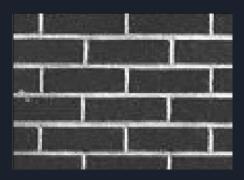


Image: <u>Brick</u>
Window
Size - **21**



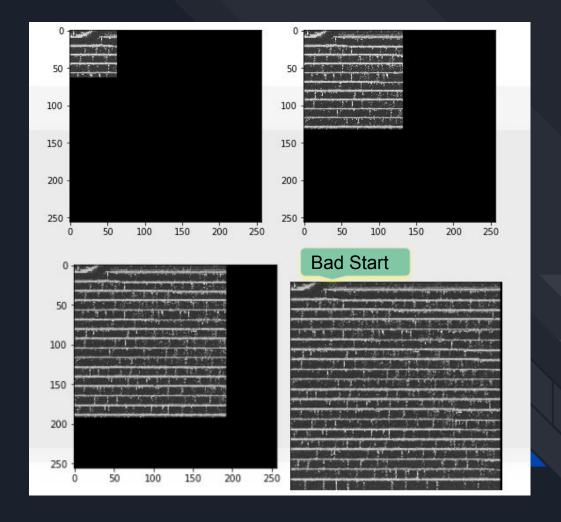
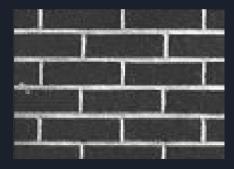
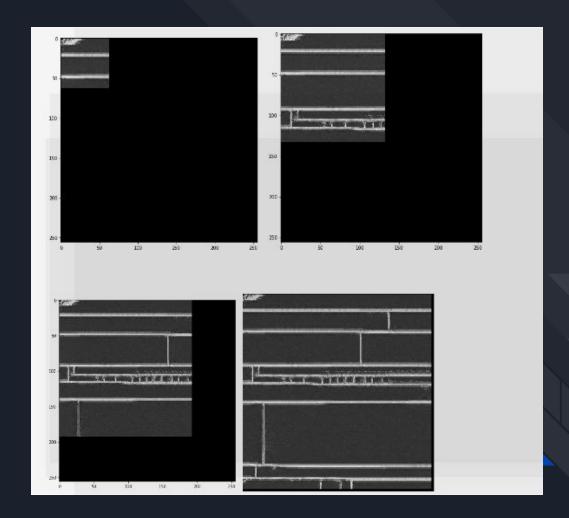


Image: <u>Brick</u> Window

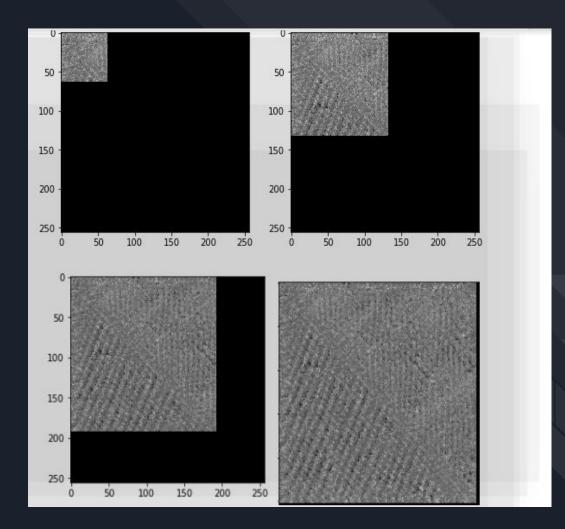
Size - **15**





Not **So** Good Case





Challenges

- One problem of the algorithm is its tendency for some textures to occasionally 'slip' into a wrong part of the search space and start growing garbage or get locked onto one place in the sample image and produce verbatim copies of the original.
- One of the biggest challenges of this approach is the hyperparameter window-size which greatly influences the output characteristics and quality.
- Greedy, slow and heuristic based approach.

Advantages

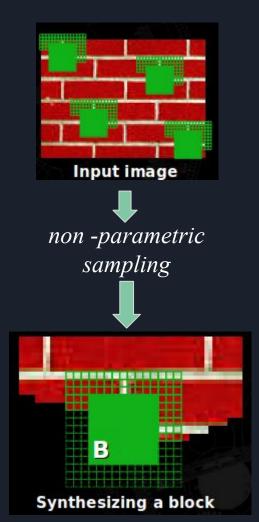
- Conceptually simple approach, easy to understand and implement.
- Has the capacity to model a wide-range of real world textures.

Image Quilting for Texture Synthesis Transfer

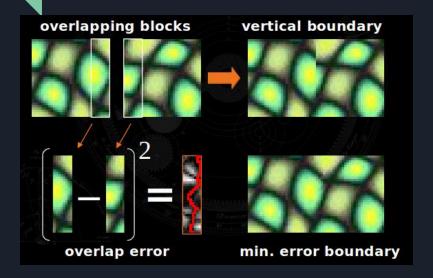
Efros & Freeman, 2001

Idea

- For most complex textures very few pixels actually have a choice of values that can be assigned to them. That is, during the synthesis process most pixels have their values totally determined by what has been synthesized so far.
- Taking this into consideration, we define
 the unit of synthesis in this approach to
 be a block Bi.



