Rapid Prototyping Objects

SteamVR™ Tracking

Introduction

The best method to verify the performance of a tracked object in SteamVR is to build a prototype and test it. Prototyping consists of two systems. The mechanical system locates the sensors and holds them in the correct position. The electrical system consists of a series of circuit boards that interface the sensors to SteamVR.

Mechanical System

Manufacturing Processes

Prototyping of the mechanical system is best done with a low volume manufacturing method. The process selected will ultimately depend on lead time, desired quality, and quantity. The SLA additive manufacturing process is highly recommended for low procurement time and cost while having good finish quality. Parts can be painted to further improve aesthetics. FDM is another form of additive manufacturing that also has low procurement time and cost. However, it often suffers from low finish quality. If something simple like a frame is desired to hold sensors and electronics this can be a good choice. Another option if many copies of the same part are required is cast urethane. When ordering 10 or more parts the pricing can be competitive but keep in mind the longer lead time due to tooling fabrication. Machining may be a good process too, depending on the part complexity. The benefits are that parts can be complex and machined out of a thermoplastic. Piece part costs are high though, especially for larger parts.

Whichever method is selected, the design of the tracked object should be optimized to take advantage of the strengths of each prototyping process. Be sure to quote several manufacturers to get the best pricing and lead time. Don't be afraid to ask your manufacturer for design feedback. A good manufacturer will be able to suggest ways to decrease the lead time and cut costs.

Prototype process	Cost	Lead time	Finish quality
SLA	$ - $$	Fast	High
FDM	$	Fast	Low
Cast Urethane	$$$	Medium	High
Machining	$$$	Fast	Med - High

Design Considerations

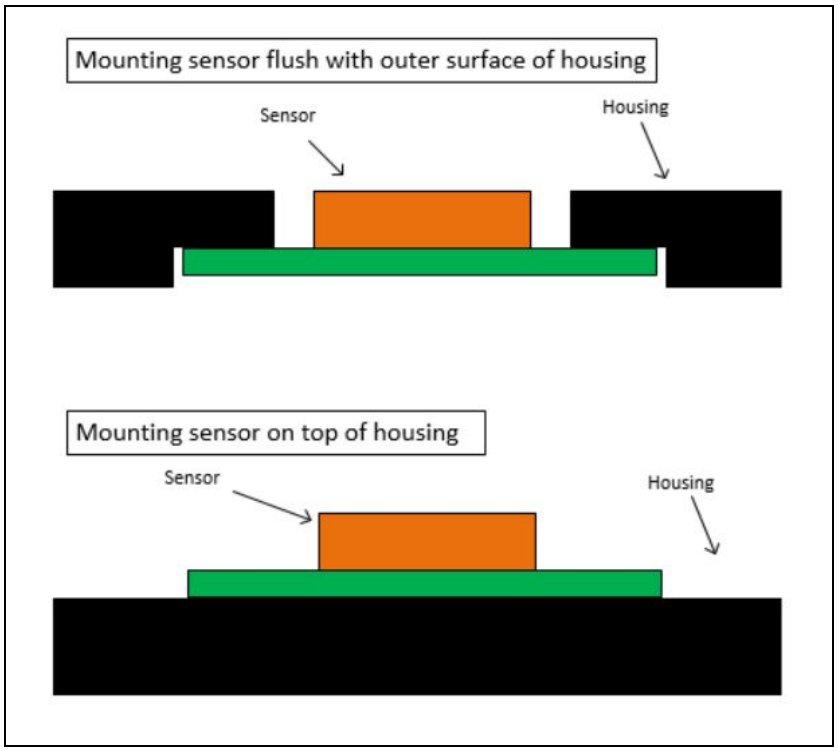
Sensors should be left uncovered for the first prototypes. As explained in the **Sensor Covering** document, choosing the right material and geometry is a complex subject. Verification of sensor placement prior to implementation of covers is also beneficial in that it may be useful for debugging potential tracking issues.

