EXAMPLE 6.2
Rear-wheel Odometry

INPUTS:					
Forward velocity	$v^b_{eb,x}$ =	10	m s^{-1}		
Heading	ψ_{nb} =	30	deg	0.523599	rad
Yaw rate	$\dot{\psi}_{nb}$ =	0.1	rad s^{-1}		
Body frame to rear-wheel	$l^b_{br,x}$ =	-2	m		
frame lever arm	$l^b_{br,y}$ =	0.2	m		
Track width	T_r =	1.5	m		
Left-wheel scale-factor error	s_{rL} =	0.01			
Right-wheel scale-factor error	s_{rR} =	-0.01			
Error in assumed track width	δT_r =	0.05	m		
Heading error	$\delta\psi_{nb}$ =	1	deg	0.017453	rad

Wheel velocities
Rear-wheel frame speed:
From (6.26), $v_{er} = v^b_{eb,x} - l^b_{br,y}\dot{\psi}_{nb}$

v_{er} = 9.98 m s^{-1}

Speed dfference between wheels:
From (6.33)
$v_{erL} - v_{erR} = T_r\dot{\psi}_{nb} =$ 0.15 m s^{-1}

True wheel speeds:
v_{erL} = 10.055 m s^{-1}
v_{erR} = 9.905 m s^{-1}

Measured wheel speeds:
$\tilde{v}_{erL} = (1 + s_{rL})v_{erL} =$ 10.15555 m s^{-1}
$\tilde{v}_{erR} = (1 + s_{rR})v_{erR} =$ 9.80595 m s^{-1}

Odometry speed and yaw rate measurements:
Rear-wheel frame speed:
From (6.22),
$\tilde{v}_{er} = \frac{1}{2}(\tilde{v}_{erL} + \tilde{v}_{erR}) =$ 9.98075 m s^{-1} Error= 0.00075 m s^{-1}

Yaw rate:
From (6.33), $\tilde{\dot{\psi}}_{nb} = \frac{\tilde{v}_{erL} - \tilde{v}_{erR}}{\tilde{T}_r}$
Assumed track width:
$\tilde{T}_r = T_r + \delta T_r =$ 1.55 m

$\tilde{\dot{\psi}}_{nb} =$ 0.225548387 rad s^{-1} Error= 0.125548 rad s^{-1}

Body-frame velocity

From (6.26), $\begin{pmatrix} \tilde{v}^b_{eb,x} \\ \tilde{v}^b_{eb,y} \end{pmatrix} \approx \begin{pmatrix} \tilde{v}_{er} \\ 0 \end{pmatrix} + \begin{pmatrix} l^b_{br,y} \\ -l^b_{br,x} \end{pmatrix} \tilde{\dot{\psi}}_{nb}$ $\quad v^b_{eb,y} = -l^b_{br,x}\dot{\psi}_{nb} =$ 0.20000 m s^{-1}

$\tilde{v}^b_{eb,x} =$ 10.02585968 m s^{-1} Error= 0.02586 m s^{-1}

$\tilde{v}^b_{eb,y} =$ 0.451096774 m s^{-1} Error= 0.25110 m s^{-1}

North and East velocity

Heading solution: $\tilde{\psi}_{nb} = \psi_{nb} + \delta\psi_{nb} =$ 0.541052 rad

Frame transformation:

$$\begin{pmatrix} \tilde{v}^n_{eb,N} \\ \tilde{v}^n_{eb,E} \end{pmatrix} = \begin{pmatrix} \cos\tilde{\psi}_{nb} & -\sin\tilde{\psi}_{nb} \\ \sin\tilde{\psi}_{nb} & \cos\tilde{\psi}_{nb} \end{pmatrix} \begin{pmatrix} \tilde{v}^b_{eb,x} \\ \tilde{v}^b_{eb,y} \end{pmatrix} \qquad \begin{pmatrix} v^n_{eb,N} \\ v^n_{eb,E} \end{pmatrix} = \begin{pmatrix} \cos\psi_{nb} & -\sin\psi_{nb} \\ \sin\psi_{nb} & \cos\psi_{nb} \end{pmatrix} \begin{pmatrix} v^b_{eb,x} \\ v^b_{eb,y} \end{pmatrix}$$

$$\begin{pmatrix} \cos\psi_{nb} & -\sin\psi_{nb} \\ \sin\psi_{nb} & \cos\psi_{nb} \end{pmatrix} = \begin{matrix} 0.866025404 & -0.5 \\ 0.5 & 0.866025 \end{matrix} \qquad \begin{pmatrix} v^n_{eb,N} \\ v^n_{eb,E} \end{pmatrix} = \begin{matrix} 8.560254 \text{ m s}^{-1} \\ 5.173205 \text{ m s}^{-1} \end{matrix}$$

$$\begin{pmatrix} \cos\tilde{\psi}_{nb} & -\sin\tilde{\psi}_{nb} \\ \sin\tilde{\psi}_{nb} & \cos\tilde{\psi}_{nb} \end{pmatrix} = \begin{matrix} 0.857167301 & -0.51504 \\ 0.515038075 & 0.857167 \end{matrix}$$

$\begin{pmatrix} \tilde{v}^n_{eb,N} \\ \tilde{v}^n_{eb,E} \end{pmatrix} =$ 8.361507063 m s^{-1} Error= -0.19875 m s^{-1}

5.550364872 m s^{-1} Error= 0.37716 m s^{-1}