Homework-1

Digital Image Processing

Problem 1

1. Original image of me:

A person posing for the camera

Description automatically generated

Enlarged image by 2.5 factor in paint:

Original Pixel:

1202x1600

Enlarged to 2.5 factor

Changed Pixel:

3005x4000:

A person posing for the camera

Description automatically generated

B. Original Image

A picture containing person, baseball, player, outdoor

Description automatically generated

Adjusted Image:

![A group of baseball players standing on top of a field

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4UHwRXhpZgAATU0AKgAAAAgABgALAAIAAAAmAAAIYgESAAMAAAABAAEAAAExAAIAAAAmAAAIiAEyAAIAAAAUAAAIrodpAAQAAAABAAAIwuocAAcAAAgMAAAAVgAAEUYc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFdpbmRvd3MgUGhvdG8gRWRpdG9yIDEwLjAuMTAwMTEuMTYzODQAV2luZG93cyBQaG90byBFZGl0b3IgMTAuMC4xMDAxMS4xNjM4NAAyMDIwOjAxOjEyIDE1OjAzOjI5AAAGkAMAAgAAABQAABEckAQAAgAAABQAABEwkpEAAgAAAAMwMAAAkpIAAgAAAAMwMAAAoAEAAwAAAAEAAQAA6hwABwAACAwAAAkQAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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1nNruKL255Xz5MH1bNWdPmeSWXzHaTYmdpbH1oeiCGrLlpJBOis0pVt3CK55FP1HUo5LZI12qQ5UN3FczZvE9DsVtrSwj2tvxGCXZsk8etIt0wtFljiLNKx+6OBWcXdltaHLsJINTmt2O0l/w55yPzqa70uWOPzE/eEDLgDkVqtyGuhnryBzT1461oibCov+mAg8GM5/AirUZy+D17VLLS0OOWVvt8khOT5p49OeldBq+pJpVnHNKPvDgdzVTlaJnCPMzm5fG5baVhaNl+6wYGmwXX9rXJmuGkLSciRlwD9K5ZR5tDp5uVG/H4VfUrcraPiQDO56fF4mtdG0WSykBF5APLfA4yKuEOV2E5aXNPw3pkVvrDrcY8xEBj56+tdqGVl4bgcVK0eondo53xIttNdWkN2H8t9wUL3NZblLeeytIsCJZM4x3HSsKnxHVTS5DJvWJ8q4lLItwhKAjOcHaPpQqRh32NnaAVJYcDPP6Vm4e9clT0M+NsnPOT1NW0ORjFdCehjLcpX65KJ3UfL9c0yXMsse4MFjXgA9+9BBPb+VGRlSM9SRkVrxqk8LRttZXUrn61cXYDlWUqSjDDDO78Dio84rtOWw0mkDle+KGJG34Z0qXUrl5zlbaEZduzew96y/EyxmSY2MEqxk8ZBwfXFcrd5WOyMLQuanhnWb26jNnMku5FIU46gV6Da3sGnaVAlzNGHWMEoXG8556VC0kD+E56/v4L++L2wdZEQNhxywB9PQV0ME8bRxshyWUNx2qoslozdYtYlbzkAR2+8AOD71kjI5xkd60uKwIw+2Qsp4KPxj3Wpr6UQ2sk27bhaTeodDjkzHtC8k8j371U8V3klxfwwmQhIo+A3YkgGqqbE0erMDEZHJJ/Kus0yW4NtZ20mAnmEjI5x2qIbmkloelaAGS6CKOGjJ/LH+NcD4i05DruoOVwsku3nucCrfxk7RNC+1RrO/ha2IkWZQVkHY+grtdOj1DygJIgsZG4FjzXLNSuawaS1JL7SWvri1mknI+zksFC9ePWsm7FvY7RIiSXEsnynP3BnrUyi7o1pzVmYGtRhTZQrwqWwH0O41kkFzllyPpVWT3MmySJTkVdVcEUEmfeuEuGkbkKM1Vg+dBJuYbueKBPYvRMVAZWOfetO3bkH+IcmnERhalGY9SmUcgtkfQ8/pVJ1cHBQr35Fd0Xoc7i7iEZX7p49Aa1PD/h+41y82bSlqn+tlP8h7/ypTklEIU25I7q7eOyt49I0uNQduD7D6+tZyeCbi8kjlvr0LEFyY4hz9Mn/CuON+a56FSyjZEaC20bU7g2lmfKTCBjyd3c1qazDb3lnDO81tA0iBgZEGTkevBpx1k7mcrKCOWKvBLvjcbkPBB4xWzp17NLDFaWqYklk6nqq9/yqrWZkmamtIqwkg5rCB5q4jYAEXUTYzkMP5VV16OZrSFYUZwzncFGeMGnb3iHsYosroMB9nlYB852munk8O2mpoXmgVpdm0Z7U6t1EqhpLU5D/hEJILpnZJJEDHCgcEVuwaXN59sWicCM9Me1YQbbNZNHX6TL9mvlZ1O0oVziue8TWdzPqjNDAWy5fIGa2ekjLdGythpEDwtHDCPIOY+ny/StI6woH+sjAqvZ3J5kyN9YQ9Z0A9qoyT6XI++Z4mI7sQaTgrgp2djG1GBbrxJHEgyiKo9sAbv61mTQRwSOkfKL8vPauZ7mvUSGNQenNWtvIPpzQBh6iXyxVNyl/mY9B60lui7AF6dhmkD2LiRspHyEe1aFoVwfXNOIjQm1GxsYYo7m1MjMMhwMmrOjajot/dGBoQsroShcY/CuuL90yb1GXmt6VZzyRGFHZTg7VquvjG0gBWK2kUHnAxzSfvKw4y5XcYfFtsH3LatuPOcinHxqg58qTj0NTGCsOVVsjPiu1YZa3PPJz/WulLxXehWt6fJRJIVK+d90fWk4pFKVzlrlCzt86EesSbQfpUNs0ltMRGWQspwwPzA45/McVMiUdVeIH0S2dBlTEpJzmsZY+QMVUSmOEOJYhg8k/wDoJqabUk01FDQSSl+RsUnGKqBD2Kx8Sn+HT5j7baU+JJx93Tp+fRa1dupHM0H/AAkNzj/kGTf980f2/edtNl+mKVkxqTYz+39QJ+XS5Pyp39uaoW/5Bj/jUuN9RqVkcgzvu++/T+8aTJ/vN/30a0MAGSwBZvzqWQbV4yOPWoYLc7G1Uf8ACUuMf8sv/ZRUWrwxom5EAYtyR3rje529DNjA3j6VK/COR6UugEvkxtoU5ZFJ3P2965l+BkcYoWwF2zdiUBYmtKMAPwO9XERtJZWtyiedAkmM43DNSf2ZYxvGUtYlKsCCFxiuiPwmMiw+n2e4n7NHknk7etC2FoD/AMe0f/fNIkb9itRwII8f7tP+xW2P9RH+VVEaF+yW/wDzxTr/AHa3YoIm0qFDGu3ZjGPepmXDc4+5iRLh1VcKDwKz7kBXBAwcis5D6nS2fzeFUzzguB9N1ZwA44qoFMG/19t/10/9lNasaIUJKgnPpVoh7DxGmfuj8qXYv90VZIbR6ClwM9BQAYGegpQBnpUSGf/Z/+Ex5Gh0dHA6Ly9ucy5hZG9iZS5jb20veGFwLzEuMC8APD94cGFja2V0IGJlZ2luPSfvu78nIGlkPSdXNU0wTXBDZWhpSHpyZVN6TlRjemtjOWQnPz4NCjx4OnhtcG1ldGEgeG1sbnM6eD0iYWRvYmU6bnM6bWV0YS8iPjxyZGY6UkRGIHhtbG5zOnJkZj0iaHR0cDovL3d3dy53My5vcmcvMTk5OS8wMi8yMi1yZGYtc3ludGF4LW5zIyI+PHJkZjpEZXNjcmlwdGlvbiByZGY6YWJvdXQ9InV1aWQ6ZmFmNWJkZDUtYmEzZC0xMWRhLWFkMzEtZDMzZDc1MTgyZjFiIiB4bWxuczp4bXA9Imh0dHA6Ly9ucy5hZG9iZS5jb20veGFwLzEuMC8iPjx4bXA6Q3JlYXRvclRvb2w+V2luZG93cyBQaG90byBFZGl0b3IgMTAuMC4xMDAxMS4xNjM4NDwveG1wOkNyZWF0b3JUb29sPjx4bXA6Q3JlYXRlRGF0ZT4yMDIwLTAxLTA0VDE4OjMyOjE4PC94bXA6Q3JlYXRlRGF0ZT48L3JkZjpEZXNjcmlwdGlvbj48L3JkZjpSREY+PC94OnhtcG1ldGE+DQogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAKICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIAogICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgCiAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgIC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uNUl1C+uriQxGWSWaUGHmHAHetddd06zuNUSaSSCOSWOX/AI9T+9li/n0Fc1byTHrV4NexVjmr1IVDcsOcVLHN5E12cf8ALpMajt/O4pdW/wBH02eavTPLOT8Hqb+W4tJufOvIZx/1xqfV/Fa6vNPDBKBDDN/3/qta3A0/z70z/Z/+WGKsWCzWtuIIZqRBv6LeXX2O3iihx/13roPEenSaz4O1K28szTRQ/aofJ7mLkfqKwNPmvPtR/wBE88f9MZfJmrstDu4t0XMg/wCmVdFOp7MDwhVP/brVfbWvrOlnRNcutP6QRXczf9sCKyq+mPCdxbpfmFNec+RjvUW6q7NWjZkdR/b1t/wisFp5Q+1wy9MfufK9a6jwf40udRNvpqQ7TajBhjQyy15XcXHT1r6e+Dnwln8D+DrjxZr9mqau6ebZWkwEbQKRkLJyQZfU15GKcIHs4WnPETPCvGniq8sbCfT9RjkiubV5TKZIsykdiK+qvg/8btJ1r4f6BsAgZbdY3hX+E46V8s/GSx1vxdJcXF81rb/apBcLDHyeMVznwZ07xJoviaG3s7i3mt3aGKaGEmbbgc89q82ceeHtDu5PZz5D718C+IE8V694l8uch4liUlfvpv3/APxFY/xH8E+X4PvQLiS5v0dLiORlz5oQ5eH8U3j8ar6AzfC/Rb/UNWstUuZNSu0RP7EsZLh1UJ9+baDsTl+X4HrXH+LPj3qurQTxaRHHBaNHlftsP+kn2++ER/rTpz9wU/jL/wAMZoZmnhkjSaWFUaOt/wAUfDsa95t5p7rBqbfM8bnak/8A8S3vXC+Adat7LUNK1sQhLW8VraaBX8x45s8x8f7e1v8Agdex2c9xJJukRYo921dzfM1dFOoc/IeJTwz2F1LBdRy2tzE+xlZPnWmxkfwV2nxKSGaaNjEu9fl81f4q4lY2k+43lvXX7Qz5CPVrgLb2/wBoj4S8tv3f/bWOugvIiiedXKa8zSaasc0GXju7WRP/AAKirrbecRo6P/B/B/frOpUNIHmPxs1K3uLjQbWMeddbpJXB/wBTjHl8/wDfFQfChli8RIs8nlJ5PC1hePNSi1nxTcogwkI8mKb3NJ4Ha6Gp301tFiWGObFvXXD4Dh/iYg474+fEiW+8V32naReCLT7eUQST4z5rHnFeSf8ACQ39qc299P6fNcZq3rVrNa+INRM9vcG5M9zjn24qv/aZPb9P/r14x7Wp7L4H0vUrfQoPFDa1FcxNJ5U9io+X8PevpD4caTDqktja6jGJIJJERoz6gV8z6L4fm0XQ9KWU586+M/5nNfVPg+1aOPSli/dsZ4UT6b0r0KFOn7M5Jc/OcZ+0xprfBnxFomr+DbZdL/tD/Rbw2yDlcZU49q+XvGni7xdrmvTXc0rzMwGGUDGK+5/2svDjapY6BGzZtkllklf0CKT/ADr5htdFi1Uzy+T92Up19MVFBe6TXn7x1/xK8a/Y5tG1XQLuO4sb+IxTTOeN/Y17h8JdA8Tap4d0rVFK2UFzEGf7UuJSpGeU7Grlz8NfBy2sNoulWrWlt88ULIPLi+g7V20fjBo4QiNAqxrt3bf4a5p4JzNYVvZ/wzSbw6ZrOaG5uX/eLtZofl21xf8AwqnSPCuhWGj2MsyafDJ5hF5KZZG+rk5NbknjZ2Vv9It/yrLv9cg1RdtzdJJ/wKongHychdPGTpz55nnureKrfxt4kewhFsLGzubV7REP7yYxXaGR8egIFeU+Ngbzxj4jlY/u2v5ZIvwcCvovTdP8O/bofssdol1u3LsCb/7/AP7JXgfhbw/B4y8R6tLPHuspY7id5Je/mjOPylNYVKP1c2lW9p75yMdvPxN5PP1qW2t+wrXurCKGSYxL58P/AD2pNPsYRNxyayMS7Bb/ALmoPEn/ACDW+hrW+z/uf8+lYfi5ttvDF/zxOaYzgL7Uv9PsdLJ5/wCPjFasFtBbkfuM8VgWcp1DULmWe2+ygT4g966iGxPBEH2n1oImakP7gfuf3Fdjp0v7zy/+eVcdYt9nm9q6nw8sMNuMVVMRxXxQsjbeKDdQ8G6ihm/7bZ8kfoa5S6s73yfN8mYwf6jz6+k4vF2heDtHj/tqza6FxLtjcAzSLn6VV074o/D+a6jae3LWUckYdZoSACenUV9HQn+7PMqU6ftD5tgiuLbnyJh/2wqO5sZm4+xTf9+K+5vG154X8J2S6jstvsE2yWMffB9xXnV18cfBttI4Szaby+skMRIrT2xl9XpkP7PfwBOk2Ft4t8YwR/ayvn2WluARakj/AFj+sxB5b8K6bxprWpfErVbnRtHk8qyt0+Z5BlHf0rnpP2ltFmSKBLPUJUddkaLEeapD9oLRI5MW2mXf/bOOvEqUZ1Knvn0FDE0MPT5KZ09n+yPoeoXNvceINZvdWHlZmton8hJfY7fn2f7JOKpeLrVvD3j6xj8OaJBZ2+jWp6RgBg5+6MfSsqT9pbTomVzDc4Wq5/aC0WdXmNncszdTIn7x/oK0nhZ8nIc8MVDn5z0/wP4tPirwLqt1ql3Po62t20DTJI0Tp+5ST+H/AH68a8U2Ohz3Es2la3JrYaTE4uLZlf8ARE8yvYfg/wCMrD4jaL4gj0qFz9gvI1lUJjBaNW/lXJfEawvrO+eNjoNvCzZSONo2vZP9tv4k/DNKEOT92FaftP3h5jbzPpd06Y/0a4/1kf8Azz/6aV7R4CvdQ8ceKjf3UyJpukwKJYx93znTap/4EDXi+oaf5w/evLL/AOQoq0vDWqvDHY20pmgtoNQtWuI43ERaJZB5ckntHGHz64qP4ZnA9X+JiRJCjD+J0auAXtXq3xesTbnaq7YhKENeaRW3TiuqmOZna1CZdNd4/wB55csUn/kWOukZN0M399Ef7lZmpaekOn3MmP8AlnJXRrdW+grcajcnba2gNxK3oKP4hkfOGn+A/Ef2ODz9GuvPh8nHyjt+Ndt8NfCmuaX4kklv9NmiiMQAmlUZ/nXczftD+H/+WMMpH/PTYcVEP2htOMmI9LuT/wAAr0bHFeCdzY8SfCvTvEfhO9tRBGiN5kz+ZHl8nvXgmk/s9XXhu4hvLbSJZrgcH95Xrkn7R9oreXHplwT7LSt+0NH/ANAa6/KvJ+o/9PD1J5gqhzi/DnVJvsfnWExMMsR+96V6vY215YLbyR27b4pVlP8AwCuL/wCF/SN/q9Duj/wEVWf9oS4lb914fuGP0FdtOj7MwnX9oew/GqS58XeF7eSxgDyRh9sMn3t7DFfNS/Cjxaw+XTnx/tGHP8q7L/hf+ptHmPw9dn6qKsR/HrVgv/IuXA/3elYxpzgEpwPIpPGWutNFnVrr/vof4VVPibWv+gvef99j/CiivTPCuwPibV+v9p3P/fdTWd/e3n+uv7l/rJRRWUijp/hXfXM3xG0RHnkZQ902M/8ATldV6J8DbWO4XxRvXP8Ao1sv4b5B/QUUV4mL+M9rB/w0UfG3hqx0a1U26N80uTvbNczAg8+D60UVwnb1NbYMRU3RbGHVvHWmQXS+bH5k/B/3Q386KKzqAcr8StBstL8UPJbwhGe3y1ckl7NYzjyZCtFFaCO10e8lu7g+Yc8f0rYsYEtcCMY5oorensQd1N4P07xRpqWl+srwLPvCpIV5qNfgb4UjXLW1xMf+mty7f1oor18OcNQ2YPhpouqeG9Ls75bi9gsyBF505J445Peq6fBvwosqMNO5Tp85oopHOKvwY8IrGQNJjx+77nt0pn/CpfCxXH9lxY+lFFAFj/hUPhXH/IKi/IVIfhP4V/6BEH/fIoorqLPQvg34N0fw7H4hXTbKOzFwlsZfKGN+PNxmuV+JXgjStFmF5YwfZpJXbesaqFbPqMUUV5//AC8O6n8B58tjD97bzjNc00CM0tsR+6ni+cetFFc1QiB9AeKLl9X+GWialc/Nd3Gm287sOBuMec1wP2dNw4oorrpGsyLXPl0HUCOotpT+ldbYWMN8USZA6yAls96KK1MiwvhbSd3/ACD7f/vgVNH4Z0qCNylhAp/3BRRXUjkJP7DsP+fSL/vkU7+x7H/n0h/74FFFA0JJpNlu/wCPSH+D+AVJ/Ztpuz9miz/u0UUGqH/YbX/n2i/75qRbK32j9xH/AN80UVx3Yj//2Q==)