If sensor covers are needed on prototype objects they need to be transparent and diffuse at the target wavelengths (830 - 850 nm). Any optically clear material can meet the transparency requirement but will leave the sensors visible and won't block potentially saturating high intensity light bursts. While blocking out visible light is not absolutely necessary, the tracked object will have better aesthetics and more reliable tracking. Use a material that selectively allows IR light to transmit while blocking UV and visible light. Bar and sheet stock of such materials exist primarily to support the development of remote controls, laser lenses, and heat sensors. Compare transmission curve properties to the material

requirements discussed in the **Sensor Covering** document. One known source of such materials is ePlastics (http://www.eplastics.com/Plexiglass_Acrylic_Sheet_Infrared_Transmitting). Others can be found by looking for “infrared transmitting plastic” in your search engine of choice. The best performing materials will be darker colors like black, dark red, and dark blue. If specific grades or colors are desired, work with your plastic resin supplier to obtain samples or raw materials.

Sensor covers should also act diffuse at the target wavelengths. Volumetric diffusers exist but can be challenging to obtain. Applying a surface texture to the outside of a sensor cover is an effective way to introduce diffusion into the optical system. Bead blasting generates favorable results. The specific texture is not incredibly important as long as any glossy exterior surfaces are eliminated. The SteamVR Tracking reference object uses an MT-11020 texture. Less aggressive textures should also work well.

Sensors should be mounted flush or proud of the outside surface of the part. This will keep the enclosure from shadowing any of the sensors. This is obviously not a concern if the sensor is mounted on the outside surface of the tracked object. Mounting of the sensor to the enclosure should be done with pressure sensitive adhesive (PSA), hot glue, or epoxy. Keep in mind that some manufacturing processes like SLA have a low surface energy and are difficult to bond to with standard PSAs. Sensors must be mounted rigidly and not deviate position once they are calibrated in SteamVR.

