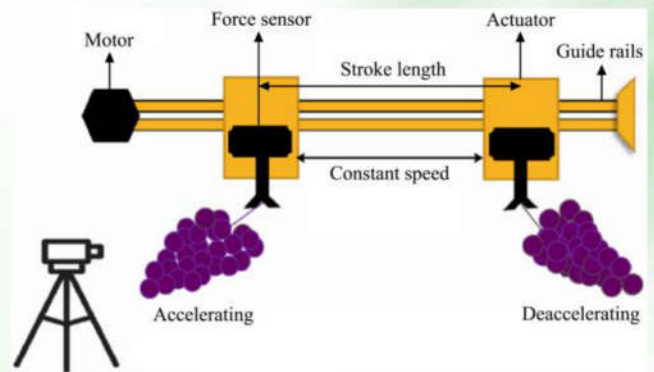
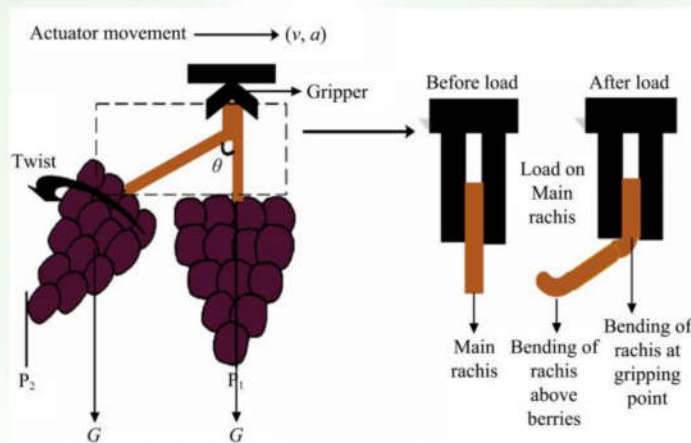


Figure 1 Vibration damage of hanging grape cluster during robotic transportation

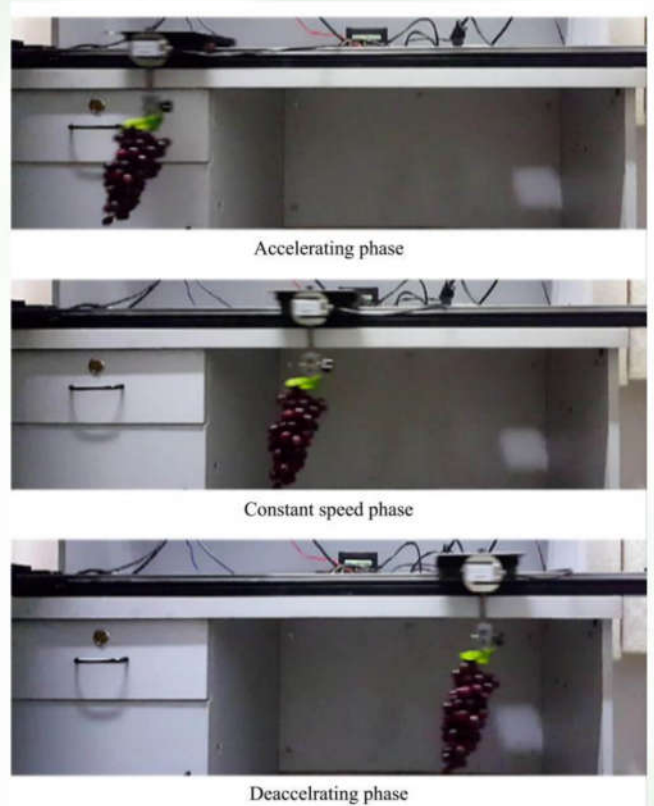


a. Schematic diagram of experimental observation of cluster's vibration at accelerating and decelerating of actuator



a. Swing angle of the grape cluster      b. Bending load on the main rachis  
 Note:  $v$  is speed;  $a$  is acceleration;  $\theta$  is swing angle of the grape cluster;  $G$  is gravity;  $P_1$  and  $P_2$  are extreme positions of grape cluster before and after load.

