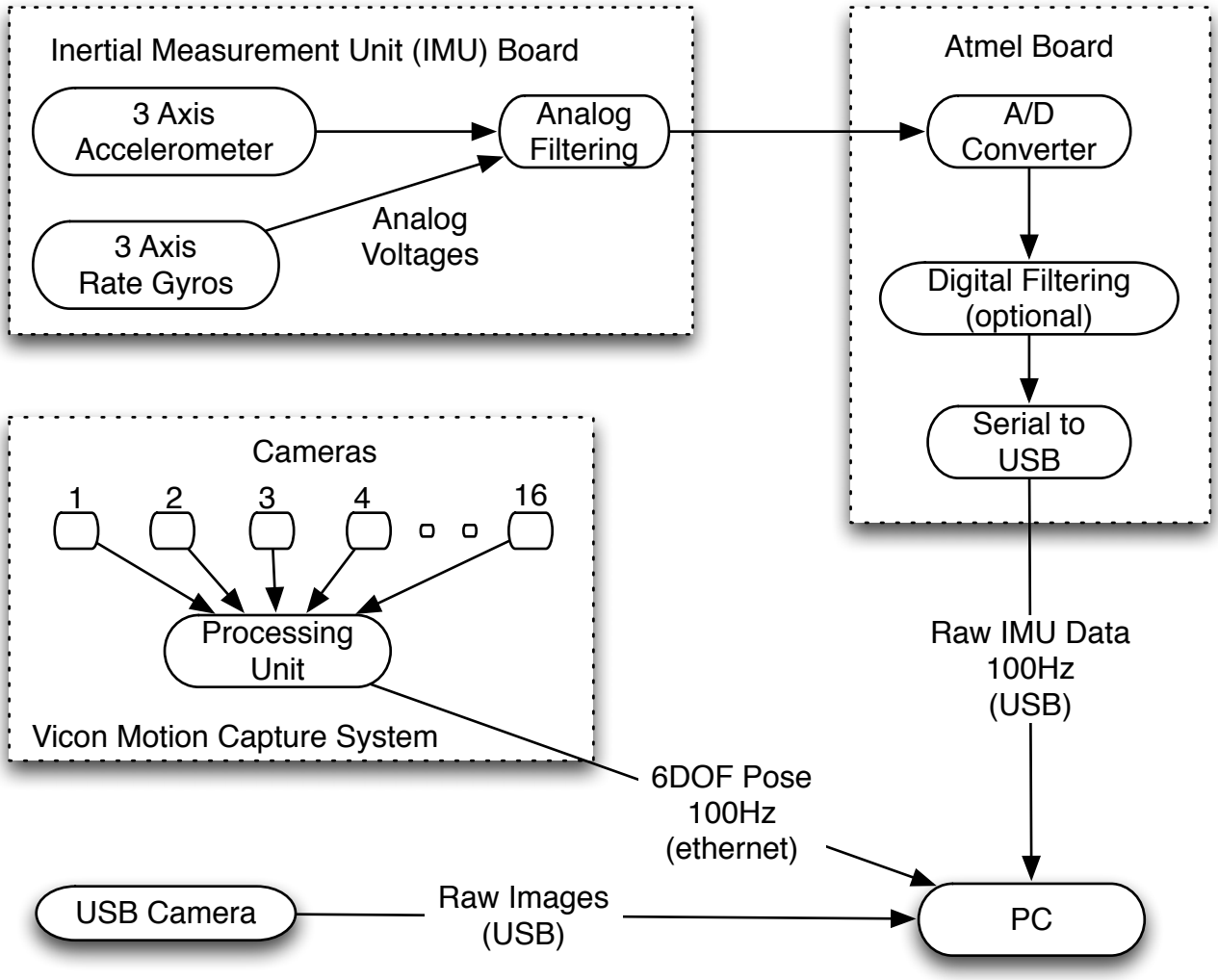
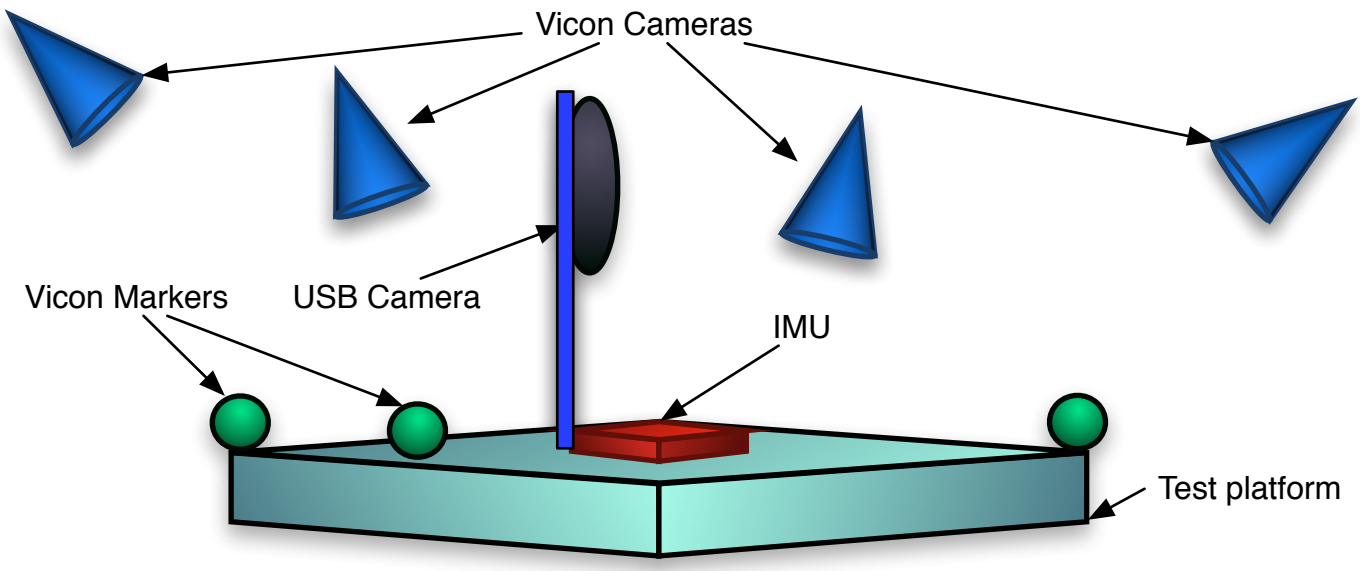
**ESE-650 Project 2**
**Upenn, Feb 2011**

