CS8803: STR, Spring 2018: Problem Set 1

Due: Wednesday, January 24th, beginning of the class

Instructions
There are 2 questions on this assignment (3 pages). These are short, simple problems. The maximum answer length should not exceed the space provided.

1 Markov Assumption

This is not meant to be a tricky question, just one to get you thinking about an important assumption that is often made. One paragraph each, at most.

1.1
Give one robotic example where the Markov assumption is used (correctly or not). Is the assumption valid or not? Explain.

1.2
Give one real-world example where the Markov assumption is used (correctly or not). Is the assumption valid or not? Explain.
2 Bayes Filter Derivation

Recall the derivation for the Bayes Filter in the slides:

\[
Bel(x_t) = P(x_t | u_{1:t}, z_{1:t}) \quad (1)
\]

\[
\ldots \quad (2)
\]

\[
\propto P(z_t | x_t) \int P(x_t | u_t, x_{t-1}) P(x_{t-1} | u_{1:t}, z_{1:t-1}) \, dx_{t-1} \quad (3)
\]

\[
\propto P(z_t | x_t) \int P(x_t | u_t, x_{t-1}) P(x_{t-1} | u_{1:t-1}, z_{1:t-1}) \, dx_{t-1} \quad (4)
\]

\[
\propto P(z_t | x_t) \int P(x_t | u_t, x_{t-1}) Bel(x_{t-1}) \, dx_{t-1} \quad (5)
\]

2.1

In the slides, the Markov assumption is invoked between lines (3) and (4) to drop \( u_t \). Why is this incorrect? (Why does the Markov assumption not enable you to drop \( u_t \))

2.2

Provide a counter-example where knowing \( u_t \) gives you information about the state \( x_{t-1} \).
2.3
What does the book assume about the controls $u$ in order to drop $u_t$ from the derivation of the Bayes Filter? Is this assumption reasonable? Why or why not?

2.4
There are weaker assumptions you can make about the controls to still drop $u_t$ from the Bayes Filter derivation. Think conditional independence, and derive how $u_t$ is dropped between lines (3) and (4).