

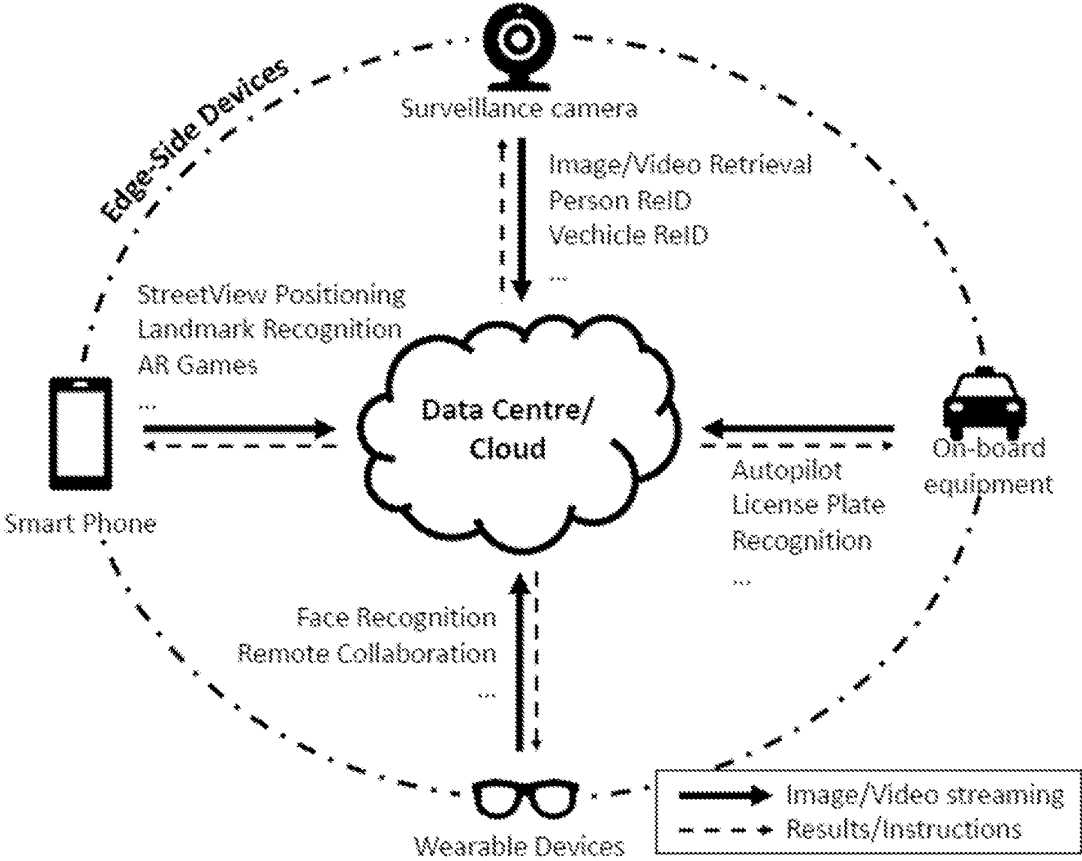


FIG. 1

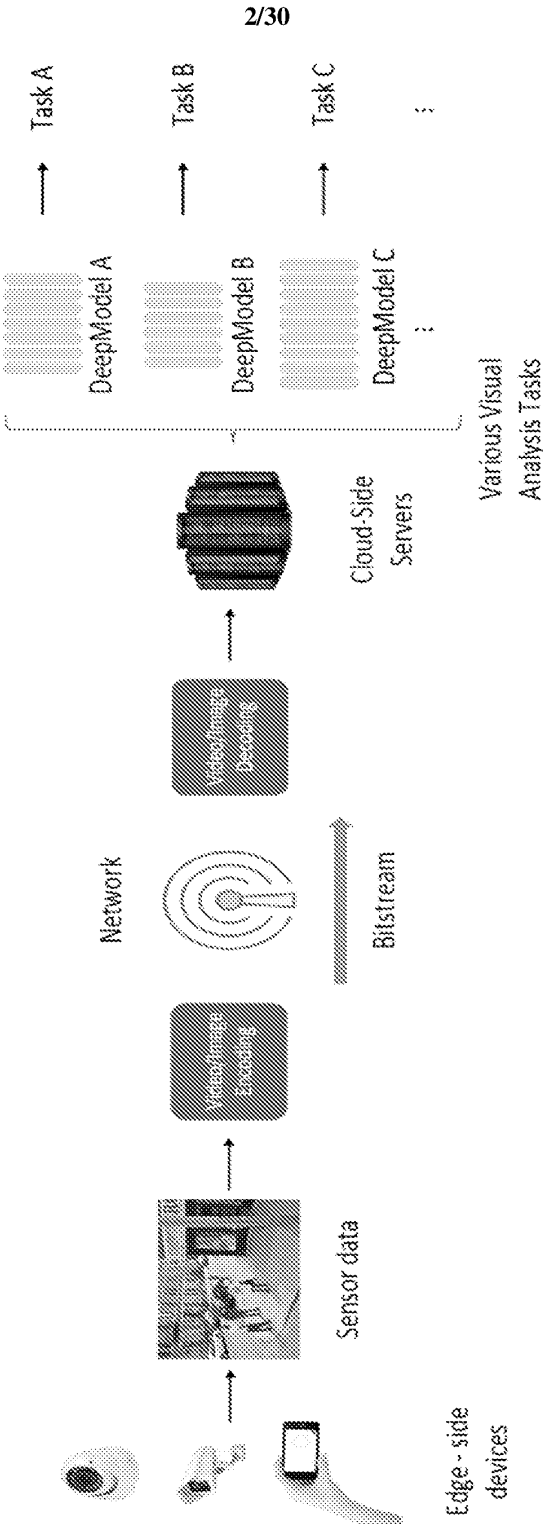


FIG. 2A

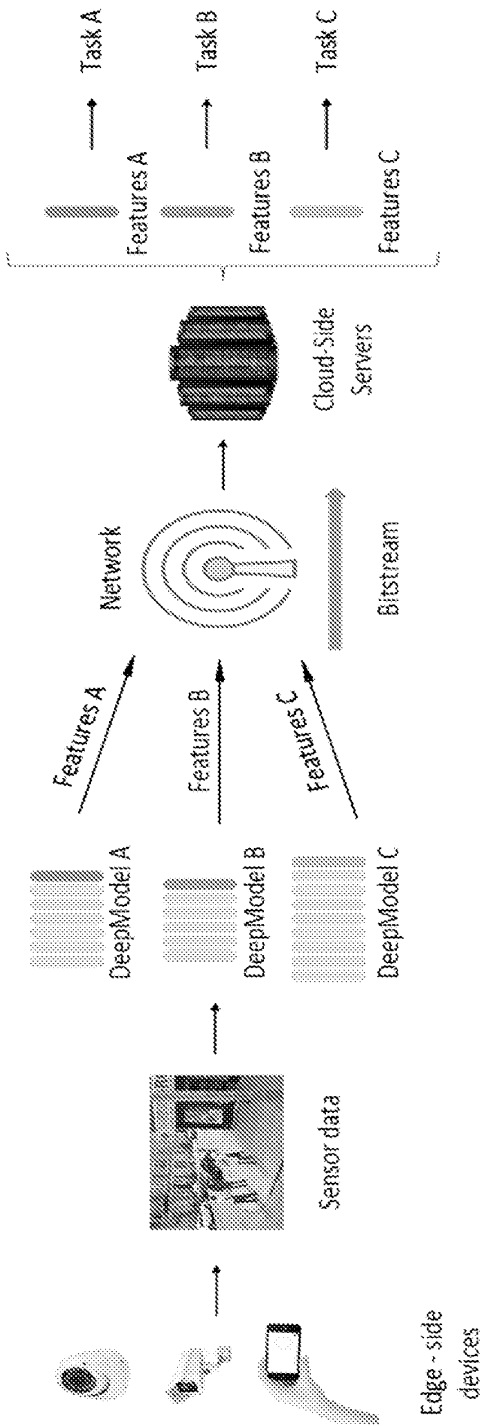
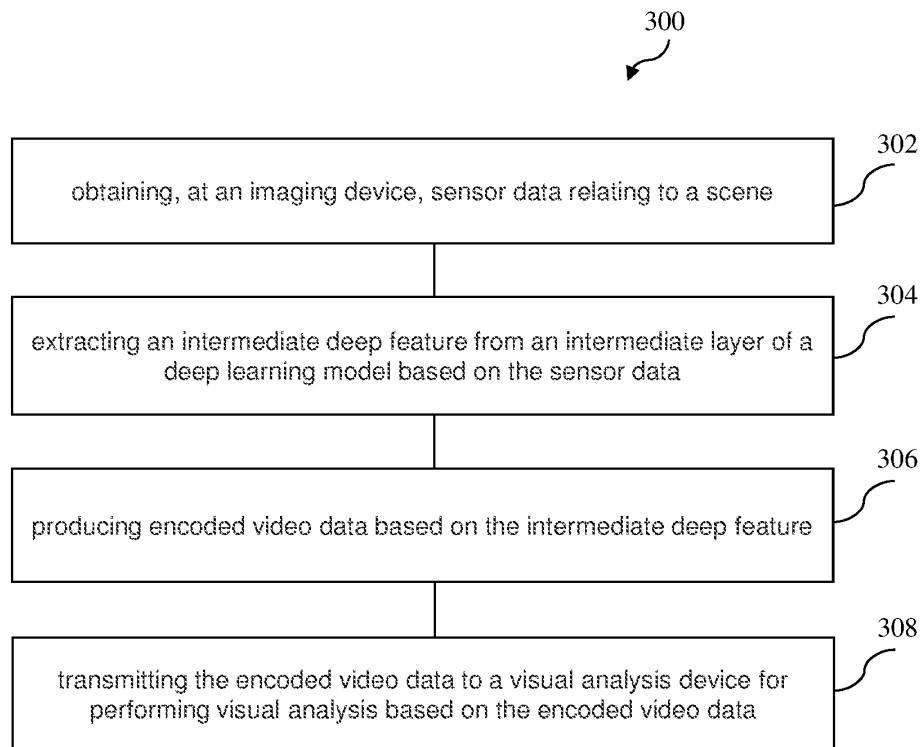
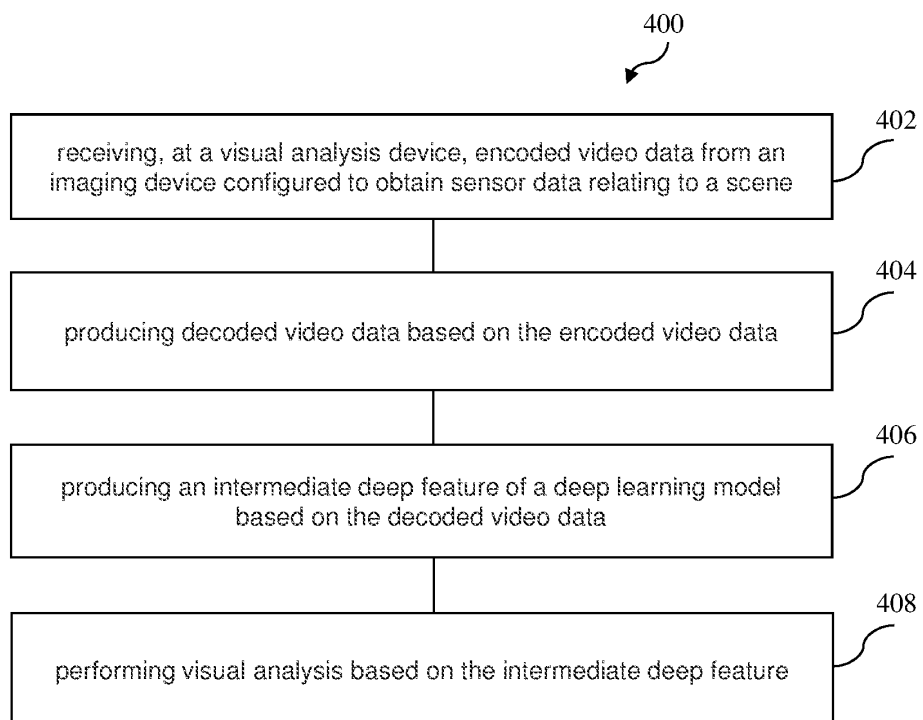


