

Supplementary Materials “Detection of Oscillations in Process Control Loops From Visual Image Space Using Deep Convolutional Networks”

Tao Wang , Qiming Chen , Xun Lang , Lei Xie , Peng Li , and Hongye Su , *Senior Member, IEEE*

S-I. Architectures of the Four Networks Selected

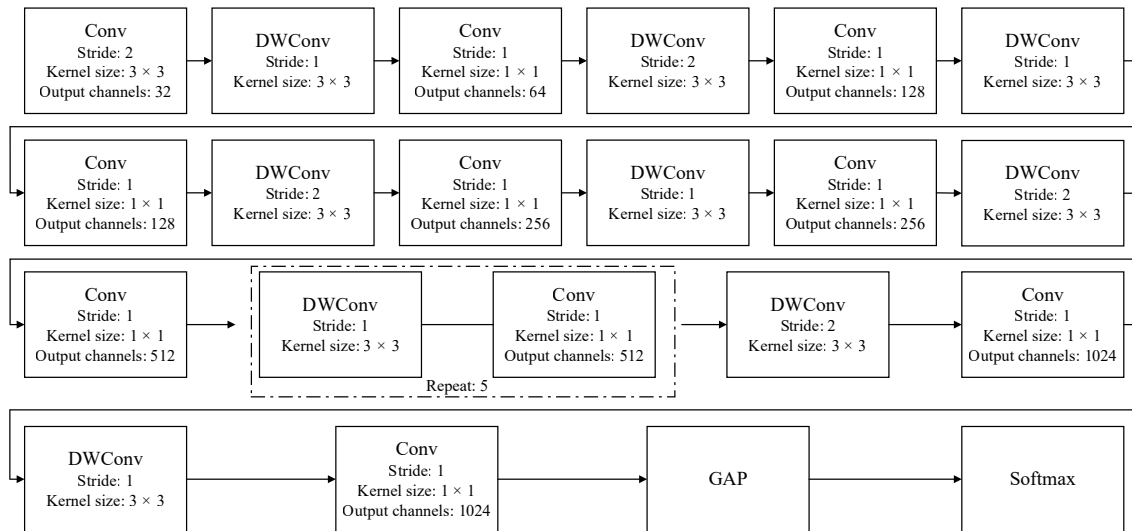


Fig. S-1. The overall architecture of MobileNet-V1.

Notice that each Conv or DWConv layer is sequentially followed by BN and ReLU processing.

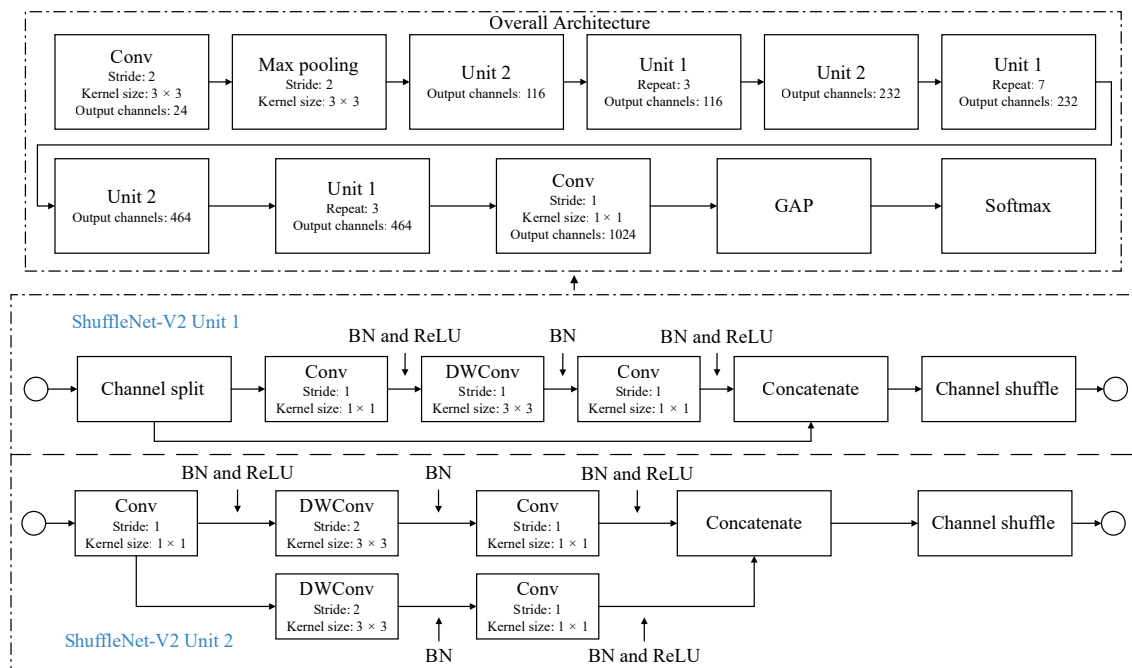


Fig. S-2. The overall architecture of ShuffleNet-V2.