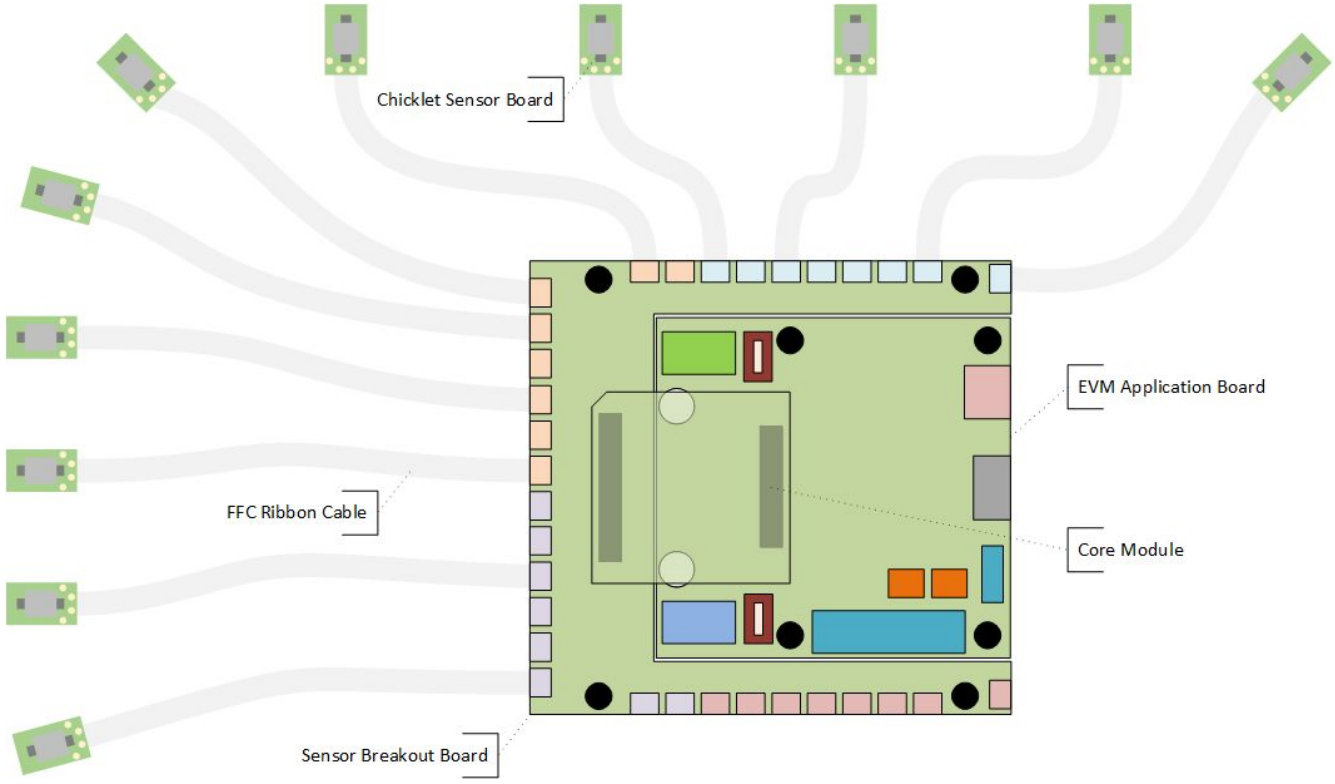


Strain relief should be provided for any cables connecting to the sensors and leaving the enclosure. Long term stress from a cable on a sensor may dislodge it from the mounting position. A cable that leaves the enclosure without a service loop orstrain relief may end up damaging the connector on the EVM board.

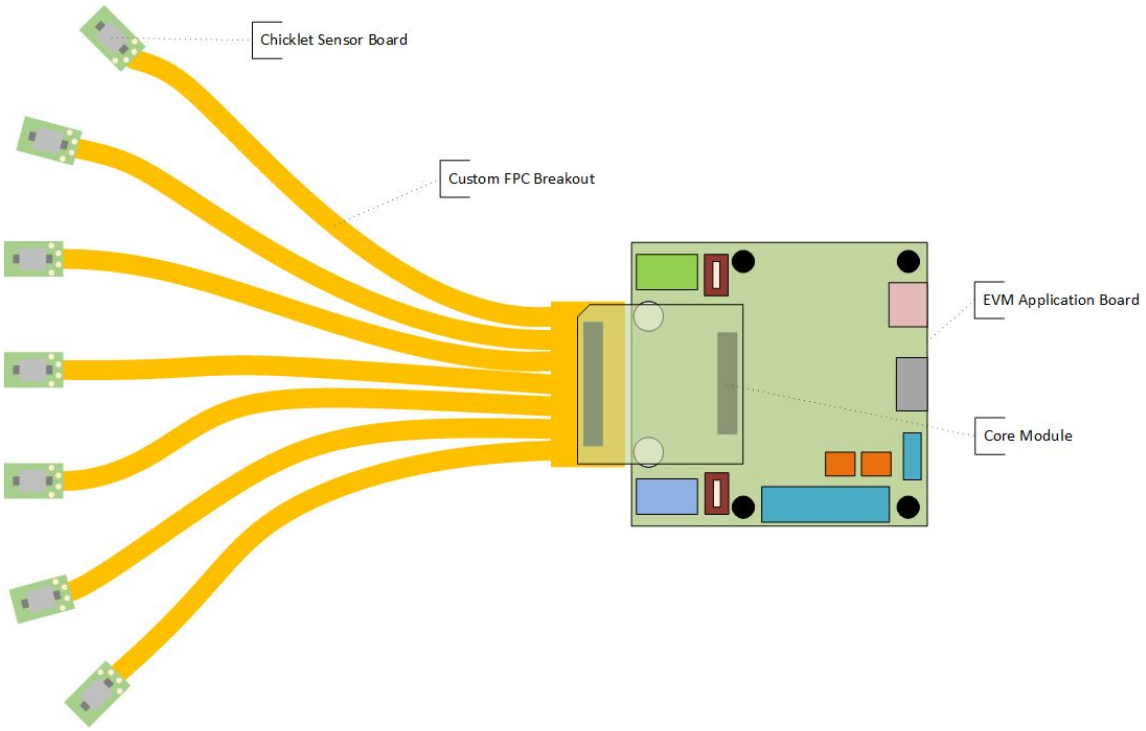
Electrical System

All the necessary electrical components required to create a tracking prototype are included in the SteamVR Tracking development kit. The kit consists of sensors, sensor cables of various lengths, and an evaluation board for the cables to connect to. The evaluation board can be used to connect to a computer running SteamVR by either USB or wireless.