FIG. 2B

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**FIG. 3**

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**FIG. 4**

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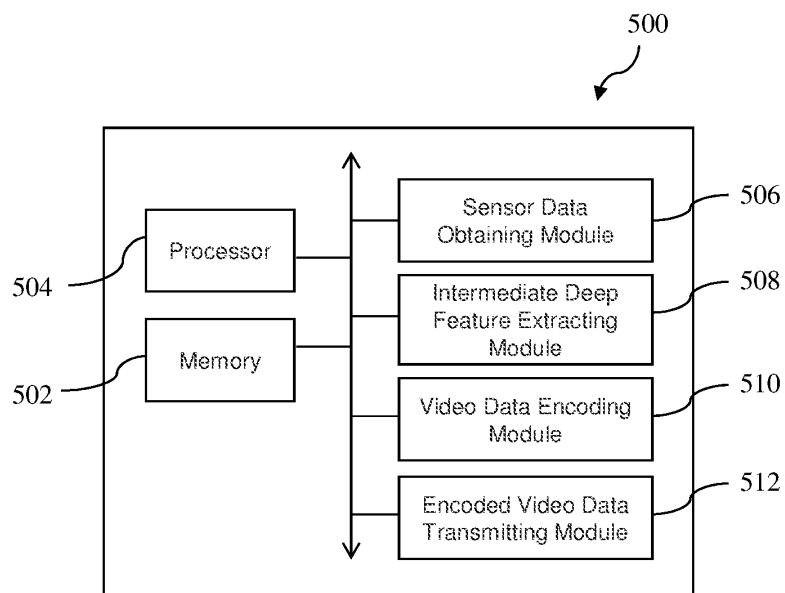


FIG. 5

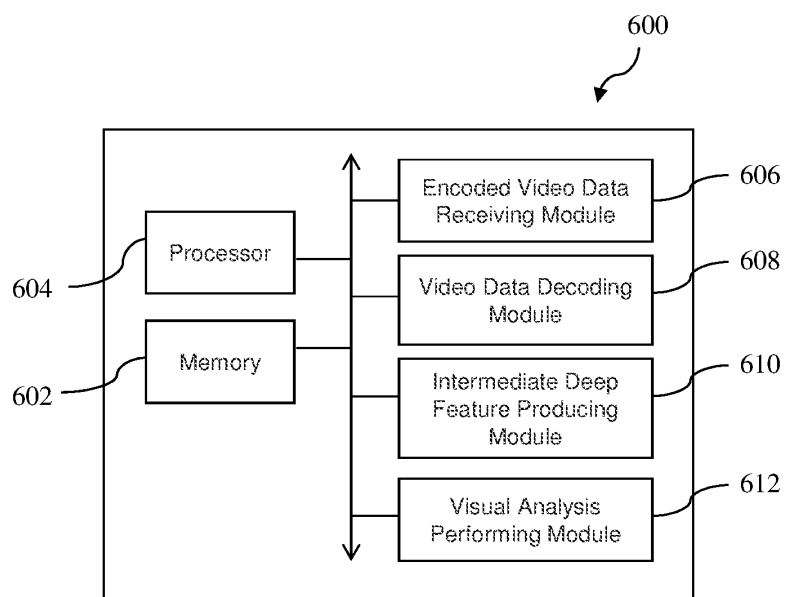


FIG. 6

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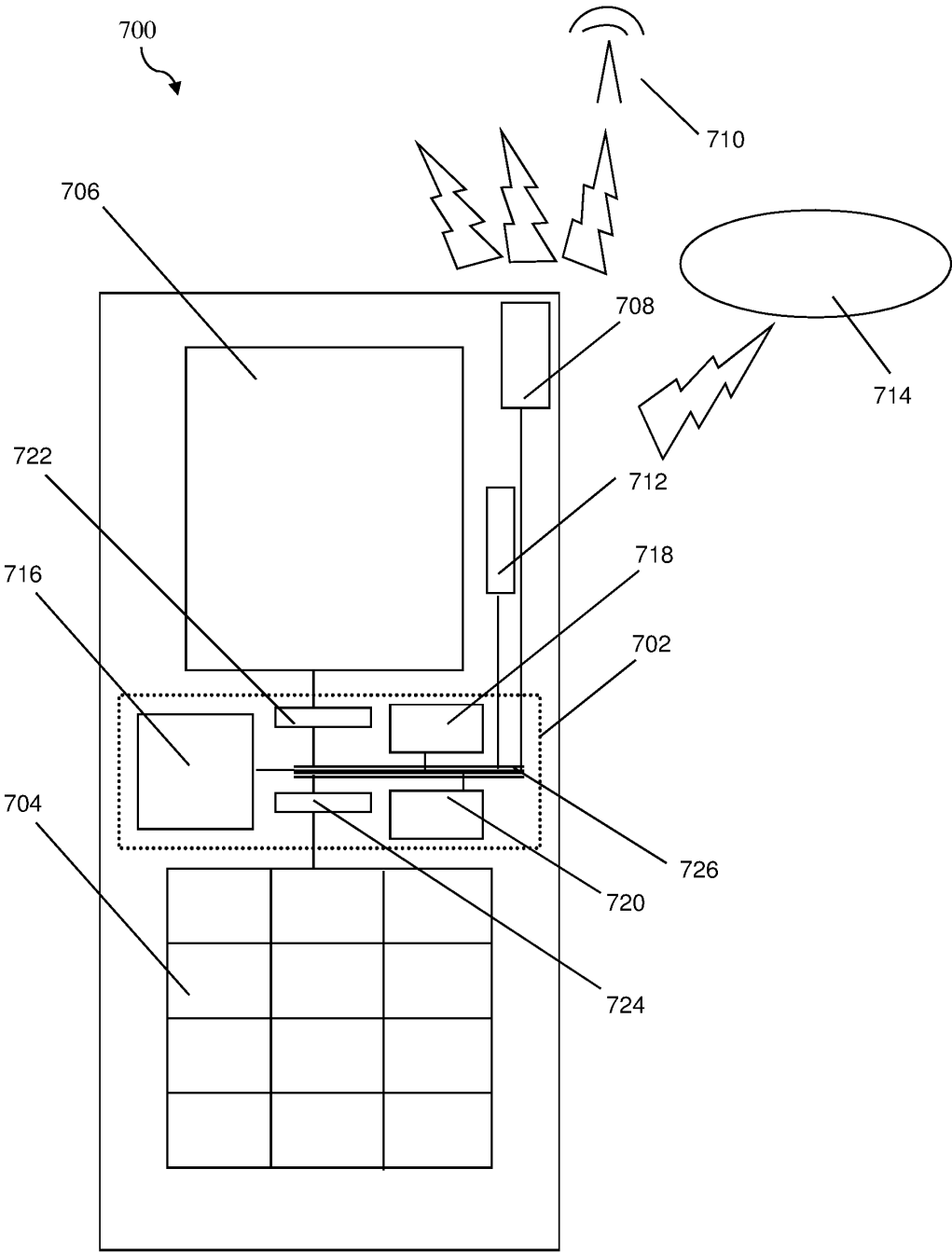