Notice that the outputs of the first and last Conv layers are activated by ReLU.

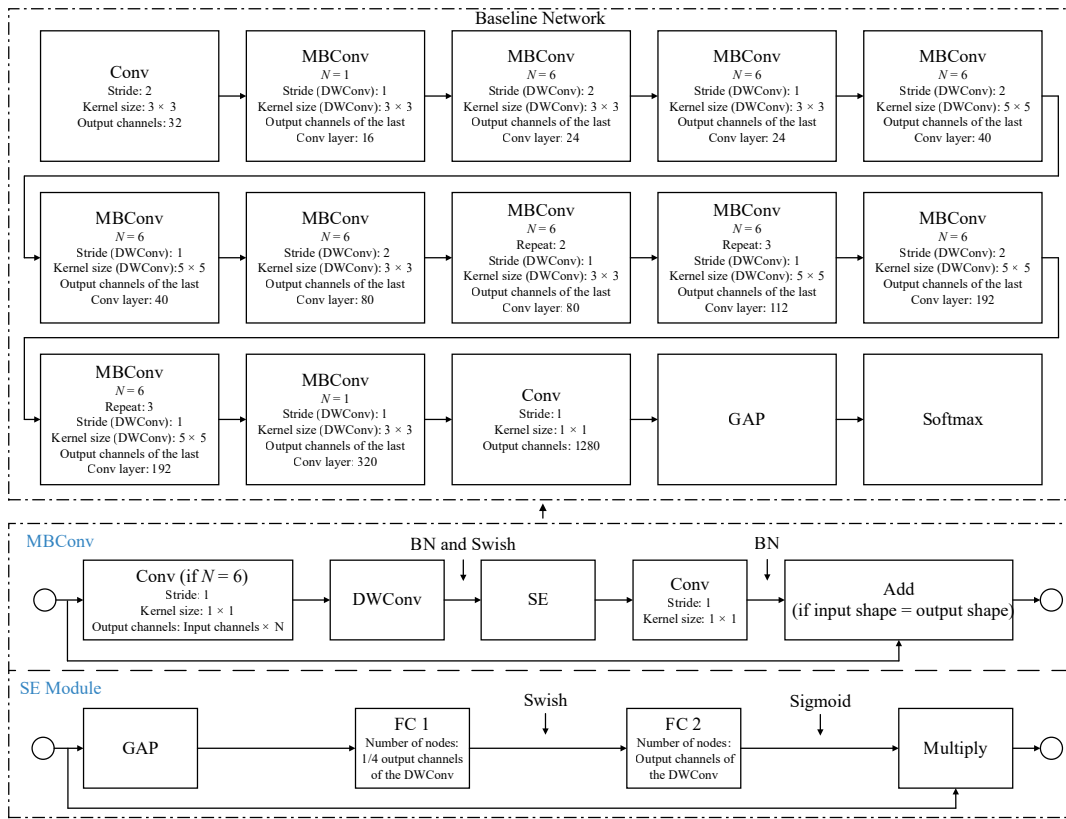


Fig. S-3. The architecture of EfficientNet-B0.

Notice that the outputs of the first and last Conv layers are processed by BN and Swish.