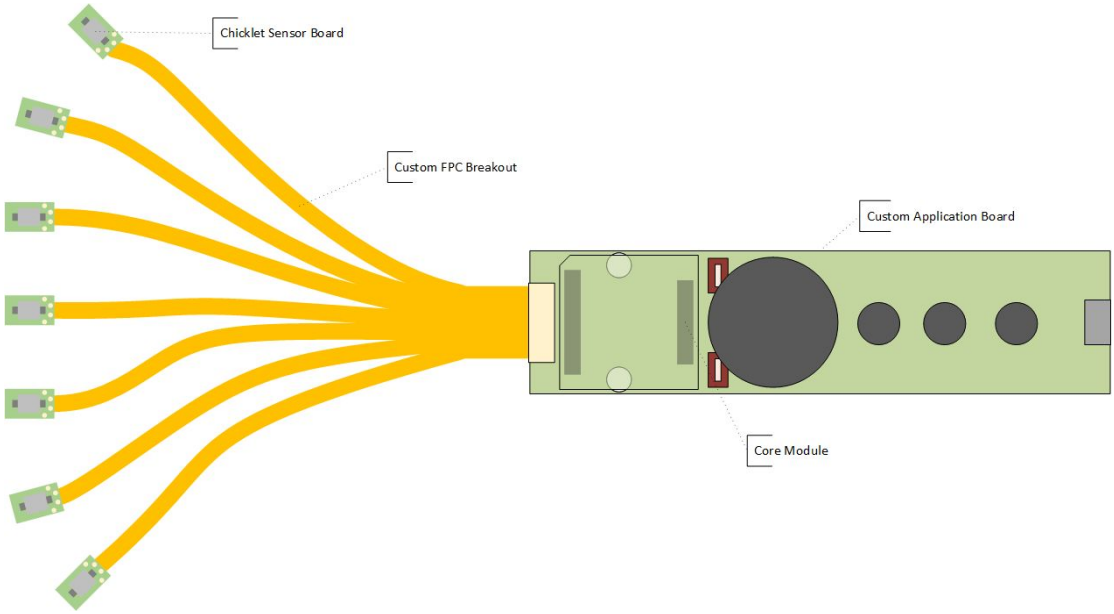
The development kit is designed to enable prototyping objects without fabricating any new printed circuit boards. After connecting the Core Module to the EVM Application Board and a Sensor Breakout Board, only the sensors remain. Up to 32 small “Chicklet” sensor boards may be connected to the Sensor Breakout Board via off-the-shelf FFC ribbon cables. Remember that only sensor channels 0-27 are sent over the wireless link, so avoid connecting to channels 28-31 when developing wireless prototypes.



As the prototypes move closer to the final form factor and industrial design, there may not be room for the sensor breakout board. It may be advantageous to design a custom flexible printed circuit to connect the sensors to the core module.



To quickly test the layout and ergonomics of controls, it may be possible to avoid laying out the circuitry of the Core Module by designing a new application board to integrate controls into the final form-factor.



Summary

Rapid prototyping is an essential tool for reducing the risk of tracked object design and development. There is no substitute for evaluating the tracking performance of an object in actual use cases. When prototyping the mechanical system, it is recommended to use a low volume manufacturing method, but the specific process selected will ultimately depend on the desired lead time, quality, and quantity. Sensors should left uncovered for the first prototypes, because choosing the right material and geometry is a complex subject and affects the final mechanical architecture. The fastest way to develop prototypes capable of tracking is to use the developement kit circuit boards. They may be configured in a variety of ways to create prototypes that move progressively closer to the production design. Once the sensor placement, ergonomics, and controls have been vetted through prototyping, moving to production tooling and quantities should pose a much lower risk to project costs and schedules.