FIG. 7

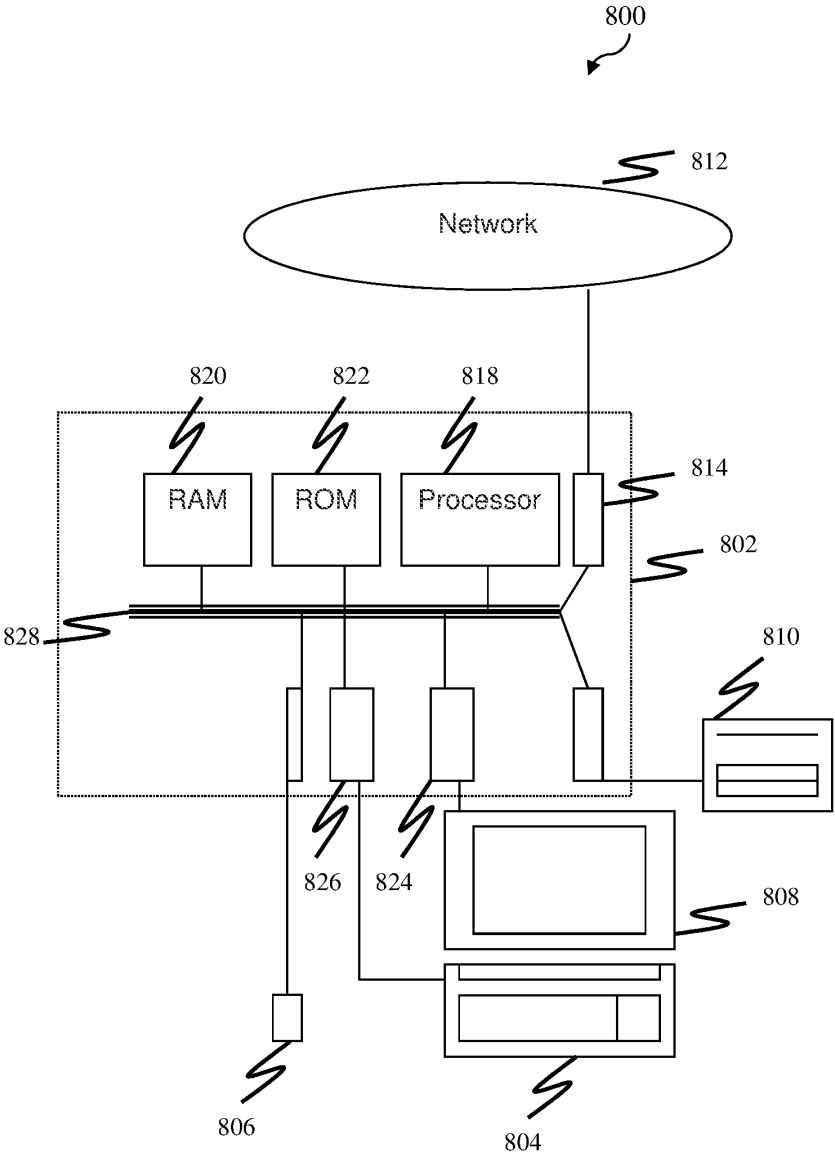


FIG. 8

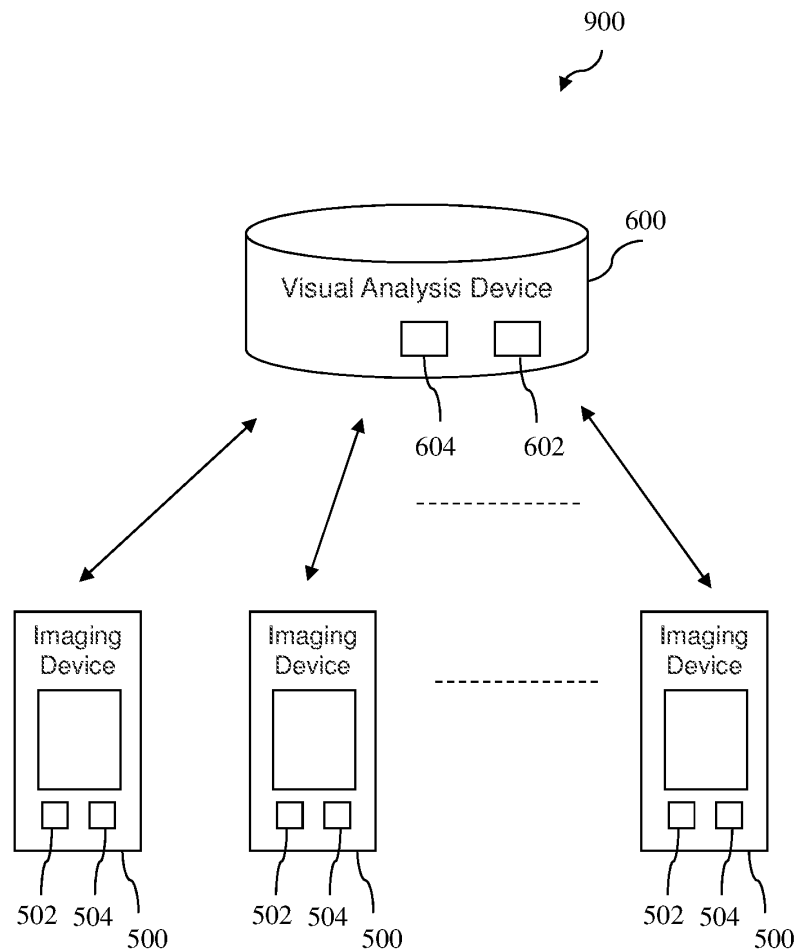


FIG. 9

Table 1: Comparison of three transmission strategies

	Transmit Video Signal	Transmit Intermediate Feature	Transmit Ultimate Feature
Load allocation	All the computing load is on cloud end	The computing load can be largely shifted to the front end	
Usability	The transmitted signal can be applied to various tasks		The transmitted feature can be only applied to few specific tasks
Privacy	Visual signal can easily expose privacy of users	It is difficult to unscramble features, especially when without corresponding models	
Research Status	Well explored and standardized (AVC, HEVC, VVC, etc.)	Research gap	Well explored and standardized (MPEG-CDVA, CDVS, etc.)

FIG. 10

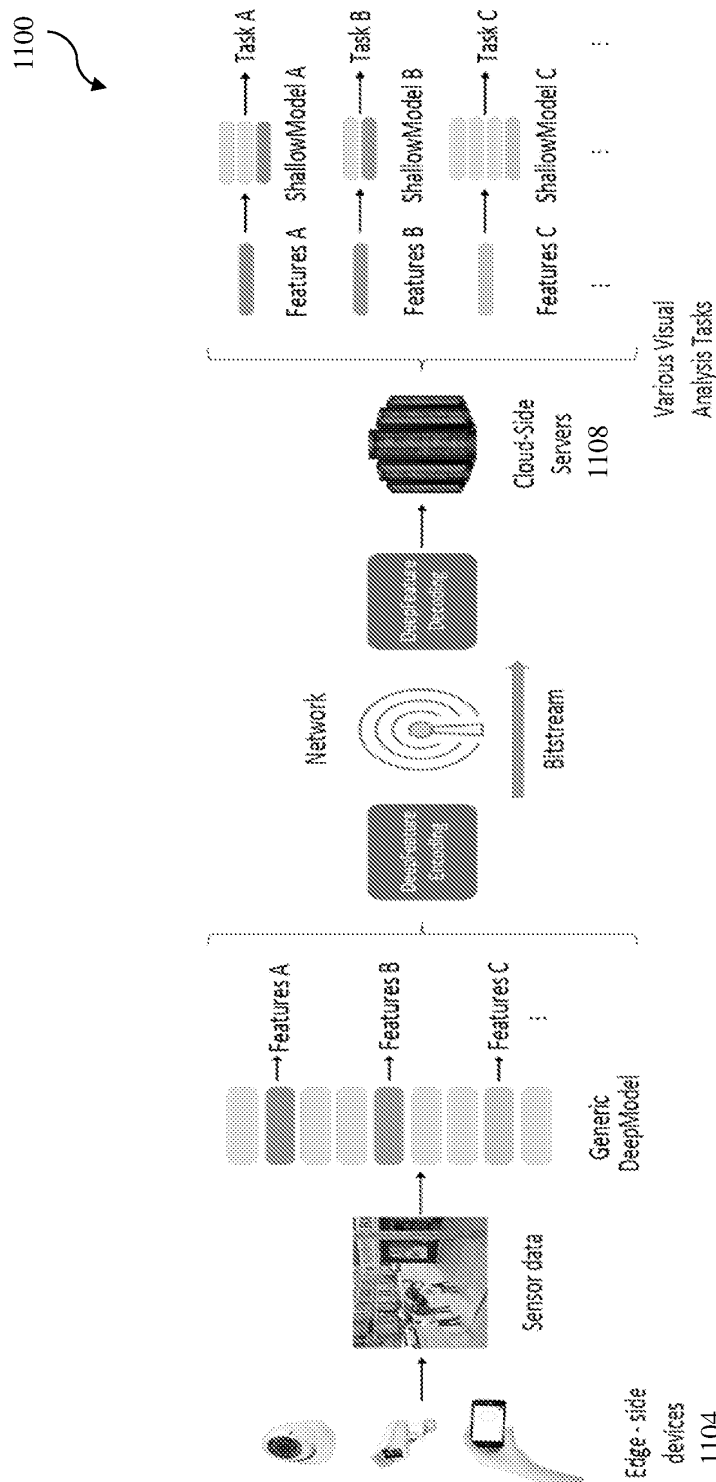


FIG. 11

	FLOPs		Usage
	VGGNet	ResNet	
<i>conv1</i> <i>pool1</i>	1.94G(12.5%)	0.12G(3.1%)	/
<i>conv2</i> <i>pool2</i>	2.77G(30.5%)	0.67G(20.4%) /	/
<i>conv3</i> <i>pool3</i>	4.62G(60.3%)	0.95G(45.0%) /	/
<i>conv4</i> <i>pool4</i>	4.62G(90.2%)	1.39G(81.0%) /	captioning, QA tracking
<i>conv5</i> <i>pool5</i>	1.39G(99.2%)	0.73G(99.9%)	captioning, QA tracking, detection, retrieval, QA
<i>fc</i>	0.12G(100%)	2.05M(100%)	detection, retrieval