02/02/2011
Rev. 2

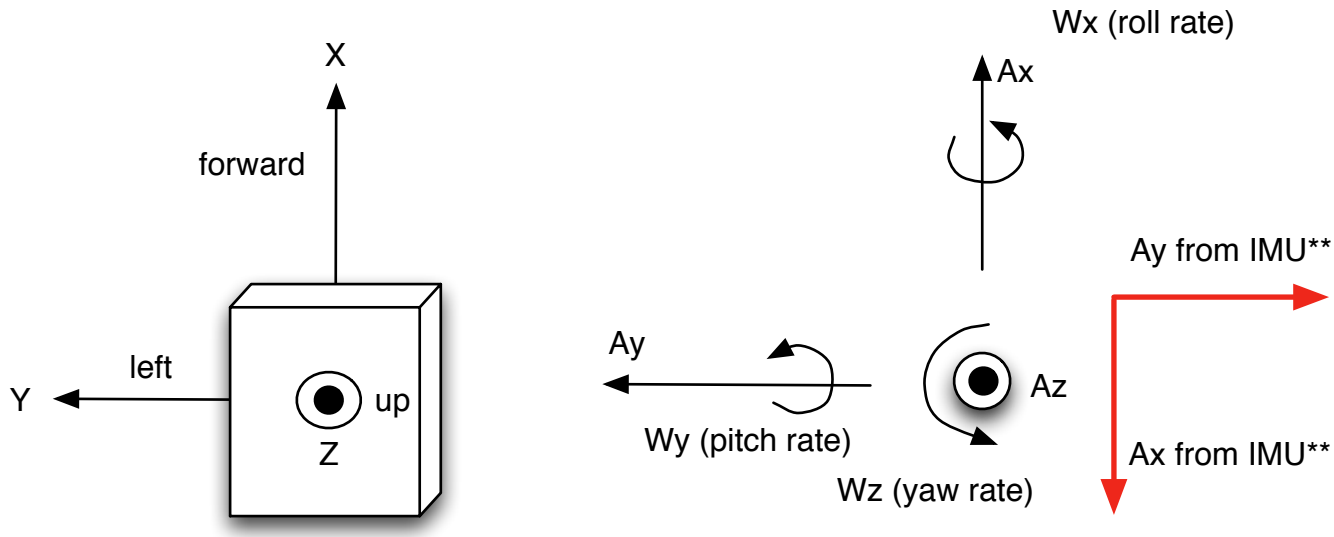
## System Diagram




## Experimental Setup



## Body Reference Frame Conventions




**Ax, Ay, Az** = accelerations along the corresponding axes (measures Normal force)
**Wx, Wy, Wz** = rotation rates about the corresponding axes (right-hand rule)

**IMU **Ax** and **Ay** direction is flipped (due to device design), so positive acceleration in body frame will result in negative acceleration reported by the IMU. All other measurements are consistent with the body frame.

Camera's optical axis is aligned with the x-axis

## Data Formats

**IMU Packet** (raw 10 bit ADC values) : 6xN matlab matrix (holding N samples)

| Ax | Ay | Az | **Wz** | Wx | Wy |
|---|---|---|---|---|---|

Note that angular rates are out of order! (original order of data is preserved)

There is also a vector of time stamps (unix time) of length N

**Vicon Packet** : 3x3xN matlab matrix (holding N rotational matrices)
1xN vector of time stamps (unix time)

**Images** : two Matlab arrays: uint8 M*N*3*K image array and K*1 timestamp array, where K is the number of images

## Construction of the Rotation Matrix

$$R = R_z * R_y * R_x = \begin{matrix} R00 & R01 & R02 \\ R10 & R11 & R12 \\ R20 & R21 & R22 \end{matrix}$$

# IMU Information

http://www.sparkfun.com/products/9956

## Sample Calculations

In order to convert from the raw A/D values to physical units, the equation is typically as follows:

value = (raw - bias) * scale_factor

scale_factor = Vref / 1023 * sensitivity

Vref = 3.3V = 3300 mV = reference voltage for A/D converter
The A/D converter is 10 bit, so maximum value is 1023
sensitivity for accelerometers is measured in mV/g and for rate gyros in mV/degree/sec

For example, the value in radians for a given raw rate gyro measurement is :

value = 3300 / 1023 * pi / 180 / sensitivity