Optical Methodology, Database Verification and Accuracy

A Technical White Paper

How FOV Pro predicts the installed field of view of professional CCTV cameras: the geometry it is built on, how its data is verified, how the measuring instrument is characterised, and the conditions under which its output can be relied on. This document describes the methodology at a level sufficient for professional evaluation while protecting proprietary implementation details.

Makalen Pty Ltd

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www.fovpro.app · www.fovpro.com.au

1. Executive Summary

FOV Pro is a mobile application that shows you the field of view of a specified CCTV camera, live, through the phone's own camera, from the intended mounting position. Its purpose is to close the gap between what a camera datasheet promises and what the camera will actually see once it's on the wall, before equipment is specified, ordered or installed.

This paper documents how that calculation is made. It covers the optical model the application is built on, the reasoning behind decisions on methodology, how the camera specification database is sourced and graded, how the phone itself is characterised as a measuring instrument and, with equal weight, what the application does not model and the conditions under which its stated accuracy holds.

It is written for the technical reader: security consultants, design engineers, integrators and project managers who need to decide whether FOV Pro output can be relied on in pre-sales design, coverage documentation and client communication. If you are inclined to assume corners were cut somewhere, whether that's aspect ratios divided in degrees, unverified scraped data or phone optics taken on faith, this document provides evidence to test that assumption.

FOV Pro was designed and is developed by a security industry professional with twenty-five years in the field, starting in installation and commissioning in 2001 and progressing through project management, sales engineering and consulting across enterprise and government environments. Every design decision in the application was made against a single test: would I trust this output on my own project?

2. Background: The Datasheet-to-Reality Gap

Most people in this industry have lived some version of the same moment. A camera is selected from a datasheet, installed exactly where the design said it should go, and the first look at the feed doesn't match what was expected. The doorway is clipped. The horizontal reach is wider than the plan implied. The vertical coverage falls short of the loading dock apron. The specification was correct and the outcome still wasn't.

The gap has several causes. Published field of view figures are measured under conditions the datasheet never fully describes. Wide angle lens distortion inflates some quoted values and not others. Varifocal ranges are summarised by two endpoints with nothing said about the behaviour in between. And the mental translation from 105 degrees horizontal to what will actually be in frame from that corner at 3.2 metres is one that even experienced engineers struggle with.

Desktop design tools address part of this by modelling coverage as polygons on a floor plan. That abstraction is useful for layout, but it answers a different question. A plan view cone does not show a client what the camera will see, and it is only as good as the specification data behind it, which is frequently imperfect in widely used tools. Section 6 covers this.

FOV Pro answers the question directly. Stand where the camera will be mounted, select the camera and focal length, and see the frame that camera will produce, live, through the phone. For the sales engineer, consultant or project manager who has to communicate coverage before a contract is signed, this replaces inference with observation.

Making that answer trustworthy, rather than just persuasive, is what the rest of this paper is about.

3. Design Principles

Four principles govern the engineering of FOV Pro. They are worth stating up front because they explain most of the decisions in the sections that follow.

1. **Constants over variables.** Every source of run time variability in the simulation chain is either eliminated or empirically pinned to a measured constant. A prediction built on floating variables is a guess with good presentation.
2. **Evidence over eyeballing.** Device values and constants are taken from documented, corroborated evidence and worked through the mathematics. They are never set by visually tuning the application against a single reference camera and generalising the result, because an eyeball match to one camera doesn't necessarily carry over to the next one.
3. **Trust datasheet data only where it has earned it.** Manufacturer specifications are the primary data source, but they are interrogated rather than assumed. Where published values are demonstrably inconsistent with geometry, FOV Pro derives the value from physical invariants instead. Section 4.2 documents the clearest case.
4. **Honesty about limitations.** Accuracy claims in FOV Pro are graded, bounded and conditional. Individual record confidence is shown in the interface rather than hidden behind a blanket claim, and the limitations in Section 7 are published here rather than left for the user to discover.

4. The Optical Model

4.1 Angular geometry is not linear geometry

FOV Pro is built on the rectilinear (pinhole) projection model, the standard model for non-fisheye lenses. For a sensor of width w behind a lens of focal length f, the horizontal field of view is:

$$HFOV = 2 \cdot arctan(\frac{w}{2f})$$

The consequence of this model, and the single most common source of error in FOV tools that take the obvious approach, is that angle does not scale linearly across the sensor. Pixels sit on a flat grid at equal spacing. The real world angles they capture do not. The mapping between sensor position and world angle is governed by the tangent function, which means field of view arithmetic has to be done in tangent space, not in degrees.

The clearest illustration is aspect ratio. The pixel aspect of a sensor is simple division: a 2592 × 1944 sensor is 1.333, exactly 4:3. The aspect of the angular field the lens projects is not:

$$FOV\ aspect = \frac{tan(\frac{HFOV}{2})}{tan(\frac{VFOV}{2})}$$

Consider a camera specifying 105° horizontal and 77° vertical. Simple division gives 105 ÷ 77 = 1.36, which looks like 4:3. The tangent space ratio is tan(52.5°) ÷ tan(38.5°) = 1.64, a substantially different shape sitting between 4:3 and 16:9. A tool that divides degrees will draw the wrong rectangle, and the error grows with lens width. Every crop, aspect conversion and zoom operation in FOV Pro is computed in tangent space.