FIG. 12

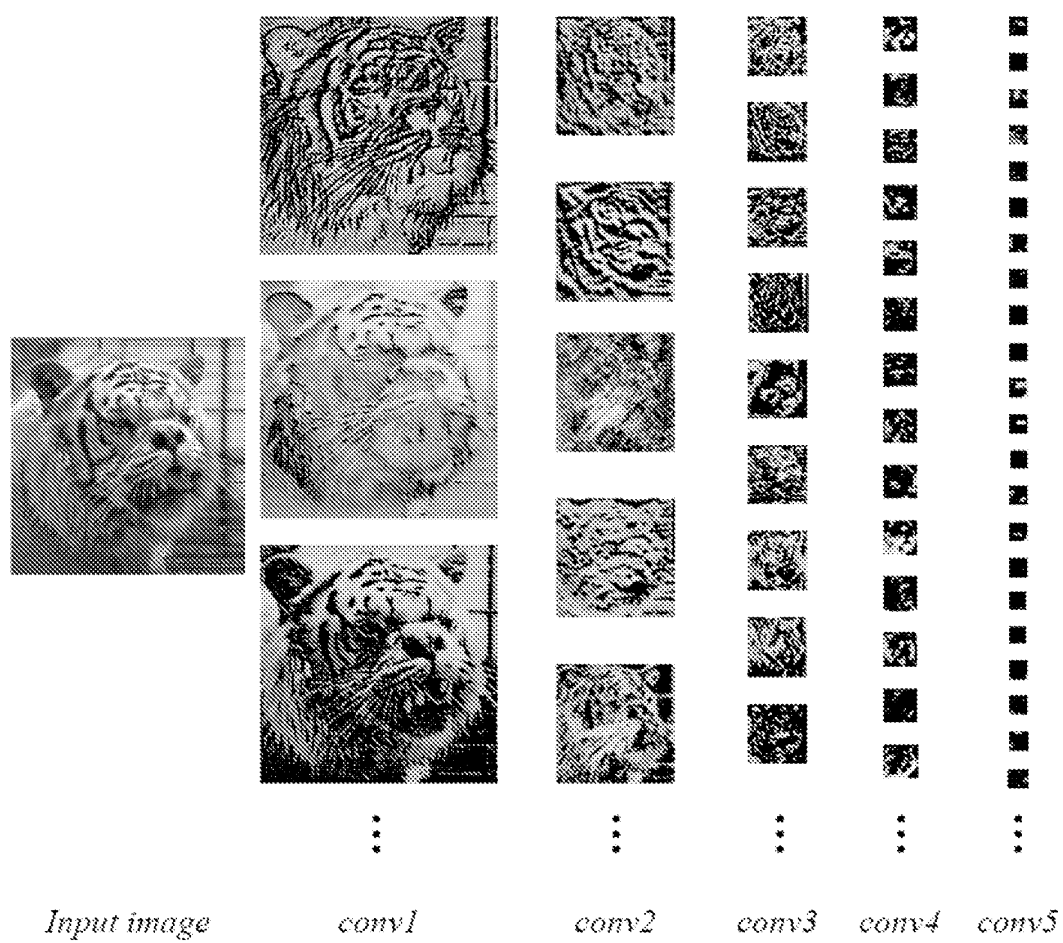


FIG. 13

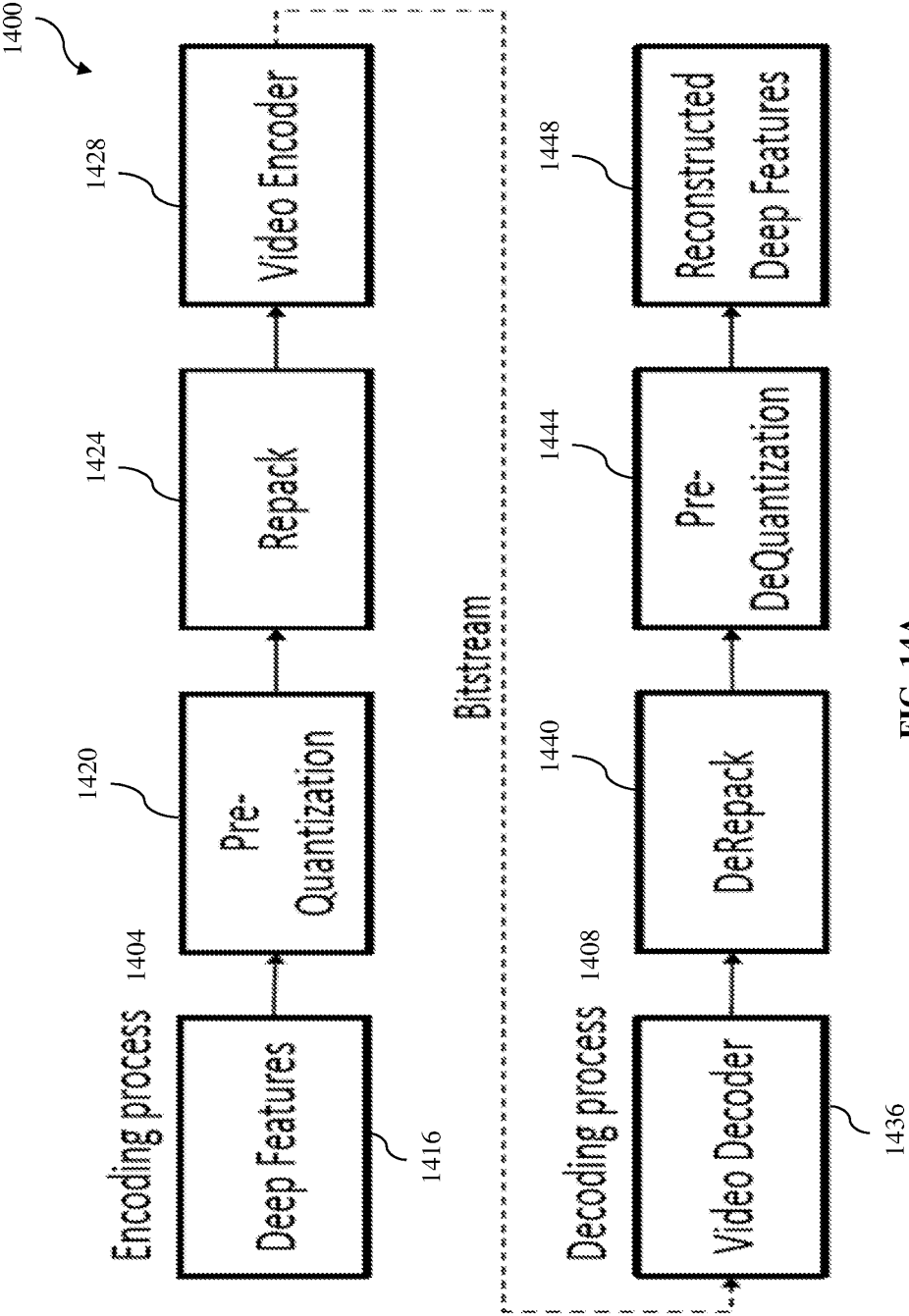


FIG. 14A

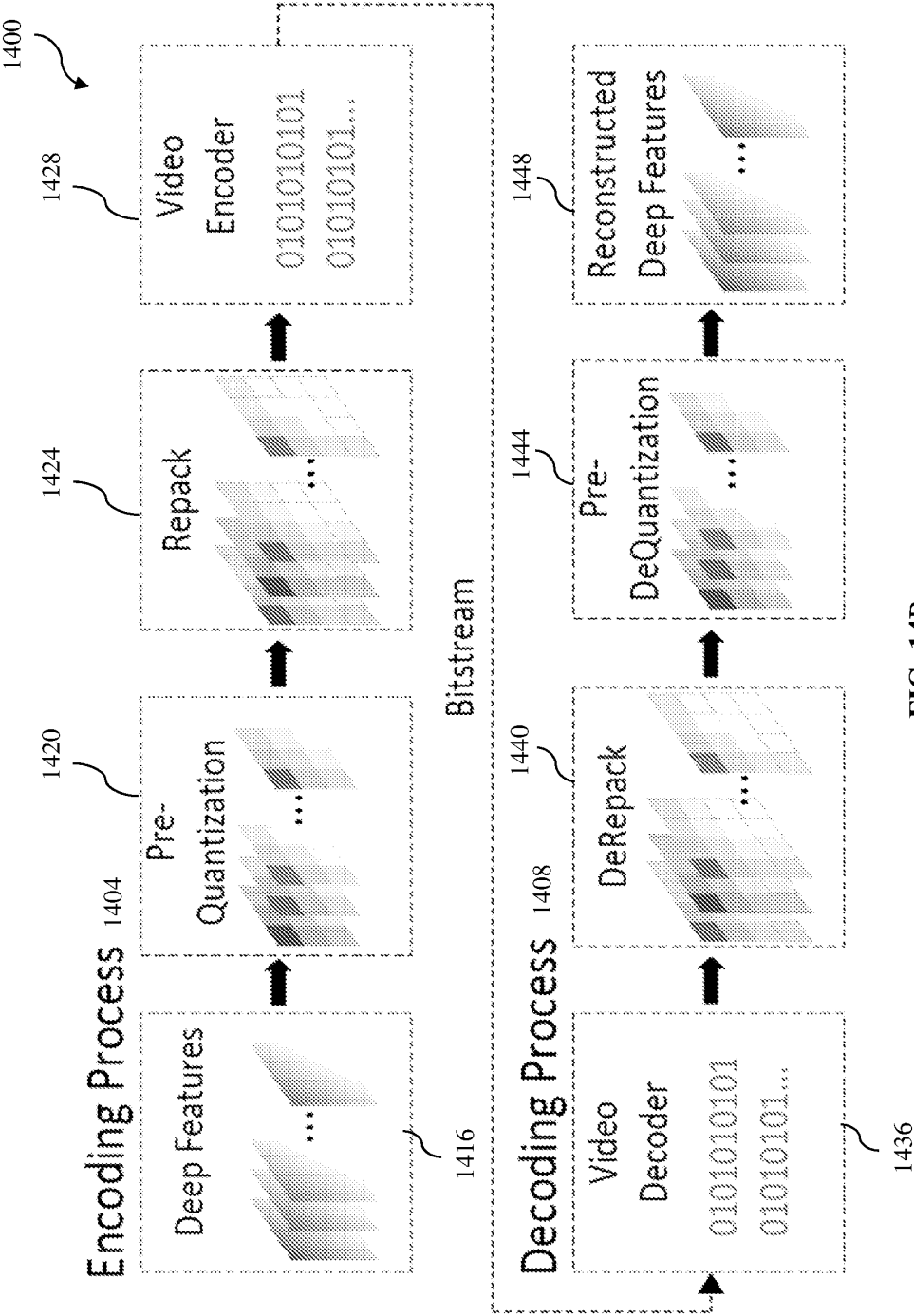


FIG. 14B

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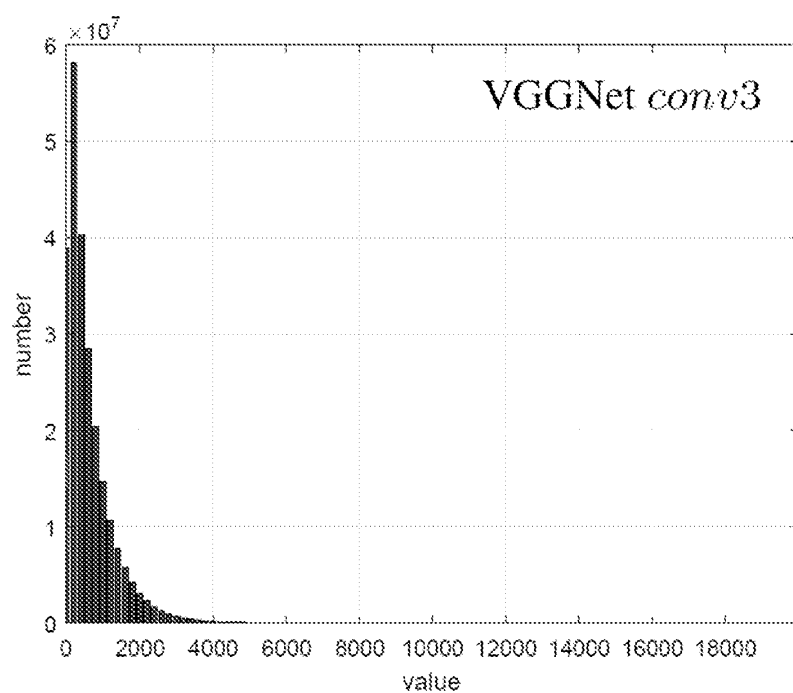


