



ERCIM "ALAIN
BENSOUSSAN" FELLOWSHIP
PROGRAMME



Scientific Report

First name / Family name

Kishorkumar Upla

Nationality

Indian

Name of the *Host Organisation*

NTNU, Gjøvik, Norway

First Name / family name
of the *Scientific Coordinator*

Raghavendra Ramachandra

Period of the fellowship

01/11/2019 to 31/10/2020

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

Face recognition (FR) system is a basically computerised algorithm which enables identification and/or verification of face from a digital image or from a video data. It is very popular and most active area of research as it received importance in many practical or real world applications. The most important application of FR is in video surveillance for security applications which demands accurate face recognition as time progresses. It is also very challenging due to variations of the faces with different poses, unique expression of faces, facial occlusions and also with the low resolution (LR) nature of acquired data. The nature of low resolution comes since data is normally acquired from a distance and it also depends on the different environmental conditions. The research of FR for low resolution images has great scope as it is more practical scenario in almost all data acquisition devices. During one year stay at NTNU, Gjøvik as ERCIM fellow, I have done research on the topic of low resolution face recognition and its related applications.

Many FR approaches consists pre-processing of data including super-resolution of LR image in order to increase its accuracy. Super-resolution (SR) is an algorithmic technique to increase the spatial resolution of the given LR observation. Literature shows that the SR using machine learning algorithms outperform than the existing traditional methods.

In machine learning, specifically convolutional neural networks (CNNs) obtain breakthrough results in the SR task. CNN has ability to learn abstract representation of input image. During this fellowship duration, I worked on SR of face image with the focus to improve the FR accuracy. In this directions, we proposed to apply solution based on compact CNN network which is capable to obtain SR of face image of size as small as 8x8 pixels for upscaling factor of 8. This work is extended for FR system with the motivation to increase its accuracy. Further, the idea of SR is also applied for thermal imagery which are very useful for surveillance applications during night-time. During my stay as an ERCIM fellow, I have published five conferences papers, participated in two challenges and also written two journal papers which are currently under reviewed. Further, our work has been recognised as a winner of the Perception Beyond the Visible Spectrum (PBVS) challenge and also received best paper award in the PBVS workshop of CVPR-2020 conference. Our future directions focus in designing generative adversarial network (GAN) which has an ability to generate visually appealing solutions. In GAN, discriminator network forces the generator network to produce the perceptually visible solutions. Use of GAN in order to obtain SR image allows to extract more features from the LR image which results in accurate FR algorithm.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Journal Papers:

- Vishal Chudasama, Kartik Nighania, Kishor Upla, Kiran Raja, Raghavendra Ramachandra, Christoph Busch, "E-ComSupResNet: Enhanced Face Super-Resolution Through Compact Network", Special Issue in IEEE Transactions on Biometrics, Behavior, and Identity (IEEE TBIOM), 2020 **(Under Review Submitted on July 2020)**
- 2. Vishal Chudasama, Kartik Nighania, Kishor Upla, Kiran Raja, Raghavendra Ramachandra, Christoph Busch, "Compact and Progressive Network for Enhanced Single Image Super-Resolution-ComPrSRNet", ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM), August, 2020 **(Under Review Submitted on July 2020)**

Conference Papers:

- Chudasama, Vishal, Heena Patel, Kalpesh Prajapati, Kishor P. Upla, Raghavendra Ramachandra, Kiran Raja, and Christoph Busch. "TherISuRNet - A Computationally Efficient Thermal Image Super-Resolution Network." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, pp. 86-87. 2020. **(Awarded as Best paper)**
- Rai, Aashish, Vishal Chudasama, Kishor Upla, Kiran Raja, Raghavendra Ramachandra, and Christoph Busch. "ComSupResNet: A Compact Super-Resolution Network for Low-Resolution Face Images." In 2020 8th International Workshop on Biometrics and Forensics (IWBF), pp. 1-6. IEEE, 2020.
- Prajapati, Kalpesh, Vishal Chudasama, Heena Patel, Kishor Upla, Raghavendra Ramachandra, Kiran Raja, and Christoph Busch. "Unsupervised single image super-resolution network (usisresnet) for real-world data using generative adversarial network." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, pp. 464-465. 2020.
- Kalpesh Prajapati, Vishal Chudasama, Heena Patel, Kishor Upla, Raghavendra Ramachandra, Kiran Raja, Christoph Busch. "Unsupervised Single Image Super-

Resolution using Cycle Generative Adversarial Network”, 3rd International Conference on Intelligent Technologies and Applications (INTAP), NTNU, Gjøvik, Norway, September 27-30, 2020.

- Kalpesh Prajapati, Vishal Chudasama, Heena Patel, Kishor Upla, Raghavendra Ramachandra, Kiran Raja, Christoph Busch. “Unsupervised Real-World Super-Resolution using Variational Autoencoder And Generative Adversarial Network” 25th International Conference on Pattern Recognition (ICPR) workshop **(Under Review)**

Challenge participation:

- Rivadeneira, Rafael E., Angel D. Sappa, Boris X. Vintimilla, Lin Guo, Jiankun Hou, Armin Mehri, Parichehr Behjati Ardakani et al. "Thermal Image Super-Resolution Challenge-PBVS 2020." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops, pp. 96-97. 2020 **(Winner of the Challenge—USD 500 Prize Money)**
- Lugmayr, Andreas, Martin Danelljan, and Radu Timofte. "Ntire 2020 challenge on real-world image super-resolution: Methods and results." In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops, pp. 494-495. 2020 **(14th, 18th and 19th Rank in Track-1 in this challenge).**

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

- Attended one day NBL workshop at NTNU, Gjøvik on 4th March, 2020.
- Attended and presented our work in IWBF 2020 virtually during 29-30th April, 2020.
- Attended and presented our works in CVPR-2020 during 14-20th June, 2020.
- Attended and presented our work in INTAP 2020 held at NTNU, Gjøvik during 28-30th, September, 2020.

IV – RESEARCH EXCHANGE PROGRAMME (REP)

- One week Research Exchange Programme (REP) at INESC TEC, Porto, Portugal during 1-5th October, 2020.
- One week Research Exchange Programme (REP) at IGD, Fraunhofer, Germany during 19-23rd, October, 2020.