Problem 02:

1. Loading and showing image:

#%%

#importing cv2

import cv2

# Using cv2.imread() method

img = cv2.imread('1\_4.bmp')

# Displaying the image using cv2.imshow()

cv2.imshow('Lena\_Image', img)

#Maintain output window until user presses a key

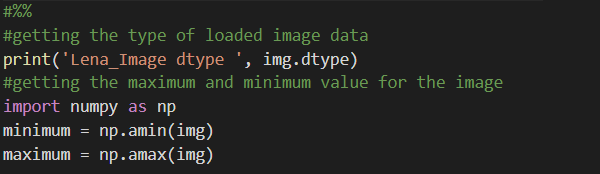
cv2.waitKey(0)

cv2.destroyAllWindows()

A screen shot of a person

Description automatically generated

b.



**Output:** Lena\_Image dtype uint8 (the range of pixel is unsigned 8-bit integer for this image)

Minimum = 0

Maximum = 255

c.

#converting data to double type

print(img.astype(np.float))

Output:

[[[126. 126. 126.]

[152. 152. 152.]

[171. 171. 171.]

...

[162. 162. 162.]

[163. 163. 163.]

[164. 164. 164.]]

[[124. 124. 124.]

[155. 155. 155.]

[176. 176. 176.]

...

[163. 163. 163.]

[164. 164. 164.]

[164. 164. 164.]]

[[121. 121. 121.]

[154. 154. 154.]

[175. 175. 175.]

...

[163. 163. 163.]

[164. 164. 164.]

[165. 165. 165.]]

...

[[ 94. 94. 94.]

[ 96. 96. 96.]

[ 96. 96. 96.]

...

[ 30. 30. 30.]

[ 26. 26. 26.]

[ 23. 23. 23.]]

[[103. 103. 103.]

[ 99. 99. 99.]

[ 96. 96. 96.]

...

[ 31. 31. 31.]

[ 26. 26. 26.]

[ 22. 22. 22.]]

[[104. 104. 104.]

[ 96. 96. 96.]

[ 93. 93. 93.]

...

[ 32. 32. 32.]

[ 26. 26. 26.]

[ 22. 22. 22.]]]

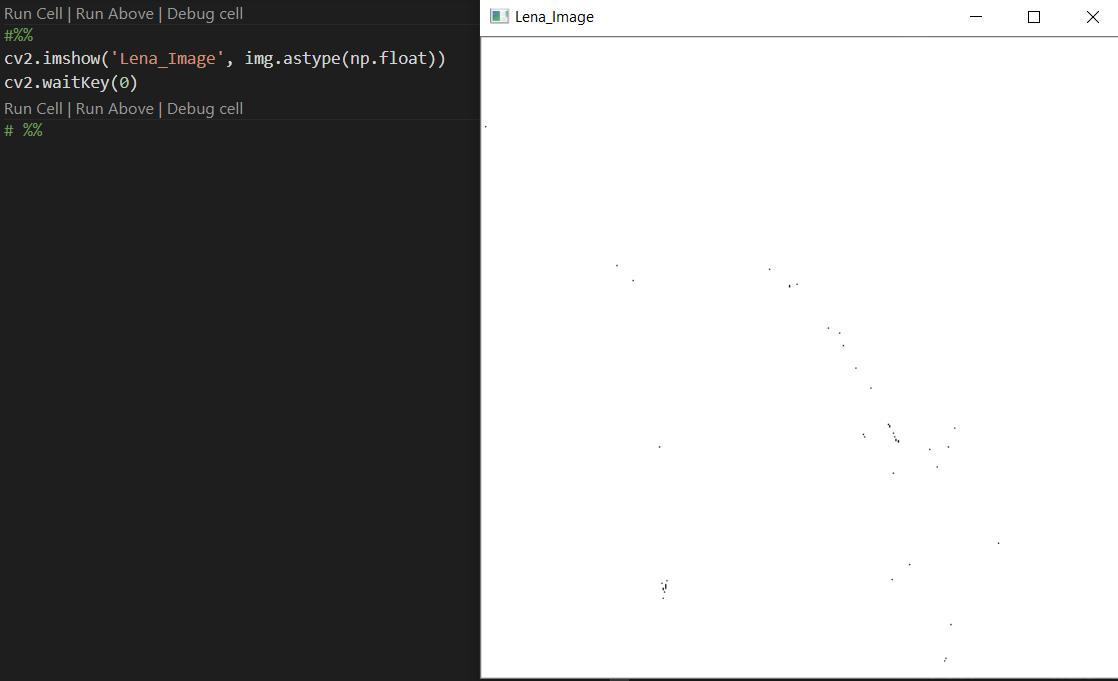
#%%

cv2.imshow('Lena\_Image', img.astype(np.float))

cv2.destroyAllWindows()

cv2.waitKey(0)

