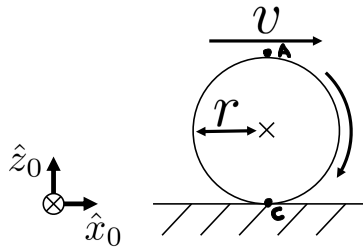


1. **Spatial Velocity:** A cylinder rolls without slipping in the \hat{x}_0 direction on the $\hat{x}_0 - \hat{y}_0$ plane. The cylinder has a radius of r and a constant forward speed of v . Let ${}^0C=[C_x(t),0,0]^T$ be the position of the contact point at time t . Let ${}^0A=[A_x(t),0,0]^T$ be the position of the instantaneous top of the cylinder at time t .
- (a) What is the linear velocity of the point C ? (hint: just need to compute $\frac{d}{dt}C_x(t)$)?
 - (b) What is the linear velocity of the point A ?
 - (c) What is velocity of the body-fixed point currently coincides with C ?
 - (d) What is velocity of the body-fixed point currently coincides with A ?
 - (e) What is the spatial velocity of the cylinder in $\{0\}$ -frame?
 - (f) What is the spatial velocity of the cylinder in frame $\{C\}$? ($\{C\}$ has the same orientation as $\{0\}$, while its origin is at the contact point C)

Note: The first 4 questions are all referring to the inertia frame $\{0\}$



- 2. Modern Robotics: Exercise 3.21
- 3. Modern Robotics: Exercise 3.28
- 4. Modern Robotics: Exercise 5.5
- 5. Modern Robotics: Exercise 5.6