FIG. 15A

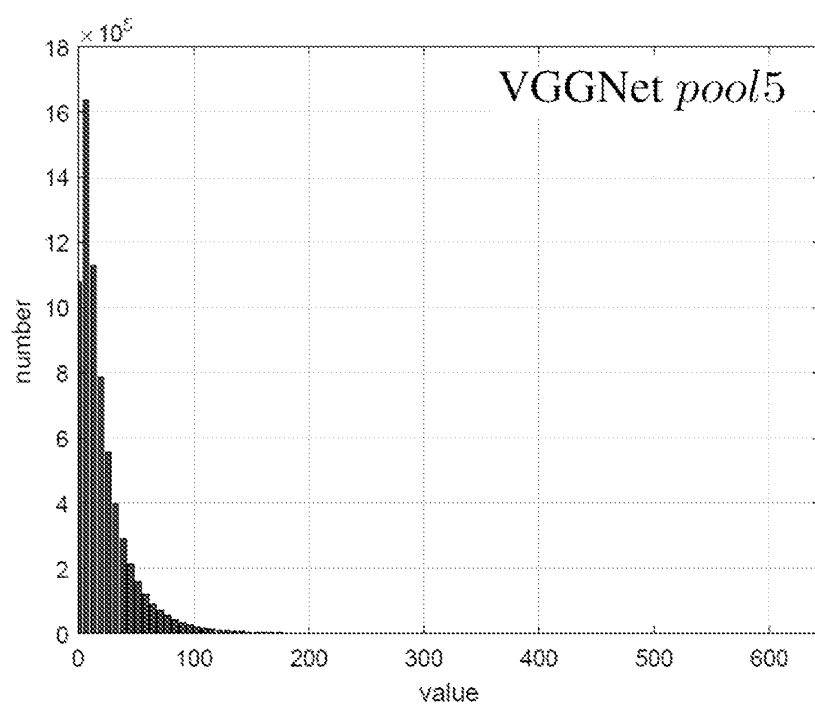


FIG. 15B

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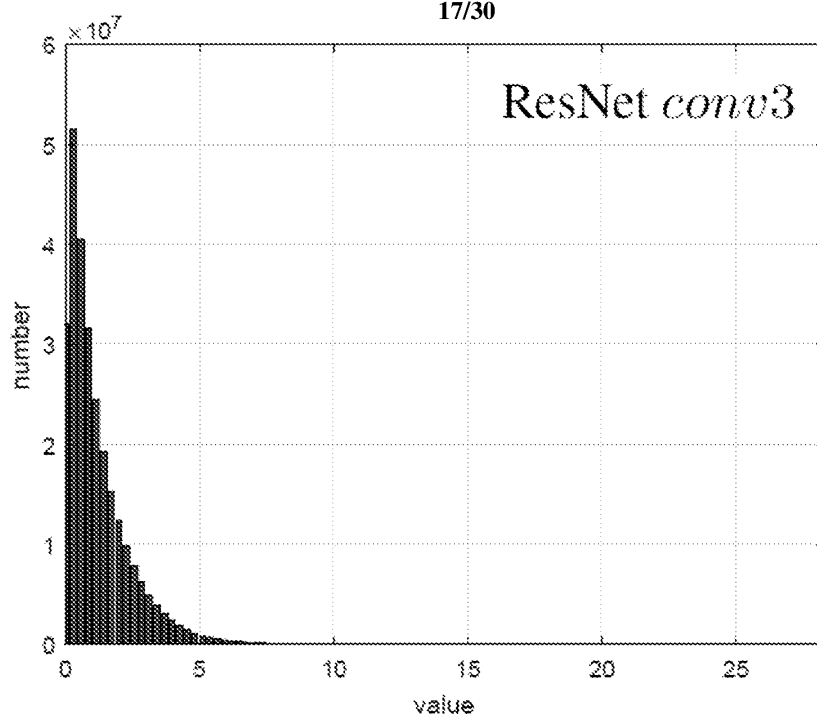


FIG. 15C

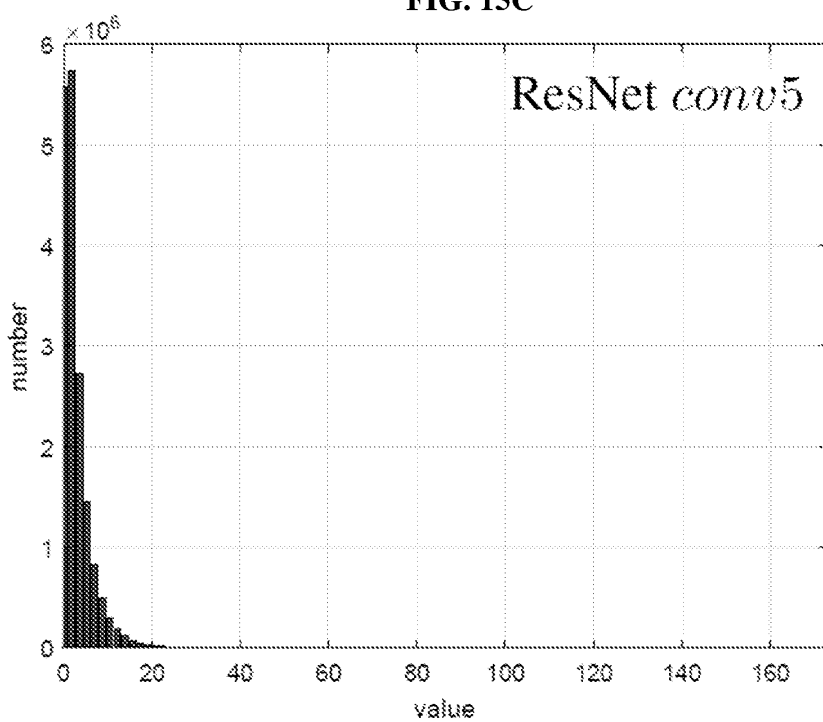


FIG. 15D

Algorithm 1 Channel concatenation by distance

Require: D_{quant} : Quantized feature maps with shape of (H, W, C)

Ensure: D_{repack} : Repacked feature maps

```

1: procedure REPACK( $D_{quant}$ )
2:    $D_{repack} = \text{zeros}([H, W, C])$ 
3:    $D_{repack}[:, :, 0] = D_{quant}[:, :, 0]$ 
4:    $channel\_list = \text{list}(\text{range}(1, C))$ 
5:   for  $i$  in  $\text{range}(C - 1)$  do
6:      $anchor\_map = D_{repack}[:, :, i]$ 
7:      $rest\_map = D_{quant}[:, :, channel\_list]$ 
8:      $optimal\_index = \text{argmin}(\text{distance}(anchor\_map, rest\_map))$ 
9:      $D_{repack}[:, :, i + 1] = D_{quant}[:, :, channel\_list.pop(optimal\_index)]$ 

```

FIG. 16

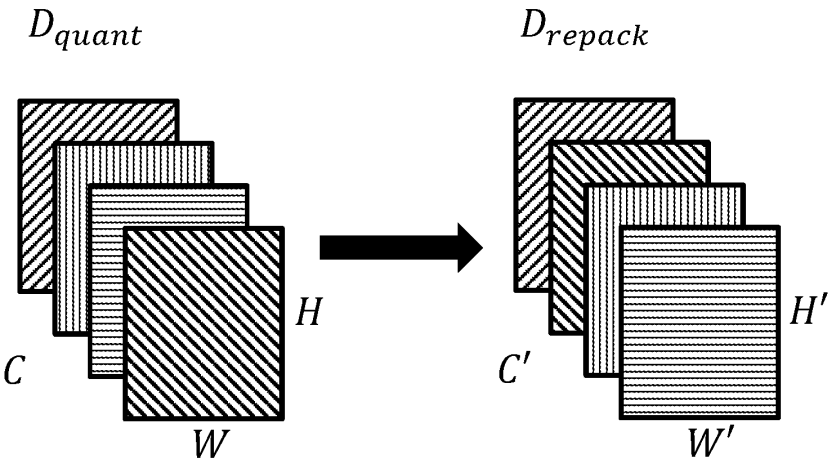


FIG. 17A

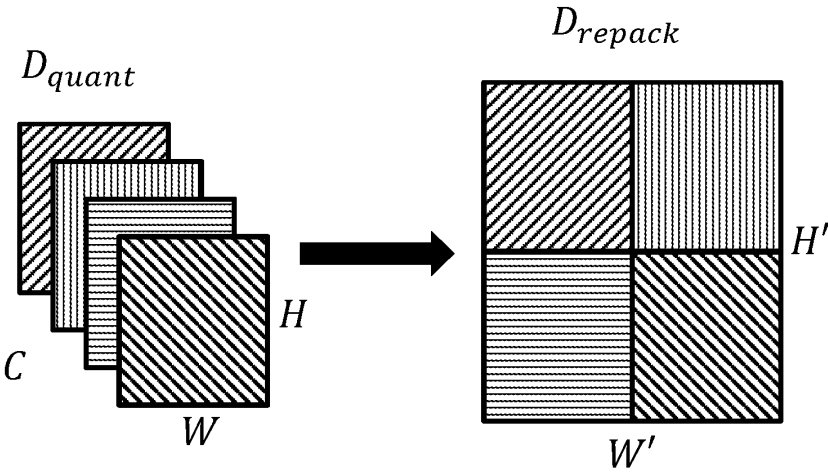


FIG. 17B

Algorithm 2 Calculate similarity between two ranked sequences of documents

Input: S_p : ranked sequence of documents returned by the retrieval system with pristine features; S_r : the sequence inferred from the reconstructed intermediate deep features.