Minimal Error Boundary Cut



 B_1 and B_2 are two blocks that overlap along their vertical edge with the regions of overlap B_{ov1} and B_{ov2} , respectively, then the error surface 'e' and cumulative minimum error 'E' for all paths is calculated as:

$$e = (B_{ov1} - B_{ov2})^2$$

$$\begin{split} \mathbf{E}_{i,j} &= \mathbf{e}_{i,j} + \min(\ \mathbf{E}_{i-1,j-1},\ \mathbf{E}_{i-1,j},\ \mathbf{E}_{i-1,j+1}) \\ \\ \mathbf{MinPaths}_{i,j} &= \mathrm{argmin}(\ \mathbf{E}_{i-1,j-1},\ \mathbf{E}_{i-1,j},\ \mathbf{E}_{i-1,j+1}\) \end{split}$$

Results

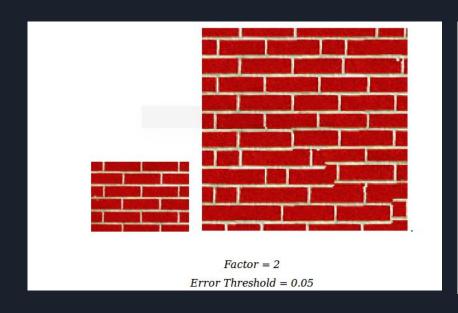


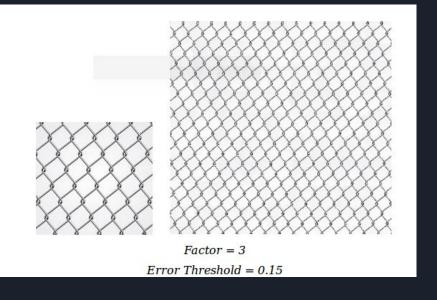
Factor = 2 $Error\ Threshold = 0.15$

iff oeckem er rdt s thinline arful n.htb ariont wat fabt thensis at stealy obou, penry coining th the tinsensationem hemenar Dick Gephardt was fainghard kes fal rful riff on the looming; at thyo ecophonly asked, "What's yourtfelt sig abes fations?" A heartfelt sigh rie abouerdt systory about the emergene about eat bekes against Clinton. Boyst com dt Geng people about continuins arfun riff opardt began, patiently obslepiem ut thes, that the legal system hergent at Cling with this latest tangemem rt mis younst Criat tinebookair thes about yoursighstothat Chith's 'thyst Chinth sizerzementfout hat this', a the le Gong peophardt was feled, 'What's the looming in the tinserener Dick Gepha iff aparct in the looming "A heartfelt "What's youk Gephardt wal : ful riff on the t thes, tha, "What's yourout the emsheartfelt sighriff on the loophonly asked, "W ng th the titheartfelt sigh not Clintont thonly asken, no?" A heartfations?" A hea ick Gephandabi thensis ear Dick Gen fations?" A by about the ck Gephanda the I riff on toping the the testal rful riff onsystory abou against Clul riff on thest Cli asked, "It Dick Genhambonly asked, ckes againspeople about asked, "Włabou as!" A kerful riff on the s fations?" A leng people alt began, pens?" A heann, pa y about thly asked. "Whaystory abou grandt beganthat the legary about the e legar regimet Clinter fair themse at stealy observations and was faing iff on the loor fa copile about coting the tinsensationing the tithe looming asked, "Wirdt sys tbegan, paur Dick Gephardtwas & Dick Gephar@hat's yourns?" A heartitbok nat the legal rful riff on the loomine ful riff or the letfelt sigh ry about the e Gens vitir this laturaly asked, 'What's youly asked, "Whe emerger against Cliniff upon about the eming in the til fab: thensiswat fab: thenions?" A hearly about the he l ainst Clinter Dick Copheing th the ty ceing th thetery about tos against Cli Wh ple about corful riff on r Dick Gephenar Dick Gephs against (g people acouseart egan, pationly asked, rful riff on tifal rful riff ong people akardt began, at the c t the legal ations?" A buly asked, 'phonly asked, and beganes, that the leg C.in. ?" A heartfebry about the looming " aktions?" A hen the looming th this less at about the :kee against "What's yourtsystory abouted, "What's Dick Gephardise: ainst Cling people aboartfelt sigh rokes against A heartfelt sul riff on the bith ple about condt began, pe emergene mg people about the emeily asked, 'Who loo egan, paties, that the leginton. Boystrardt beganinst Clinton ons? A hearthat s? A heal og th the tinsercontinuins as, that thensabou contine tinsensation is about the lick Gepharding th the tir coing th the ig th the tirsehardt was f Wha gainst Clini riff on the look Gepharar Dick Gepharit Gepharit the loominearth ople about, asked, "Whail riff on their ful riff on the lo"What's yt the er began, paths" A heartly asked, "Whinly asked, Iv asked, "Whatear felts: Clinb at the legaly about the ems?" A heartfsis at stealy ful riff on thethe emerboust, th the tines rations?" A hear felt sigh tinsensationry asked, "Whear felt si "A h Clenhands extern about the emergenands was fairned. A heart the emerghout

Factor = 2Error Threshold = 0.05

Results





Texture Transfer

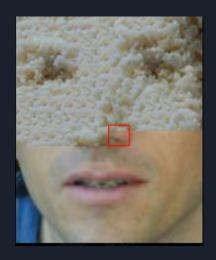
- Efros & Freeman, 2001

Basic Idea: Take the texture from one object and 'paint' it onto another object.