Figure 4 Observation of swing angle of grape cluster and bending load on main rachis during linear robotic transportation



b. Time phases of grape cluster during linear transportation

Figure 3 Hanging force analysis in different phases of linear transportation of grape cluster

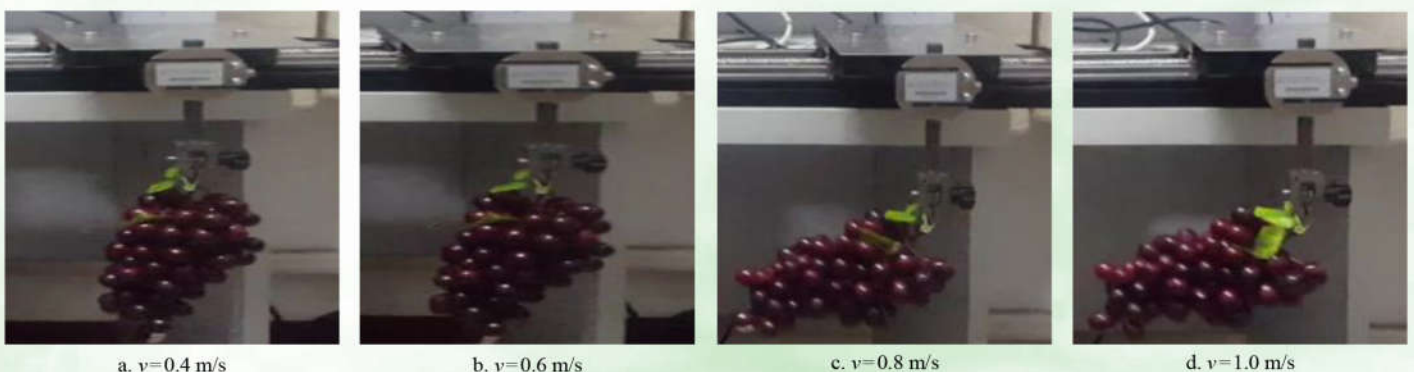


Figure 7 Swing angle at different speed excitations