Output: Similarity score

```

1: procedure BUBBLE_INDEX( $S_p, S_r$ )
2:   for element in  $S_r$  do                                 $\triangleright$  generate list to be sort
3:     ordered_list.append( $S_p$ .index(element))
4:   cnt_swap, cnt_total = 0
5:   for i in range(len(ordered_list)-1) do                 $\triangleright$  Bubble sort
6:     for j in range(len(ordered_list)-i-1) do
7:       cnt_total += 1
8:       if ordered_list[j] > ordered_list[j + 1] then
9:         cnt_swap += 1
10:        swap ordered_list[j] and ordered_list[j + 1]
11:   Similarity score = cnt_swap/cnt_total

```

FIG. 18

Table 3: Lossy feature compression results (Comp.Rate:Fidelity)

Feat.	Classification				Reconstruction				Detection			
	QP12	QP22	QP32	QP42	QP12	QP22	QP32	QP42	QP12	QP22	QP32	QP42
VGGNet												
conv1	0.116 0.996	0.080 0.983	0.048 0.955	0.028 0.839	0.070 0.999	0.041 0.997	0.019 0.989	0.006 0.955	0.096 0.982	0.065 0.954	0.037 0.913	0.013 0.850
pool1	0.146 0.994	0.099 0.984	0.057 0.914	0.025 0.693	0.071 0.999	0.039 0.996	0.017 0.983	0.005 0.923	0.127 0.977	0.085 0.942	0.047 0.893	0.018 0.820
conv2	0.130 0.992	0.098 0.972	0.066 0.952	0.035 0.790	0.069 0.999	0.049 0.996	0.050 0.987	0.027 0.955	0.121 0.980	0.090 0.950	0.069 0.907	0.030 0.856
pool2	0.185 0.995	0.138 0.982	0.090 0.947	0.047 0.745	0.157 0.999	0.119 0.997	0.079 0.990	0.037 0.945	0.172 0.983	0.128 0.953	0.082 0.900	0.040 0.815
conv3	0.102 0.995	0.080 0.986	0.057 0.980	0.034 0.840	0.112 0.999	0.089 0.998	0.070 0.993	0.048 0.976	0.040 0.981	0.033 0.954	0.025 0.912	0.015 0.845
pool3	0.179 0.989	0.140 0.981	0.102 0.955	0.063 0.819	--	--	--	--	0.080 0.982	0.066 0.955	0.050 0.908	0.032 0.826
conv4	0.065 0.992	0.053 0.984	0.041 0.967	0.028 0.865	0.088 0.999	0.070 0.997	0.057 0.990	0.043 0.959	0.022 0.983	0.019 0.960	0.014 0.920	0.008 0.877
pool4	0.160 0.992	0.127 0.974	0.097 0.969	0.065 0.864	--	--	--	--	0.049 0.984	0.041 0.960	0.031 0.914	0.019 0.847
conv5	0.059 0.997	0.046 0.989	0.037 0.969	0.023 0.920	0.049 0.998	0.041 0.995	0.036 0.984	0.030 0.952	0.031 0.983	0.023 0.958	0.014 0.902	0.006 0.741
pool5	0.162 0.995	0.129 0.986	0.106 0.967	0.075 0.908	0.243 0.998	0.200 0.996	0.173 0.986	0.146 0.960	--	--	--	--
ResNet												
conv1	0.070 0.982	0.041 0.935	0.019 0.818	0.005 0.556	0.044 0.987	0.018 0.964	0.006 0.915	0.001 0.792	0.056 0.948	0.029 0.915	0.011 0.872	0.002 0.713
pool1	0.074 0.979	0.043 0.937	0.017 0.732	0.004 0.687	0.055 0.989	0.025 0.963	0.009 0.900	0.002 0.720	0.061 0.939	0.030 0.889	0.010 0.779	0.002 0.670
conv2	0.139 0.995	0.095 0.986	0.052 0.957	0.014 0.765	0.061 0.978	0.027 0.939	0.005 0.849	0.001 0.554	0.154 0.981	0.107 0.949	0.061 0.883	0.016 0.660
conv3	0.184 0.996	0.134 0.989	0.083 0.973	0.028 0.854	0.071 0.996	0.041 0.986	0.012 0.930	0.003 0.551	0.162 0.989	0.118 0.973	0.071 0.922	0.021 0.684
conv4	0.231 0.997	0.170 0.992	0.101 0.977	0.034 0.932	0.050 0.998	0.035 0.997	0.022 0.978	0.012 0.799	0.082 0.984	0.056 0.964	0.029 0.926	0.008 0.833
conv5	0.168 1.000	0.131 0.998	0.100 0.988	0.063 0.961	0.057 0.999	0.040 0.999	0.023 0.996	0.014 0.992	--	--	--	--