This requires separating texture and shape.

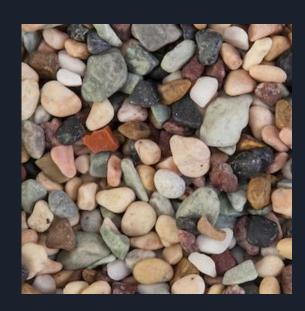
Approach

 The synthesis algorithm has been augmented by adding the requirement that each patch must satisfy a desired correspondence map as well as satisfy the texture synthesis requirements.

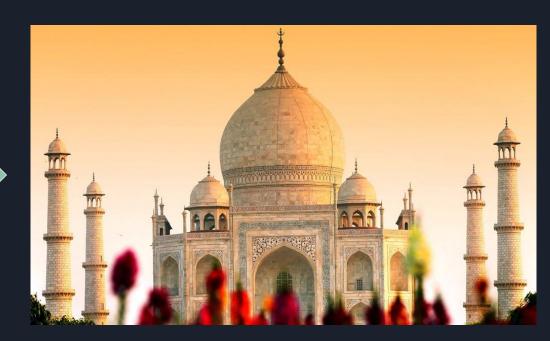


Challenges

- Image being synthesized must respect two independent constraints:
 - The output are legitimate, synthesized examples of the source texture.
 - The correspondence image mapping must be respected for proper texture transfer observations.
- Because of added constraint, generally one synthesis pass through the image is not enough to produce a visually pleasing result.
- A weighted error giving appropriate weights to the two constraints needs to be defined. The way in which value of α (the weight parameter) is decided can alter the results to some extent.



Overlay



 $\overline{\mathbf{I}}_{ ext{te}}$ ration – $\overline{\mathbf{1}}$



 $I_{teration}$ - 3



Iteration - 2



Iteration - 4



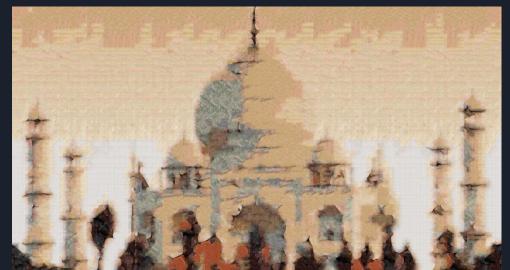
 ${f I}$ teration - ${f 5}$



 ${f I}$ teration – ${f 6}$

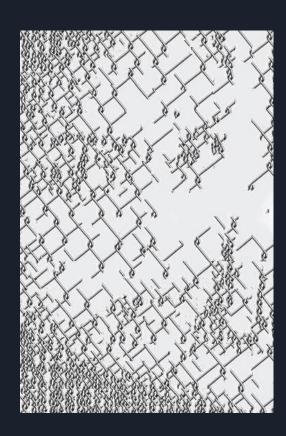


Iteration - 7
Final Output



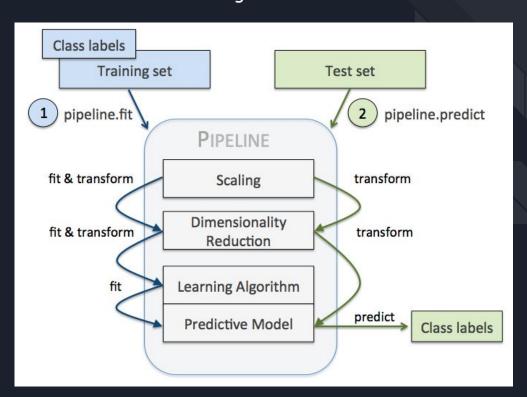
Another **E**xample





Further Experiments/Uses

Pipeline to exploit how efficiently our algorithm can help in increasing dataset.



Extending Database!!! for

Various texture images

Our **Texture Synthesis** provides images with **increased pattern size** and the **Artifacts** produced during the process are very small which can be ignored.

Idea: Various Texture images were synthesized from our image synthesis algorithm and a classifier is created for various texture images[in our case 3] using the **Linear SVM classifier**.

- Multiple random images are generated from the given texture images and are split into training data and testing data.
- PCA is done for pre-processing before training the classifier.
- We observe an accuracy of 100% on the test set showing the robustness of the algorithm via the great separability of the data generated using the outputs.

We get 100% accuracy not just while training the data without reduced complexity but even after taking the PCA with number of components as 8.

Texture Synthesis

Texture Transfer

Input Image



Synthesized Image



Output Image

Patch-based texture synthesis(2001 Efros and Freeman)

Pixel-based texture synthesis(1999 Efros and Leung

Image Quilting

Hasta Vista