```
Manipulate[
 (*by Nasser M. Abbasi*)

 tick;
 Module[{x0, y0, z0, point, d = 0.5},

  If[state == "running" || state == "step",
   t = t + speed;
   phi = currentW1 * t + 1 / 2 w1dot * t^2;
   theta = currentW2 * t + 1 / 2 w2dot * t^2;
   currentW1 = currentW1 + w1dot * t;
   currentW2 = currentW2 + w2dot * t;
   currentRaoV = currentRaoV + raoAcc * t;
   rr = currentRaoV * t + 1 / 2 raoAcc * t^2;
   If[state == "running",
    tick += del
   ],
   If[state == "reset",
    t = -speed; phi = 0; theta = 0; rr = 0; x = 0; y = 0; z = 0; currentRaoV = raoV;
    currentW1 = w1; currentW2 = w2; phi = 0; theta = 0; rr = 0; line = {LL}; tick = 0
   ]
  ];

  x0 = L1 + r Cos[theta];
  y0 = -L3 + r Sin[theta];
  z0 = L4 + L2 + d;

  x = L1 + rr Cos[theta];
  y = -L3 + rr Sin[theta];
  z = L4 + L2 + d;

  point = {x, y, z};
  AppendTo[line, point];

  g = Text@Grid[{
       {
        Grid[
         {
          {Style["Simulation for problem 1, HW3, EMA 542, Fall 2013, Univ.
               Of Wisconsin, Madison", Small], SpanFromLeft},
          {Style["ant coordinates", Bold], SpanFromLeft},
          {Grid[
            {
             {"(w2) disk", "w1 (frame)", "inertial"},
             {Grid[{
                {"x", "y", "z"},
                {padIt1[If[Abs[#] > 1000, Sign[#] * 1000, #] & /@ rr , {7, 3}], 0, 0}
               }, Frame → All, Spacings → {.2, .4}
              ],
              Grid[{
                {"X", "Y", "Z"},
```

```
          {padIt1[If[Abs[x] > 1000, 1000 * Sign[x], x], {7, 3}],
           padIt1[If[Abs[y] > 1000, Sign[y] * 1000, y], {7, 3}], padIt1[L2, {7, 3}]}
         }, Frame → All, Spacings → {.2, .4}],
        Grid[{
          {Style["X", Bold], Style["Y", Bold], Style["Z", Bold]},
          {padIt1[L1 Cos[phi] + L2 Sin[phi] + rr Cos[theta] Cos[phi], {7, 3}],
           padIt1[-L3 + rr Sin[theta], {7, 3}],
           padIt1[-L1 Sin[phi] + L2 Cos[phi], {7, 3}]}
         }, Frame → All, Spacings → {.2, .4}]
       }
      }, Spacings → {.2, .2},
      Frame → True, FrameStyle -> Directive[Thickness[.001], Gray]
     ], SpanFromLeft
    }
   }, Frame → True,
   FrameStyle -> Directive[Thickness[.001], Gray], Alignment → Center
  ]
},
{
 Graphics3D[
  {
   Text["inertial", {-r - 5, 0, 3}],
   {Arrowheads[Medium], Arrow[{{-r - 5, -2, 3}, {-r - 4, -2, 3}}]},
   Text[Style["X", Bold, 12], {-r - 3.5, -2, 3}, {-1, 0}],

   {Arrowheads[Medium], Arrow[{{-r - 5, -2, 3}, {-r - 5, -1, 3}}]},
   Text[Style["Y", Bold, 12], {-r - 5, -.8, 3}, {-1, 0}],

   {Arrowheads[Medium], Arrow[{{-r - 5, -2, 3}, {-r - 5, -2, 2}}]},
   Text[Style["Z", Bold, 12], {-r - 5, -2, 1.8}, {-1, 0}],

   GeometricTransformation[
    {

     If[showW2Coordinates,
      {
       {Arrowheads[Medium], Arrow[{LL, LL + {r Cos[theta], r Sin[theta], 0}}]},
       Text[Style["x", 12], LL + {1.1 r Cos[theta], 1.1 r Sin[theta], 0}, {-1, 0}],
       {Arrowheads[Medium],
        Arrow[{LL, LL + {r Cos[theta + Pi / 2], r Sin[theta + Pi / 2], 0}}]},
       Text[Style["y", 12], {LL + {1.1 r Cos[theta + Pi / 2],
            1.1 r Sin[theta + Pi / 2], 0}}, {-1, 0}],
       {Arrowheads[Medium], Arrow[{LL, LL + {0, 0, r}}]},
       Text[Style["z", 12], {1.1 * (LL + {0, 0, r})}, {-1, 0}]
      },
      {}
     ],
     {Red, Thin, Line[line]},
     {Red, PointSize[Medium], Point[point]},

     {Opacity[Dynamic@op], Cylinder[{{L1, -L3, L4 + L2}, {L1, -L3, L4 + L2 + d}}, r]},