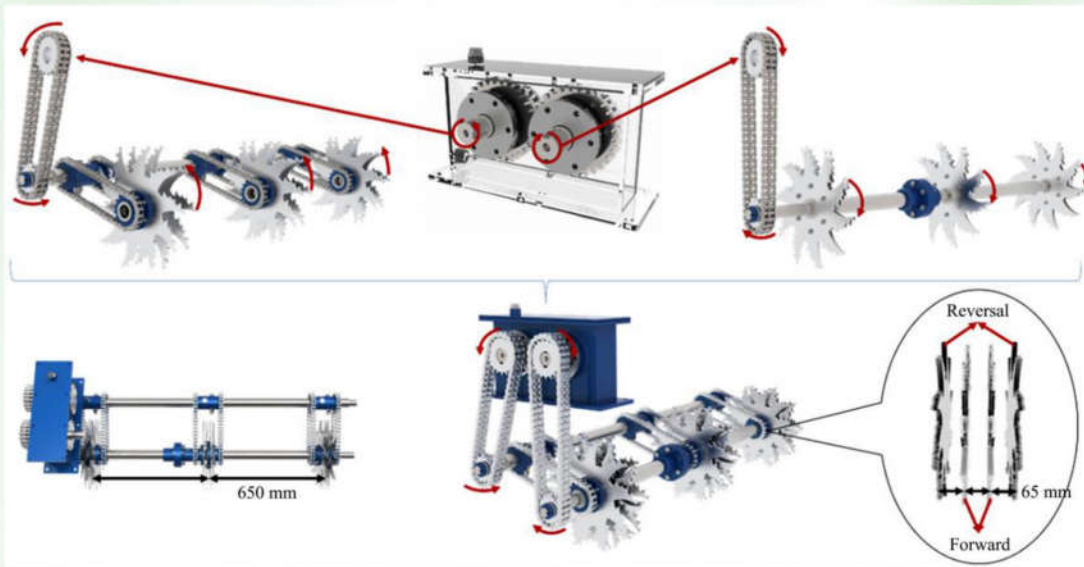


Figure 4 Schematic diagram of the bionic drive system

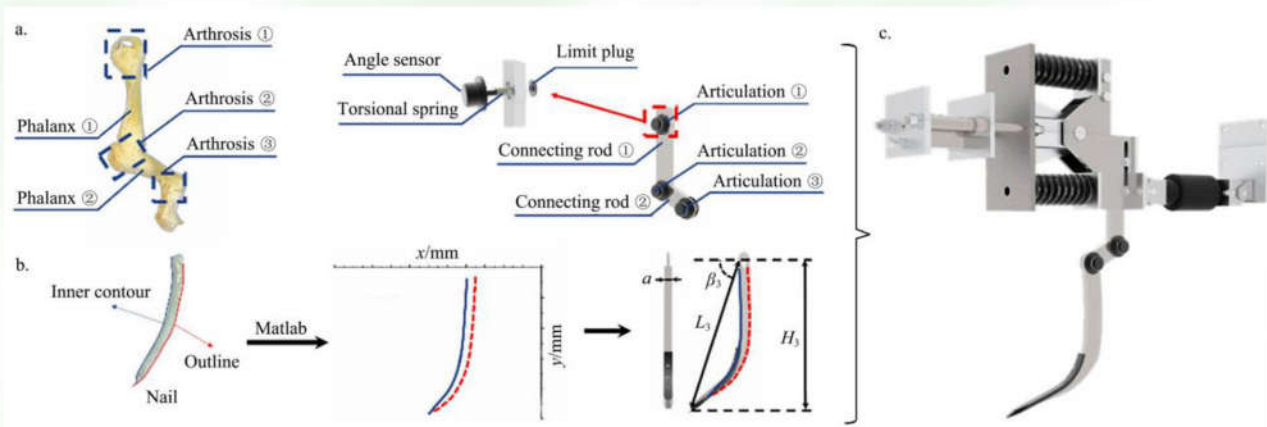


Figure 5 Diagram of the structure of the bionic self-excited vibration deep loosening

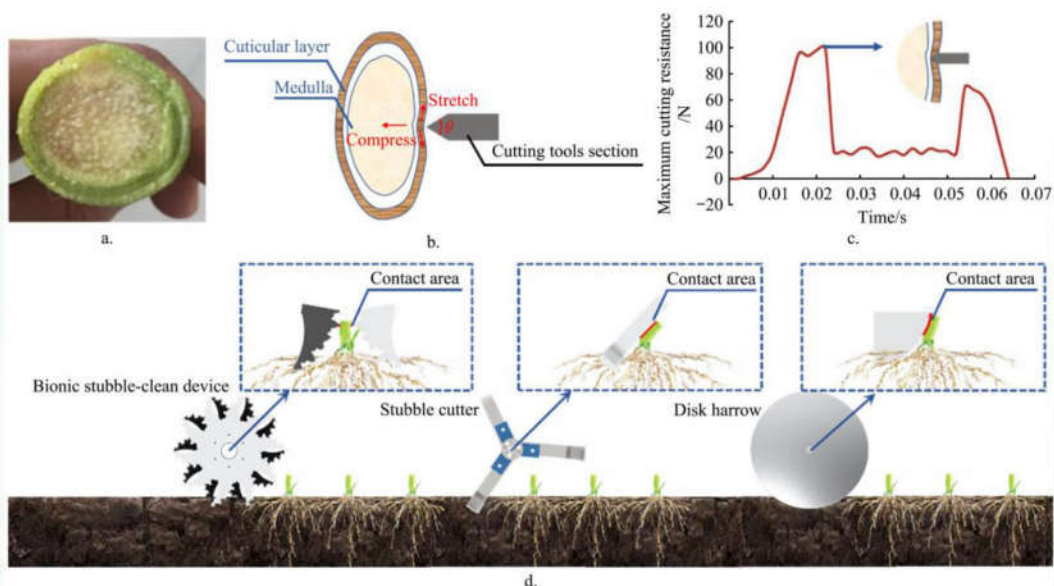


Figure 11 Schematic diagram of three types of machine for stubble principle