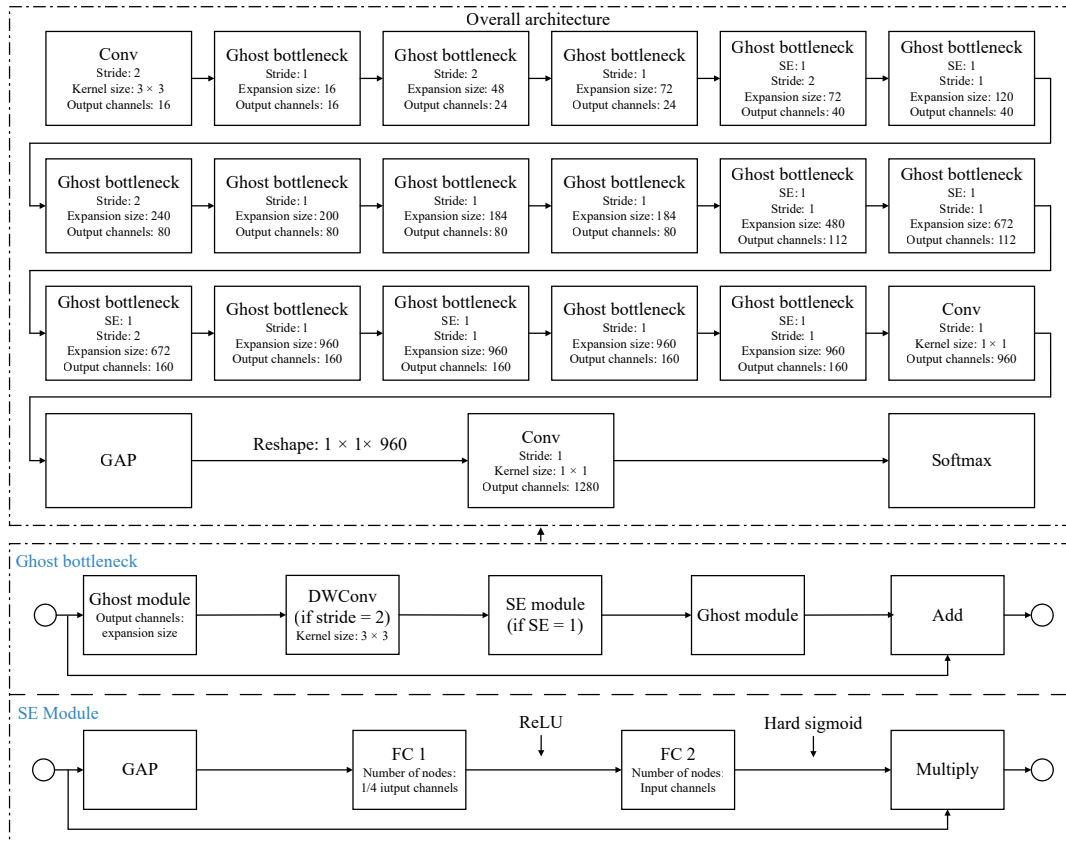


Fig. S-4. The overall architecture of GhostNet.

Notice that the outputs of the first Conv and penultimate Conv layers are processed by BN and ReLU.

Explanation of abbreviations:

Conv: standard convolution.

DWConv: depthwise convolution.

BN: batch normalization.

GAP: global average pooling layer.

FC: fully connected layer.

SE: Squeeze-and-Excitation block (a widely used attention mechanism).

S-II. Details of Labeled Loops in Industrial Datasets

TABLE S-1
LABELED LOOP DATA IN INDUSTRIAL DATASET

Loop names	Comments	Labels
BAS 1	No oscillation	#0
BAS 8	No oscillation	#0
CHEM 34	Disturbance (likely)	#0
CHEM 40	No clear oscillation (according to power spectrum)	#0
CHEM 45	No clear oscillation (according to power spectrum)	#0
CHEM 46	No clear oscillation (according to power spectrum)	#0
CHEM 47	No clear oscillation (according to power spectrum)	#0
CHEM 48	No clear oscillation (according to power spectrum)	#0
CHEM 52	No clear oscillation (according to power spectrum)	#0
CHEM 53	No clear oscillation	#0
CHEM 54	No clear oscillation	#0
CHEM 58	No clear oscillation (according to power spectrum)	#0
BAS 6	Stiction and tight tuning	#1
BAS 7	Stiction and tight tuning	#1
CHEM 1	Stiction	#1
CHEM 2	Stiction	#1
CHEM 4	Tuning problem	#1
CHEM 5	Stiction	#1
CHEM 10	Stiction	#1
CHEM 11	Stiction	#1
CHEM 12	Stiction	#1
CHEM 13	Faulty steam sensor; no stiction	#1
CHEM 14	Faulty steam sensor; no stiction	#1
CHEM 17	Faulty steam sensor; no stiction	#1
CHEM 18	Stiction (likely)	#1
CHEM 19	Stiction (likely)	#1
CHEM 20	Stiction (likely); multiple oscillations	#1
CHEM 22	Stiction (likely)	#1
CHEM 23	Stiction (likely)	#1
CHEM 24	Stiction (likely); multiple oscillations	#1
CHEM 25	Possible margin stability	#1
CHEM 26	Stiction (likely)	#1
CHEM 28	Stiction (likely)	#1
CHEM 29	Stiction	#1
CHEM 30	Stiction	#1
CHEM 32	Stiction (likely)	#1

TABLE S-1
 LABELED LOOP DATA IN INDUSTRIAL DATASET (CONTINUED)

Loop names	Comments	Labels
CHEM 35	Stiction (likely)	#1
CHEM 41	OP saturation	#1
CHEM 42	Outlier	#1
CHEM 43	–	#1
CHEM 49	–	#1
CHEM 50	–	#1
CHEM 51	–	#1
CHEM 67	–	#1
CHEM 69	–	#1
CHEM 75	–	#1
MET 1	External disturbance (likely)	#1
MIN 1	Stiction	#1
POW 1	Stiction	#1
POW 2	Stiction	#1
POW 3	No stiction	#1
POW 4	Stiction	#1
POW 5	No stiction	#1
PAP 1	Stiction	#1
PAP 2	Stiction	#1
PAP 3	Stiction	#1
PAP 4	Deadzone and tight tuning; no stiction	#1
PAP 5	Stiction	#1
PAP 6	No stiction	#1
PAP 8	No stiction	#1
PAP 9	No stiction	#1
PAP 10	–	#1
PAP 13	Stiction	#1