     {Red, Cylinder[{{0, -0.2, 0}, {0, 0.2, 0}}, 0.2]},
```

```
          {Blue, Cylinder[{{0, -0.8, 0}, {0, 2, 0}}, 0.1]},
          Tube[
           {{0, 0, 0}, {L1, 0, 0}, {L1, 0, L2}, {L1, -L3, L2}, {L1, -L3, L4 + L2}}, 0.06],
          Cylinder[{{L1, -L3, L2}, {L1, -L3, L4 + L2}}, 0.2],

          If[showW1Coordinates,
           {
            {Arrowheads[Medium], Arrow[{{0, 0, 0}, {1, 0, 0}}]},
            Text[Style["X", 12], {1.1, 0, 0}, {-1, 0}],

            {Arrowheads[Medium], Arrow[{{0, 0, 0}, {0, 3, 0}}]},
            Text[Style["Y", 12], {0, 3.1, 0}, {-1, 0}],

            {Arrowheads[Medium], Arrow[{{0, 0, 0}, {0, 0, 1}}]},
            Text[Style["Z", 12], {0, 0, 1.1}, {-1, 0}]
           },
           {}
          ]


         },
         RotationTransform[phi, {0, 1, 0}]
        ]
       }
       , ImageSize → {400, 400}, Boxed → False, AxesLabel → {"x", "y", "z"},
       ViewVertical → {0, 1, 0}, ViewPoint → {1, .5, 2}, SphericalRegion → True,
       PlotRange → {{-r - 5, r + 3}, {-r - 3, r + 2}, {-r - 3, r + 3}},
       ImagePadding → 1, Axes → None, ViewAngle → Dynamic[zoom * Pi / 180.0]
      ]
     }}, Spacings → {0, .1}, Alignment → Center];
 g
],

Text@Grid[{
   {
    Grid[{
      {
       Button[Text[Style["run", 11]],
        state = "running"; tick += del, ImageSize → {50, 35}],
       Button[Text[Style["pause", 11]], state = "paused";
        tick += del, ImageSize → {50, 35}],
       Button[Text[Style["step", 11]], state = "step"; tick += del, ImageSize → {50, 35}],
       Button[Text[Style["reset", 11]], state = "reset";
        tick = 0, ImageSize → {50, 35}]
      }
     }, Spacings → {0.4, .2}, Alignment → Center
    ]
   },
   {
    Grid[{
      {
```

```
 "slow",
 Manipulator[Dynamic[speed, {speed = #} &],
  {0.0001, 0.001, 0.0001}, ImageSize → Tiny, ContinuousAction → True],
 "fast", SpanFromLeft
},
{
 "disk r",
 Manipulator[Dynamic[r, {r = #; state = "paused"; tick += del} &],
  {0.5, 2.3, 0.1}, ImageSize → Tiny, ContinuousAction → True],
 Dynamic[padIt2[r, {2, 1}]], "ft"
},
{
 "w1",
 Manipulator[Dynamic[w1, {w1 = #; state = "reset";
     tick += del} &], {0.001, 10, 0.001}, ImageSize → Tiny, ContinuousAction → True],
 Dynamic[padIt2[w1, {4, 3}]], "rad/sec"
},
{
 "w2",
 Manipulator[Dynamic[w2, {w2 = #; state = "reset";
     tick += del} &], {0.001, 30, 0.001}, ImageSize → Tiny, ContinuousAction → True],
 Dynamic[padIt2[w2, {5, 3}]], "rad/sec"
},
{
 "d/dt(w1)",
 Manipulator[Dynamic[w1dot, {w1dot = #; state = "reset";
     tick += del} &], {0.001, 1, 0.001}, ImageSize → Tiny, ContinuousAction → True],
 Dynamic[padIt2[w1dot, {4, 3}]], "rad/sec^2"
},
{
 "d/dt(w2)",
 Manipulator[Dynamic[w2dot, {w2dot = #; state = "reset";
     tick += del} &], {0.001, 1, 0.001}, ImageSize → Tiny, ContinuousAction → True],
 Dynamic[padIt2[w2dot, {4, 3}]], "rad/sec^2"
},
{
 "ant speed",
 Manipulator[Dynamic[raoV, {raoV = #; state = "reset";
     tick += del} &], {0.001, 3, 0.001}, ImageSize → Tiny, ContinuousAction → True],
 Dynamic[padIt2[raoV, {4, 3}]], "ft/sec"
},
{
 "ant acc",
 Manipulator[Dynamic[raoAcc, {raoAcc = #; state = "reset";
     tick += del} &], {0.001, 3, 0.001}, ImageSize → Tiny, ContinuousAction → True],
 Dynamic[padIt2[raoAcc, {4, 3}]], "ft/sec^2"
},
{
 "disk opacity",
 Manipulator[Dynamic[op, {op = #} &],
  {0.1, 1, 0.1}, ImageSize → Tiny, ContinuousAction → True],
 Dynamic[padIt2[op, {1, 1}]], SpanFromLeft
```

```
      },
