Algorithm 1: Proposed DS-AMP Algorithm

Input: The received signals $\mathbf{Y}=[\mathbf{y}_1,...,\mathbf{y}_J]\in\mathbb{C}^{N_r\times J}$, the channel matrix $\mathbf{H}=[\mathbf{H}_1,...,\mathbf{H}_K]\in\mathbb{C}^{N_r\times(KN_t)}$, and the maximum iteration number T_0.

Output: The set of active MTDs Ω and the reconstructed media modulation signal $\mathbf{X}\in\mathbb{C}^{KN_t\times J}$.

1: $\forall i,j,k,n$: We initialize the iterative index t=1, the activity indicator $a_k^1=0.5$, $Z_{n,j}^0=[\mathbf{y}_j]_n$, $V_{n,j}^0=1$, the noise variance $\left(\sigma_w^2\right)^1=100$, the reconstructed signal $\mathbf{X}=\mathbf{0}_{KN_t\times J}$, $\left[\widehat{\mathbf{x}}_{k,j}^1\right]_i=a_k^1\sum\limits_{s\in\mathbb{S}}s/MN_t$, and $\left[\widehat{\mathbf{v}}_{k,j}^1\right]_i=a_k^1\sum\limits_{s\in\mathbb{S}}|s|^2/MN_t-\left|\left[\widehat{\mathbf{x}}_{k,j}^1\right]_i\right|^2$;

2: **for** $t=1$ to T_0 **do**

3: **%AMP operation:**

4: $\forall i,j,k,n$: Compute $V_{n,j}^t$, $Z_{n,j}^t$, $\phi_{l,j}^t$, and $r_{l,j}^t$ by using (20), (21), (18), and (19), respectively, where $l=(k-1)N_t+i$; {Decoupling step}

5: $\forall i,j,k,n$: Compute $\left[\widehat{\mathbf{x}}_{k,j}^{t+1}\right]_i$ and $\left[\widehat{\mathbf{v}}_{k,j}^{t+1}\right]_i$ by using (16) and (17), respectively; {Denoising step}

6: **%EM operation:**

7: $\forall k$: Compute $(\sigma_w^2)^{t+1}$ and a_k^{t+1} by using (24) and (25);

8: **end for**

9: **%Min-max normalization:**

10: Let $\tilde{\mathbf{a}}=\frac{\widehat{\mathbf{a}}-\min(\widehat{\mathbf{a}})}{\max(\widehat{\mathbf{a}})-\min(\widehat{\mathbf{a}})}$, where $\widehat{\mathbf{a}}=[\widehat{a}_1,...,\widehat{a}_K]^T=\left[a_1^{T_0},...,a_K^{T_0}\right]^T$, $\min(\cdot)$ and $\max(\cdot)$ are the minimum value and maximum value of the arguments, respectively;

11: **%Extract the active MTDs and their MAPs:**

12: $\forall k$: The set of active MTDs $\Omega=\{k|\,[\tilde{\mathbf{a}}]_k>0.5\}$;

13: $\forall k,j$: $\eta^*=\arg\max_{\widehat{\eta}\in[N_t]}\left[\widehat{\mathbf{x}}_{k,j}^{T_0}\right]_{\widehat{\eta}}$;

14: $\forall k\in\Omega,\forall j$: The reconstructed signal is $\mathbf{X}_{[(k-1)N_t+\eta^*,j]}=\left[\widehat{\mathbf{x}}_{k,j}^{T_0}\right]_{\eta^*}$.