Floating-point images are assumed to contain values between 0 and 1 the. Therefore, double image displays those colors as black and white.



d. Showing double type image

#%%

import cv2

#show double type image

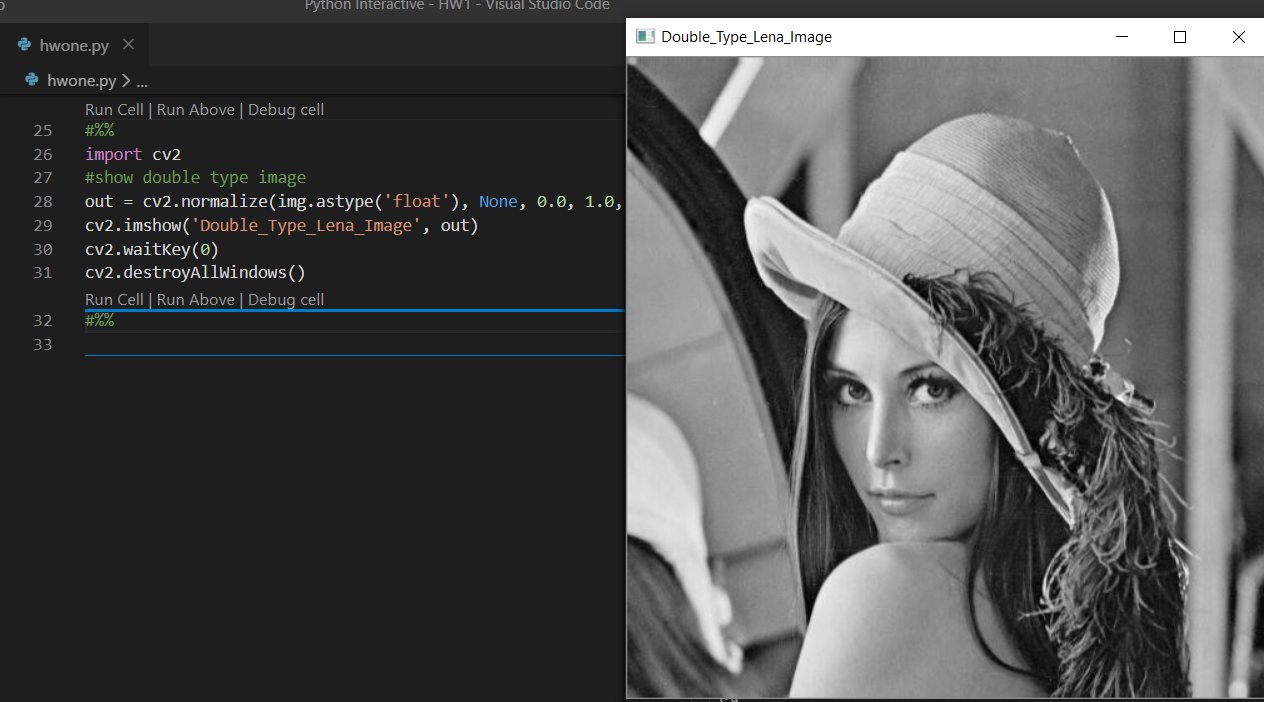
#convert to normalized floating point

out = cv2.normalize(img.astype('float'), None, 0.0, 1.0, cv2.NORM\_MINMAX)

cv2.imshow('Double\_Type\_Lena\_Image', out)

cv2.waitKey(0)

cv2.destroyAllWindows()



In order to show the double type image, we need to find the minimum (0.0) and maximum (1.0) of the image and apply normalization.

Problem 3

a. Reading image and converting to grayscale:

#%%

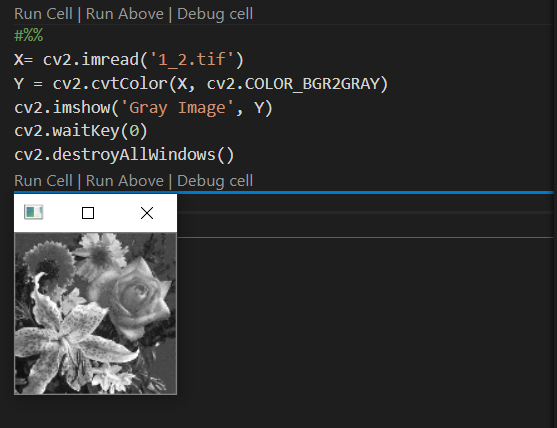
X= cv2.imread('1\_2.tif')

Y = cv2.cvtColor(X, cv2.COLOR\_BGR2GRAY)

cv2.imshow('Gray Image', Y)

cv2.waitKey(0)

cv2.destroyAllWindows()



b. Rotating “Y” 120 degrees clockwise to generate image “Z0”.