      {
       "zoom",
       Manipulator[Dynamic[zoom, {zoom = #} &],
        {10, 130, 1}, ImageSize → Tiny, ContinuousAction → True],
       Dynamic[padIt2[zoom, 2]], SpanFromLeft
      }
     }, Alignment → Left
    ]
   },
   {
    Grid[
     {
      {"time", Dynamic@padIt2[t, {7, 5}], "sec"}
     }, Spacings → {.5, .2}]
   },
   {
    Grid[{
      {"show disk coordinates", Spacer[4],
       Checkbox[Dynamic[showW2Coordinates, {showW2Coordinates = #; tick += del} &]]
      },
      {"show bar coordinates", Spacer[4],
       Checkbox[Dynamic[showW1Coordinates, {showW1Coordinates = #; tick += del} &]]
      }

     }
    ]
   }


  }, Frame → All, Alignment → Left],

{{showW2Coordinates, True}, None},
{{showW1Coordinates, False}, None},
{{speed, 0.001}, None},
{{r, 2.3}, None},
{{tick, 0}, None},
{{del, $MachineEpsilon}, None},
{{state, "reset"}, None},
{{t, 0}, None},
{{x, 0}, None},
{{y, 0}, None},
{{z, 0}, None},
{{line, {{0, 0, 0}}}, None},
{{w1dot, 1}, None},
{{w2dot, 0.2}, None},
{{w1, 1}, None},
{{w2, 11}, None},
{{raoV, 0.5}, None},
{{raoAcc, 0.1}, None},
{{currentRaoV, 0.01}, None},
{{currentW1, 0.6}, None},
```

```
{{currentW2, 0.01}, None},
{{op, 0.1}, None},
{{phi, 0}, None},
{{theta, 0}, None},
{{rr, 0}, None},
{{zoom, 32}, None},
TrackedSymbols :→ {tick},

ControlPlacement → Left,
SynchronousUpdating → False,
SynchronousInitialization → False,
ContinuousAction → False,
Alignment -> Center,
ImageMargins → 0,
FrameMargins → 0,
Paneled → True,
Frame → False,
AutorunSequencing → {1},

Initialization :→
 (
  L1 = 2.5;
  L2 = 0.7;
  L3 = 1.4;
  L4 = 1;
  LL = {L1, -L3, L4 + L2 + 0.5};
  (*definitions used for parameter checking*)
  integerStrictPositive = (IntegerQ[#] && # > 0 &);
  integerPositive = (IntegerQ[#] && # ≥ 0 &);
  numericStrictPositive = (Element[#, Reals] && # > 0 &);
  numericPositive = (Element[#, Reals] && # ≥ 0 &);
  numericStrictNegative = (Element[#, Reals] && # < 0 &);
  numericNegative = (Element[#, Reals] && # ≤ 0 &);
  bool = (Element[#, Booleans] &);
  numeric = (Element[#, Reals] &);
  integer = (Element[#, Integers] &);
  (*-------------------------------------------*)
  padIt1[v_?numeric, f_List] := AccountingForm[v,
    f, NumberSigns → {"-", "+"}, NumberPadding → {"0", "0"}, SignPadding → True];
  (*-------------------------------------------*)
  padIt1[v_?numeric, f_Integer] := AccountingForm[Chop[v],
    f, NumberSigns → {"-", "+"}, NumberPadding → {"0", "0"}, SignPadding → True];
  (*-------------------------------------------*)
  padIt2[v_?numeric, f_List] := AccountingForm[v,
    f, NumberSigns → {"", ""}, NumberPadding → {"0", "0"}, SignPadding → True];
  (*-------------------------------------------*)
  padIt2[v_?numeric, f_Integer] := AccountingForm[Chop[v],
    f, NumberSigns → {"", ""}, NumberPadding → {"0", "0"}, SignPadding → True];
  (*-------------------------------------------*)


 )
]
```

run | pause | step | reset

slow		fast	
disk r		2.3	ft
w1		1.000	rad/sec
w2		11.000	rad/sec
d/dt(w1)		1.000	rad/sec^2
d/dt(w2)		0.200	rad/sec^2
ant speed		0.500	ft/sec
ant acc		0.100	ft/sec^2
disk opacity		0.1	
zoom		32	

time 00.00100 sec

show disk coordinates ☑

show bar coordinates ☐

Simulation for problem 1, HW3, EMA 542, Fall 2013, Univ. Of Wiscons

ant coordinates

(w2) disk			w1 (frame)				iner
			X	Y	Z	X	Y
x	y	z	+0002.⋱	−0001.⋱	+0000.⋱	+0002.⋱	−000
+0000.000	0	0	50⋱	40⋱	70⋱	50⋱	4
			0	0	0	0	0