FIG. 19

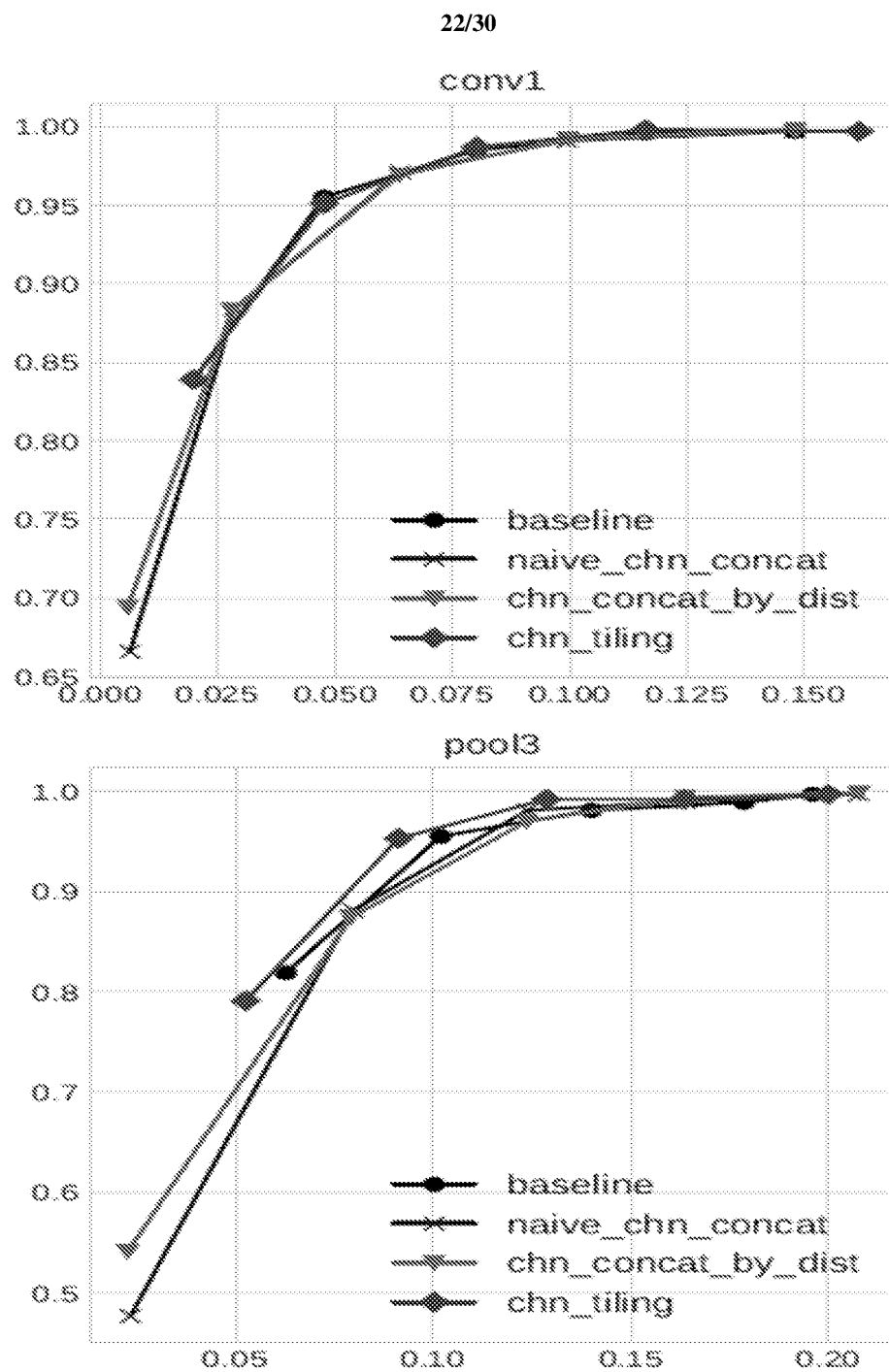


FIG. 20A

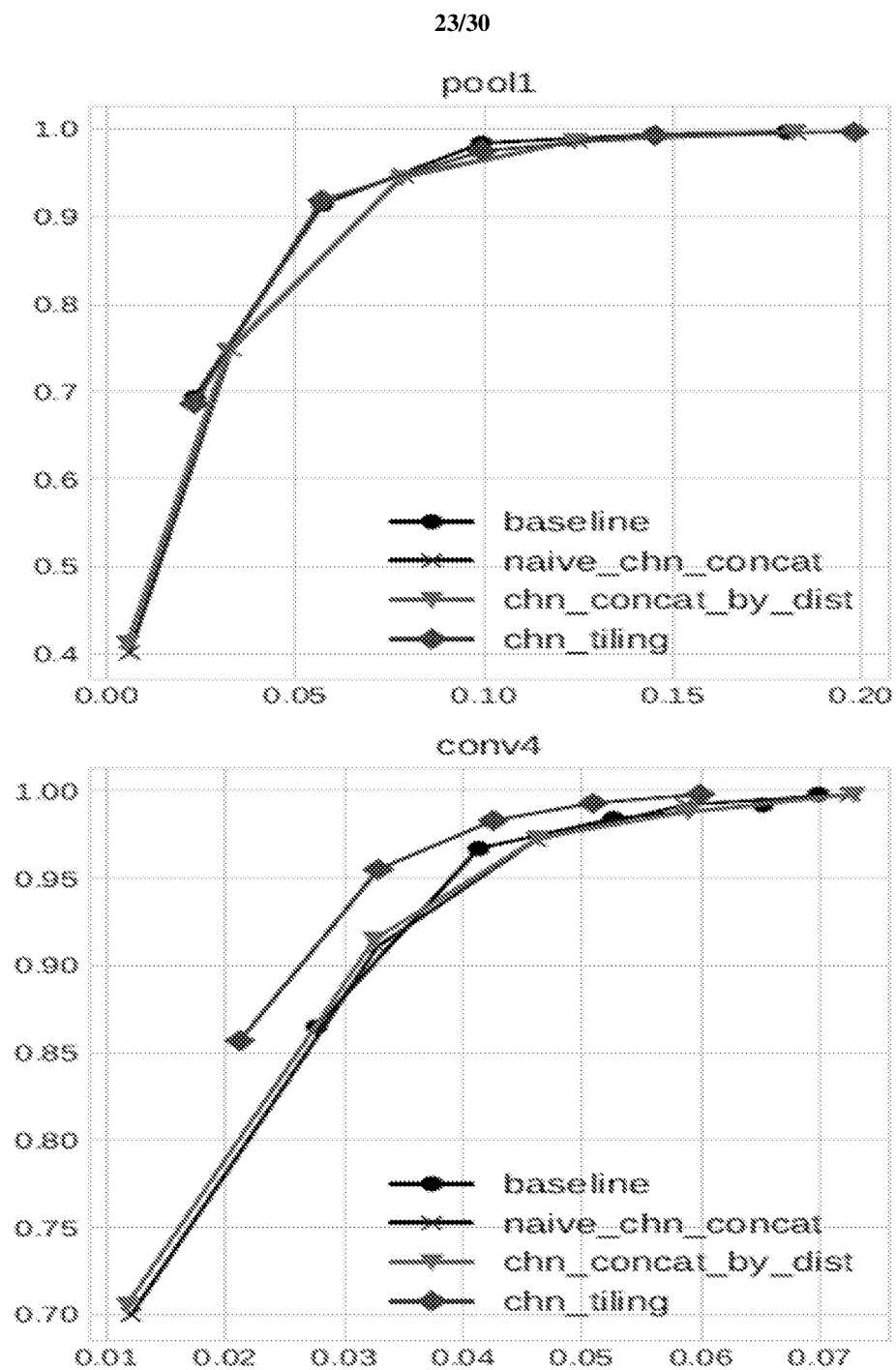


FIG. 20B

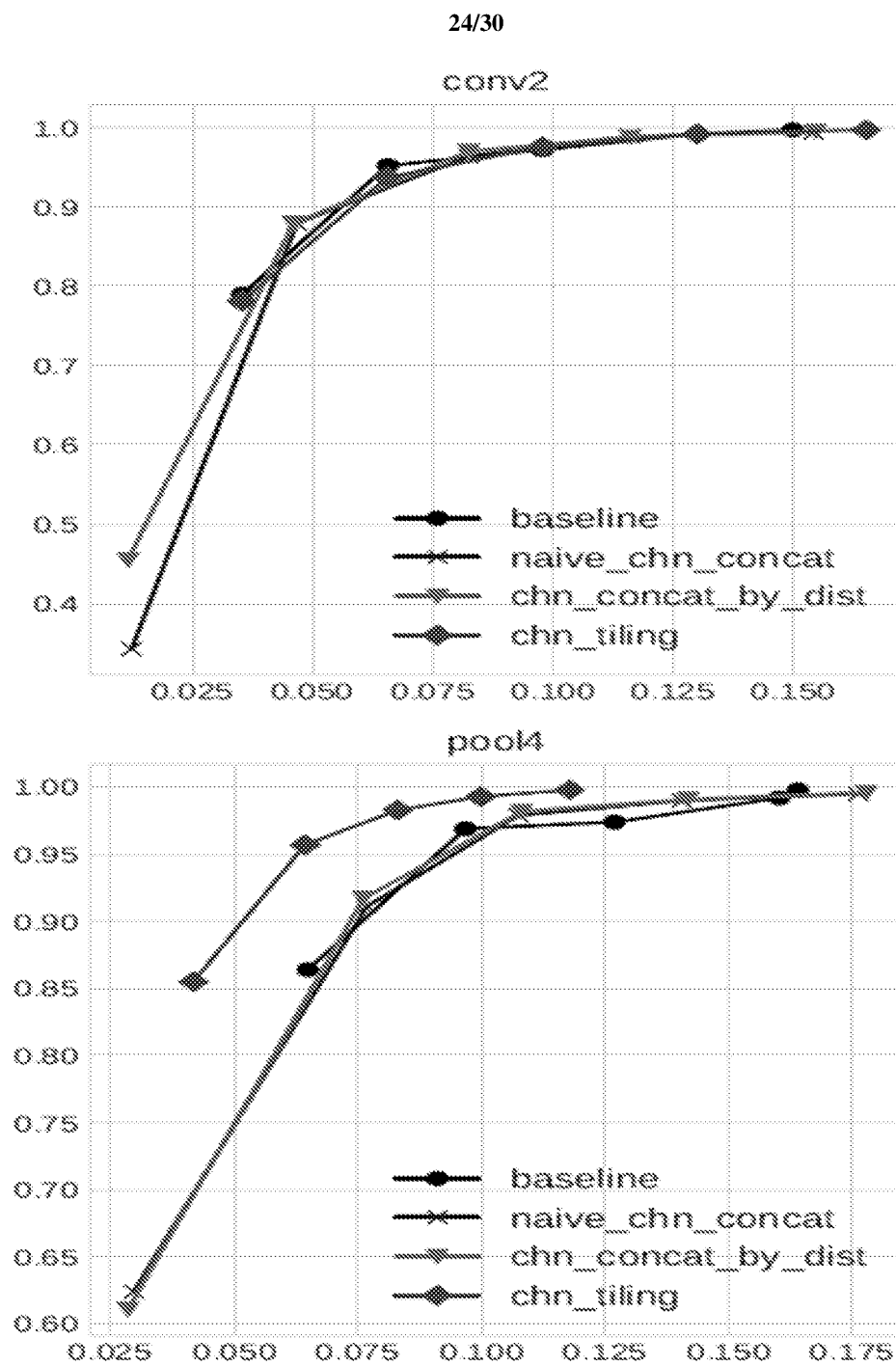


FIG. 20C

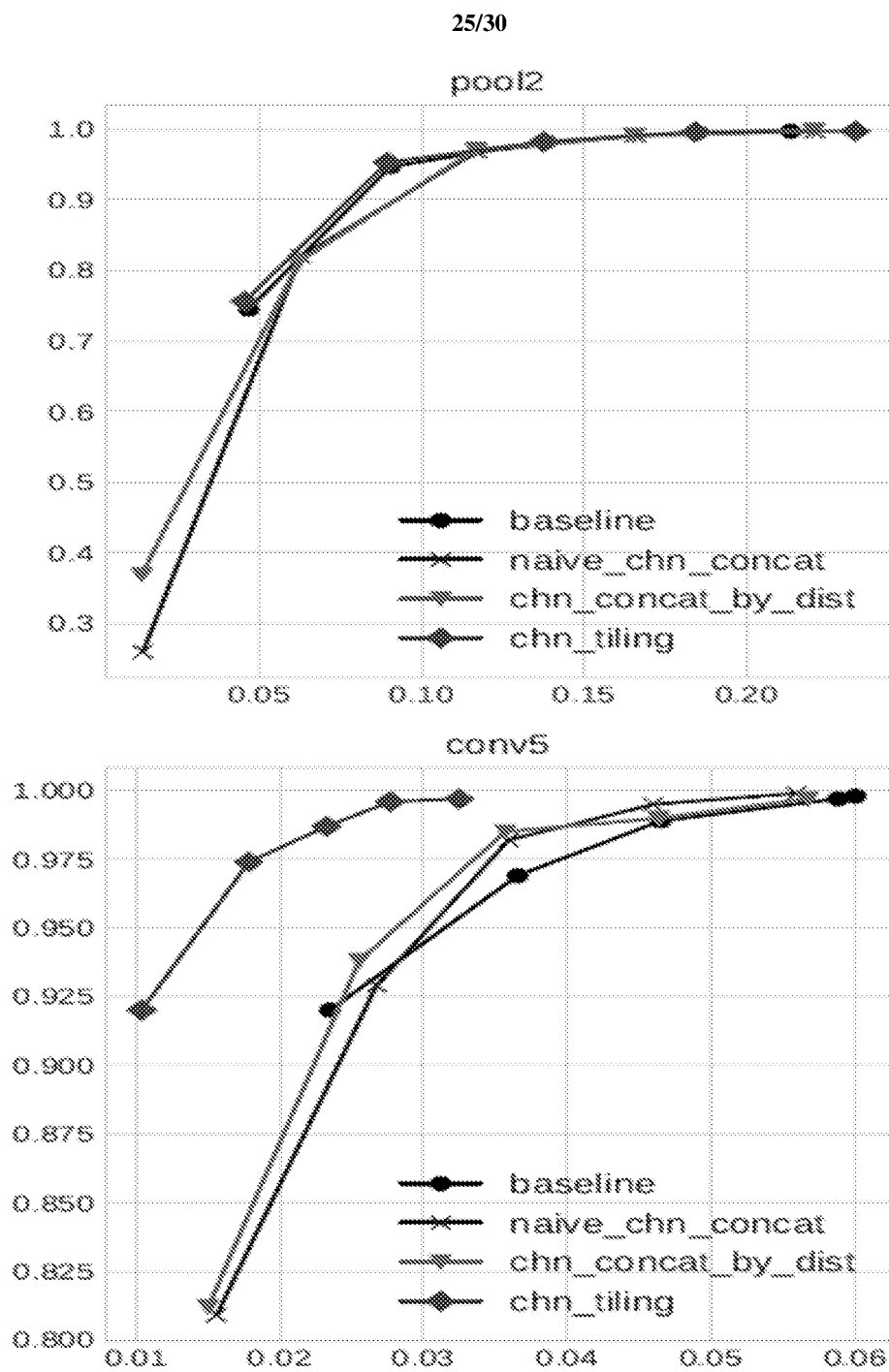


FIG. 20D

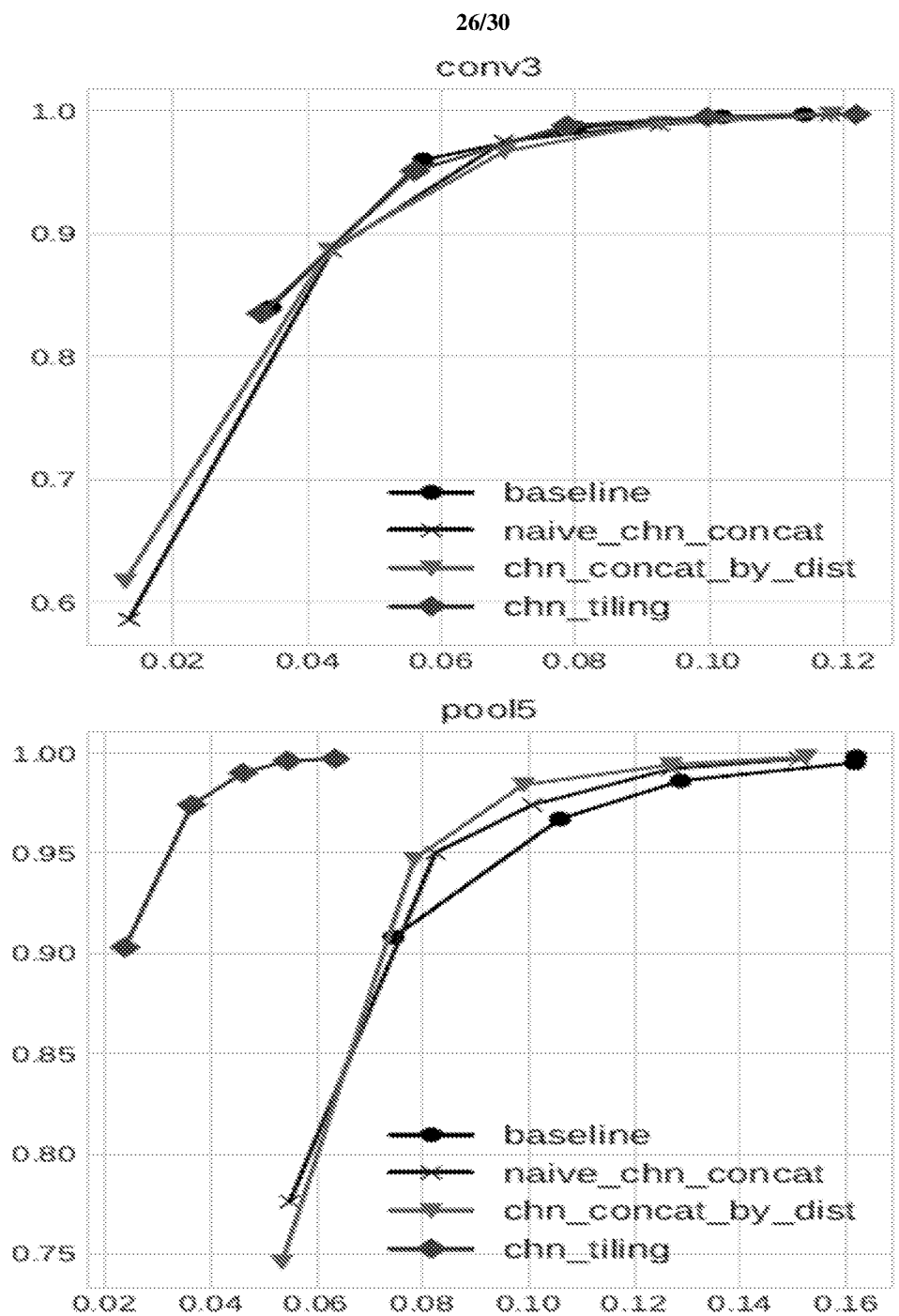


FIG. 20E

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VGGNet							
	10-bit		8-bit		6-bit		4-bit
<i>conv1</i>	1.000	0.999	0.994	0.997	0.982	0.991	0.900 0.952
<i>conv2</i>	1.000	0.999	0.994	0.997	0.988	0.989	0.921 0.967
<i>conv3</i>	0.998	1.000	0.996	0.997	0.986	0.986	0.970 0.968
<i>conv4</i>	0.999	0.999	0.997	0.998	0.992	0.991	0.975 0.972
<i>conv5</i>	0.999	0.999	0.998	0.998	0.994	0.997	0.980 0.980
ResNet							
	10-bit		8-bit		6-bit		4-bit
<i>conv1</i>	1.000	1.000	0.989	0.996	0.960	0.971	0.791 0.900
<i>pool1</i>	1.000	1.000	0.989	0.996	0.960	0.971	0.791 0.900
<i>conv2</i>	1.000	1.000	0.996	0.999	0.990	0.992	0.945 0.967
<i>conv3</i>	1.000	1.000	0.998	1.000	0.988	0.999	0.961 0.984
<i>conv4</i>	1.000	1.000	0.997	1.000	0.992	0.995	0.948 0.983
<i>conv5</i>	1.000	1.000	1.000	1.000	0.995	0.998	0.988 0.991

FIG. 21

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LOSSY FEATURE COMPRESSION RESULTS OF VGGNET-16

Feat. Maps	QP12		QP22		QP32		QP42	
	Comp. Rate	Fidelity	Comp. Rate	Fidelity	Comp. Rate	Fidelity	Comp. Rate	Fidelity
<i>conv1</i>	0.116 ± 0.022	0.996	0.080 ± 0.018	0.985	0.048 ± 0.013	0.955	0.020 ± 0.007	0.839
<i>pool1</i>	0.145 ± 0.024	0.994	0.099 ± 0.019	0.984	0.057 ± 0.013	0.914	0.023 ± 0.006	0.693