#%%

#find out height and width of image

(height, width) = Y.shape[:2]

# calculate center of image

center = (height/2, width/2)

scale= 1.0

angle = -120 #clockwise (negative)

M = cv2.getRotationMatrix2D(center, angle, scale)

Z0 = cv2.warpAffine(Y, M, (height, width))

cv2.imshow('Rotated Image', Z0)

cv2.waitKey(0)

cv2.destroyAllWindows()

A close up of a flower

Description automatically generated

c. Rotate “Y” 10 degrees 12 times to generate image “Z1”.

Screen of a cell phone

Description automatically generated

d. Yes there are differences between Z0 and Z1.

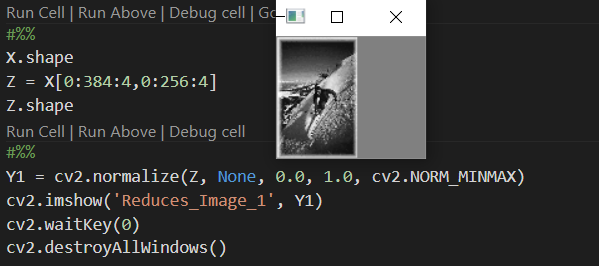
e. script and pictures are attached.

Problem 04:

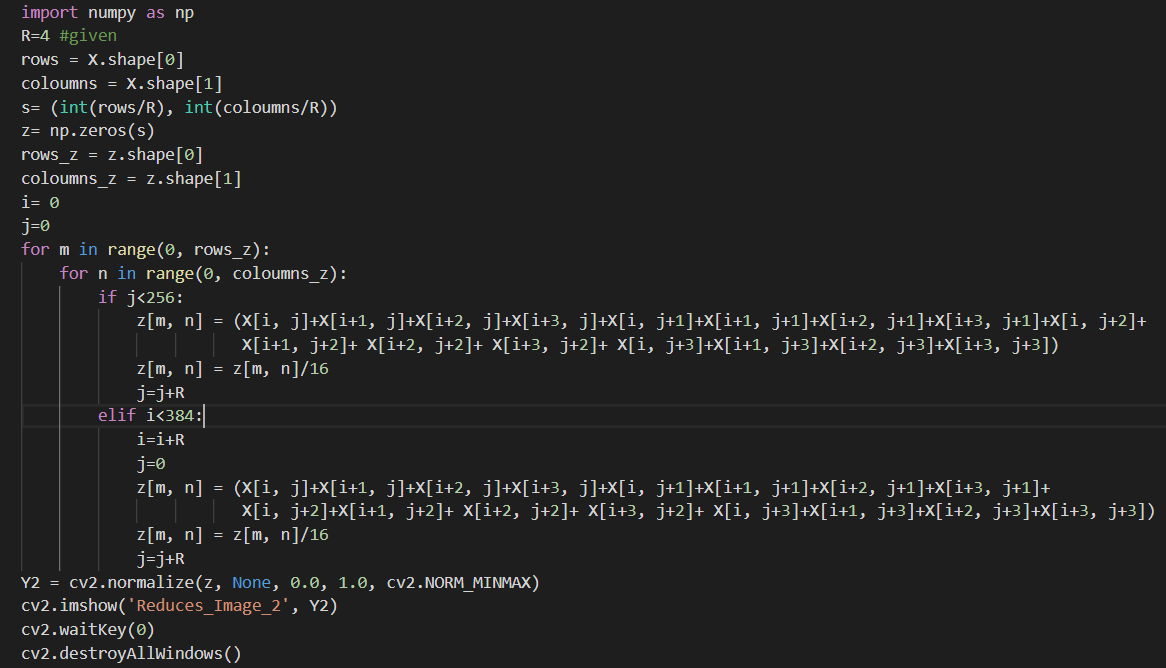
Displaying image



a. reducing the resolution by keeping one pixel out of every 4x4 pixel area



b. reducing the resolution by replacing every 4x4 pixel area in **1\_3.asc** by the average value of the pixel values in that region.



