**4.6 Error Minimization (IBRAHIM & DAVY)**

For the device to be practical, the result of the assisted cut must maintain implant frontal plane alignment accuracy to within 3°, meaning that the physical restraint must prevent no more than 0.5mm of penetration (Plaskos, 2005). The physical restraint must also respond with sufficient speed, at a rate of 1 kHz (Hungr). Assuming that mechanical play is negligible, the precision and accuracy of the device is limited by encoder resolution and update speed.

To achieve less than 0.5mm of penetration, the encoders were chosen for the highest precision in the smallest sizes available. The following table shows the details of the encoders and the respective links that they are attached to. Full specifications can be found in the appendices.

|  |  |
| --- | --- |
| Rotating Base | 1000PPR (4,000 effective CPR) – AME-1000V-T600K |
| Links 1-2 | 2500PPR (10,000 effective CPR) – TRD-SH2500VD |
| Links 4-5 | 1000PPR (4,000 effective CPR) – AME-1000V-T600K |

Using this combination of encoders, penetration is limited to an absolute theoretical maximum of 0.166mm relative to the axle of the bone mount.

To achieve an update rate of 1 kHz, a 600Mhz microprocessor with an FPU (Floating-Point Unit) is selected to perform all the data processing. The previous group of students had all processing performed on a 16Mhz microcontroller; however, analysis in the Technical Analysis Report showed that this microcontroller is incapable of achieving the necessary speed due to the lack of an FPU. Due to having only one computer/electrical engineer on the present team, the microcontroller was kept to serve as an interface between the microprocessor and the encoders/motor to reduce development time.



The OMAP3530 microprocessor is connected to the AT90CAN128 microcontroller via RS232 serial interface at 57600 baud. The microcontroller keeps track of the positions of the encoders and transmits them to the OMAP3530, which determines where the end-effecter is relative to the virtual surface using forward kinematics. A blocker position is then calculated and transmitted to the microcontroller, where it is then relayed to the motor controller via the CAN interface. Surfaces are preprogrammed with equations for simplicity.



The QNX Neutrino operating system was selected to run on the OMAP3530 for its real-time guarantee for applications running on embedded systems. It also provides a developer-friendly environment to develop and debug applications over serial or Ethernet.

At the time of writing, the device did not progress far enough to verify the functionality and performance of the control system. However, due to the speed limitations of the RS232 serial interface, the overall speed of the system can only achieve 90% of the 1 kHz requirement at 900Hz. One solution is to use a faster interface like the Two-wire interface. For a production system, a better solution is to use a single microcontroller capable of processing floating-point math. The TI Stellaris with an ARM Cortex M4 core would be a good candidate.