<i>conv2</i>	0.130 ± 0.016	0.992	0.098 ± 0.013	0.972	0.066 ± 0.010	0.952	0.035 ± 0.007	0.790
<i>pool2</i>	0.185 ± 0.020	0.995	0.138 ± 0.017	0.982	0.090 ± 0.012	0.947	0.047 ± 0.007	0.745
<i>conv3</i>	0.102 ± 0.013	0.995	0.080 ± 0.011	0.986	0.057 ± 0.008	0.960	0.034 ± 0.005	0.840
<i>pool3</i>	0.179 ± 0.020	0.989	0.140 ± 0.016	0.981	0.102 ± 0.012	0.955	0.063 ± 0.007	0.819
<i>conv4</i>	0.065 ± 0.007	0.992	0.053 ± 0.006	0.984	0.041 ± 0.005	0.967	0.028 ± 0.004	0.865
<i>pool4</i>	0.160 ± 0.017	0.992	0.127 ± 0.014	0.974	0.097 ± 0.011	0.969	0.065 ± 0.008	0.864
<i>conv5</i>	0.059 ± 0.009	0.997	0.046 ± 0.007	0.989	0.037 ± 0.005	0.969	0.023 ± 0.002	0.920
<i>pool5</i>	0.162 ± 0.017	0.995	0.129 ± 0.013	0.986	0.106 ± 0.009	0.967	0.075 ± 0.005	0.908

FIG. 22A

LOSSY FEATURE COMPRESSION RESULTS OF RESNET-101

Feat. Maps	QP12		QP22		QP32		QP42	
	Comp. Rate	Fidelity	Comp. Rate	Fidelity	Comp. Rate	Fidelity	Comp. Rate	Fidelity
conv1	0.081 ± 0.019	0.981	0.048 ± 0.015	0.949	0.022 ± 0.009	0.817	0.006 ± 0.003	0.400
pool1	0.085 ± 0.018	0.985	0.049 ± 0.013	0.923	0.020 ± 0.006	0.718	0.005 ± 0.001	0.081
conv2	0.143 ± 0.010	0.994	0.100 ± 0.009	0.985	0.056 ± 0.008	0.948	0.016 ± 0.003	0.783
conv3	0.174 ± 0.007	0.997	0.127 ± 0.007	0.996	0.077 ± 0.007	0.968	0.025 ± 0.004	0.844
conv4	0.224 ± 0.007	0.998	0.164 ± 0.007	0.994	0.097 ± 0.007	0.984	0.032 ± 0.002	0.904
conv5	0.168 ± 0.016	0.997	0.130 ± 0.012	0.992	0.100 ± 0.008	0.989	0.063 ± 0.002	0.953

FIG. 22B

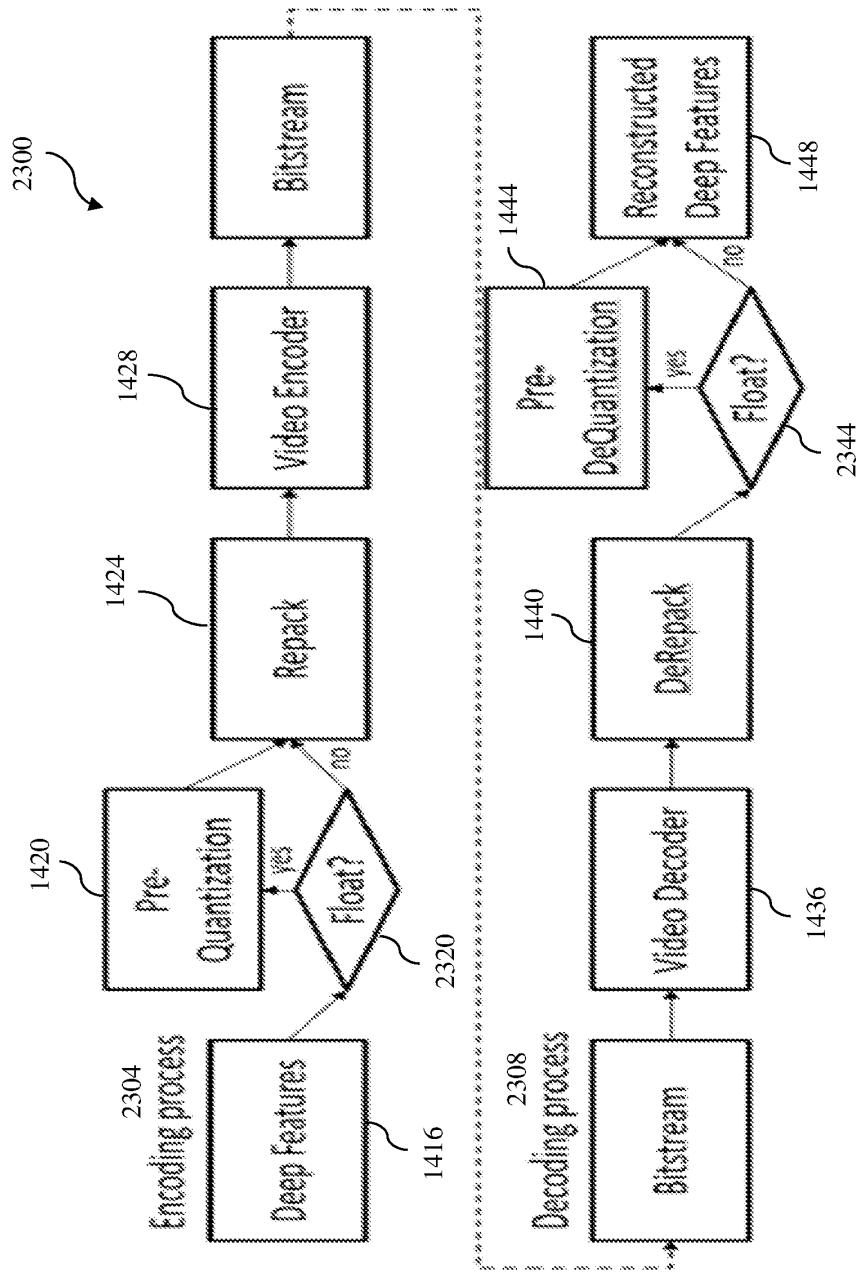


FIG. 23