Result:



Problem b:

1. Pixel repeating:

#%%

#enlarging image size by repeating technique

import numpy as np

R=4 #given

r = Z.shape[0]

c = Z.shape[1]

t= (int(r\*R), int(c\*R))

z1= np.zeros(t)

rows\_z1 = z1.shape[0]

coloumns\_z1 = z1.shape[1]

i= 0

j=0

for m in range(0, r):

    for n in range(0, c):

        if j<256:

            z1[i, j] = Z[m,n]

            z1[i+1, j] = Z[m,n]

            z1[i+2, j] = Z[m,n]

            z1[i+3, j] = Z[m,n]

            z1[i, j+1] = Z[m,n]

            z1[i+1, j+1] = Z[m,n]

            z1[i+2, j+1] = Z[m,n]

            z1[i+3, j+1] = Z[m,n]

            z1[i, j+2]= Z[m,n]

            z1[i+1, j+2]=Z[m,n]

            z1[i+2, j+2]= Z[m,n]

            z1[i+3, j+2]= Z[m,n]

            z1[i, j+3]= Z[m,n]

            z1[i+1, j+3]=Z[m,n]

            z1[i+2, j+3]= Z[m,n]

            z1[i+3, j+3]= Z[m,n]

            j= j+R

        elif i<384:

            i=i+R

            j=0

            z1[i, j] =Z[m,n]

            z1[i+1, j] = Z[m,n]

            z1[i+2, j] = Z[m,n]

            z1[i+3, j] = Z[m,n]

            z1[i, j+1] = Z[m,n]

            z1[i+1, j+1] = Z[m,n]

            z1[i+2, j+1] = Z[m,n]

            z1[i+3, j+1] = Z[m,n]

            z1[i, j+2]= Z[m,n]

            z1[i+1, j+2]= Z[m,n]

            z1[i+2, j+2]= Z[m,n]

            z1[i+3, j+2]= Z[m,n]

            z1[i, j+3]=Z[m,n]

            z1[i+1, j+3]= Z[m,n]

            z1[i+2, j+3]=Z[m,n]

            z1[i+3, j+3]= Z[m,n]

            j= j+R

E1 = cv2.normalize(z1, None, 0.0, 1.0, cv2.NORM\_MINMAX)

cv2.imshow('Enlarged\_Image\_1', E1)

cv2.waitKey(0)

cv2.destroyAllWindows()

Resulting Image:



2. Bilinear Interpolation:

#Bilinear Interpolation

from math import floor

def round\_down(num,mul):

    if num%mul==0:

        res = num-mul

    else:

        res = floor(num / mul)\* mul

    return res

R= 4

rows\_Z = Z.shape[0]

coloumns\_Z = Z.shape[1]

o= (int(rows\_Z\*R), int(coloumns\_Z\*R))

new\_Z= np.zeros(o)

rows\_newZ = new\_Z.shape[0]

coloumns\_newZ = new\_Z.shape[1]

i= 0

j=0

#making 4 point boundaries

for m in range(0,rows\_Z):

    for n in range(0, coloumns\_Z):

        if j<256:

            new\_Z[i, j] = Z[m, n]

            j = j+4

        elif i<384:

            i = i+R

            j=0

            new\_Z[i, j] = Z[m, n]

            j= j+R

#calculating points from boundaries

for r in range(0, (((rows\_Z-1)\*R)+1)):

    for s in range(0,(((coloumns\_Z-1)\*R)+1) ):

        if new\_Z[r, s]== 0:

            ax= round\_down(r, R)

            ay= round\_down(s, R)

            bx= ax

            by= ay+R

            cx= bx+R

            cy= by

            dx= cx

            dy= cy-R

            minx= min(ax, bx, cx, dx)

            maxx= max(ax, bx, cx, dx)

            miny= min(ay, by, cy, dy)

            maxy= max(ay, by, cy, dy)

            originalx= r

            originaly= s

            normalizedx=(originalx-minx)/(maxx-minx)

            normalizedy=(originaly-miny)/(maxy-miny)

            new\_Z[r, s] = (new\_Z[bx, by]-new\_Z[ax, ay])\*normalizedx + (new\_Z[dx, dy]-new\_Z[ax, ay])\*normalizedy + ((new\_Z[ax, ay]-new\_Z[bx, by]-new\_Z[dx, dy]+new\_Z[ax, ay])\*normalizedx\*normalizedy)+ new\_Z[ax, ay]

#taking care of points outside grid

for u in range (0, rows\_newZ):

    for v in range ((((coloumns\_Z-1)\*R)+1), coloumns\_newZ):

        new\_Z[u, v]=new\_Z[u, ((coloumns\_Z-1)\*R)]

for p in range ((((rows\_Z-1)\*R)+1), rows\_newZ):

    for q in range (0, coloumns\_newZ):

        new\_Z[p, q]=new\_Z[((rows\_Z-1)\*R), q]

#%%

E2 = cv2.normalize(new\_Z, None, 0.0, 1.0, cv2.NORM\_MINMAX)

cv2.imshow('Enlarged\_Image\_2', E2)

cv2.waitKey(0)

cv2.destroyAllWindows()

Resulting Image:



3. Bilinear interpolation gives better result than pixel repeating. Where pixel repetition creates blocky image with distorted artifact in some places, binomial interpolation gives smoother result than this technique.