4.2 The vertical field of view problem

The obvious way to build an FOV simulator is to take the manufacturer's published horizontal and vertical figures and use both. FOV Pro deliberately does not, and the reason is documented here in full because it shows the difference between piping datasheet values through an app and actually interrogating them.

During database development, published H/V pairs on wide CCTV lenses were repeatedly found to be geometrically inconsistent with each other. A concrete example can be found within a leading manufacturer's mainstream 2 MP dome with a 3.4 to 8.9 mm varifocal lens, a 1/2.8″ sensor and a native 1920 × 1080 output. The datasheet publishes a horizontal field of view of 100°–36° and a vertical field of view of 53°–20°. The output is exactly 16:9, so the tangent space ratio of every published H/V pair should be 1.78 at any focal length. Run the numbers and it isn't. The wide end pair implies an aspect of 2.39. The tele end pair implies 1.84. A single physical sensor cannot change shape with focal length. The wide end figures carry barrel distortion and do not describe rectilinear geometry. This is not a criticism of the manufacturer, whose documentation is among the best in the industry. It is the nature of publishing measured angles through real wide angle glass, and the same pattern appears across manufacturers. Many datasheets avoid the problem a different way, by publishing a horizontal figure only, or no angle at all, which leaves the system designer/specifier with even less to work from.

Resolving Horizontal / Vertical FOV Inconsistency

FOV Pro treats published horizontal field of view as the primary source of truth. It represents what the lens actually delivers in practice (including distortion) and is the figure most commonly referenced by installers and designers.

Vertical field of view is derived rather than quoted directly. It is calculated from the horizontal FOV and the sensor's true aspect ratio, taken from the camera's native pixel resolution (which is unaffected by lens distortion):

$$tan(\frac{VFOV}{2}) \; = \; tan(\frac{HFOV}{2}) \times (\frac{resolution_V}{resolution_H})$$

This approach produces a vertical FOV that is geometrically consistent with the horizontal figure and remains constant across the focal range, as required by the fixed physical dimensions of the sensor.

This method corrects for cases where manufacturers publish inconsistent or optimistic vertical FOV figures, often due to measurement variations on optical benches. Datasheet values referenced in this document are as published at the time of writing and subject to manufacturer revision.

4.3 Varifocal lenses

A varifocal datasheet publishes field of view figures at two points, the wide end and the tele end. Everything in between must be modelled. A pure thin lens calculation across the range drifts from real lens behaviour, because distortion characteristics change with focal length and the published endpoints already have that distortion baked in.

FOV Pro treats the two published endpoints as the manufacturer's measured truth and anchors to them exactly. At the wide and tele focal lengths the simulation reproduces the datasheet figures precisely. Between the endpoints, the field of view follows a mathematics based interpolation with a correction term that spreads the residual difference between pure geometry and the published endpoints proportionally across the range, so error is constrained at both ends rather than allowed to pile up at one of them.

4.4 Aspect ratio handling

A camera's native aspect in FOV Pro is determined from its published output resolution, the one specification that is pure sensor geometry. It is never inferred from the H/V degree pair, for the reasons established in 4.1 and 4.2. Where the application presents an alternative display aspect (for example a 16:9 view of a 4:3 sensor, matching common recorder and VMS configurations), the conversion is computed as a crop in tangent space. Angular truth is preserved rather than the frame being stretched or linearly scaled.

5. Characterising the Instrument: The Phone Itself

In FOV Pro the phone is the measuring instrument. If the instrument is not properly characterised, nothing downstream of it matters. The geometry in Section 4 can be perfect and the on-screen result still wrong. This is the objection a technical reader is most entitled to raise, and it shaped more of the development effort than any other single issue.

The simulation works by matching the target camera's horizontal field of view against the phone camera's continuous zoom, so the accuracy of the result rests on how well the phone's own delivered field of view is known, at every zoom level. Development quickly established that neither advertised phone specifications nor values reported by the operating system can be taken at face value:

- Advertised field of view figures for phone cameras are marketing values. They frequently describe the raw sensor rather than the delivered, processed frame.
- Platform behaviour differs materially. On Android, the camera framework documentation itself requires the hardware abstraction layer to adjust the reported crop region when video stabilisation is applied, and camera application developers have publicly documented substantial field of view crops from default stabilisation on common handsets. The frame an application receives can differ from both the advertised figure and what the specifications would suggest, and on some devices this happens below the level at which applications operate.
- The video pipeline is not the stills pipeline. The live video frame an application receives is frequently narrower than the same camera's photo frame. On Apple hardware this is a roughly ten per cent uniform crop that has been documented in Apple's own developer community

since iOS 8; on other platforms it varies by manufacturer and by lens. Because FOV Pro simulates through the live video frame, this class of behaviour matters directly.

- iOS reports dynamic field of view values on supported hardware that are usable in practice, but these are treated as claims to be checked against other evidence, not as ground truth.

FOV Pro's response is per-device support built on researched evidence: platform framework documentation, camera application developer notes, published camera module specifications and empirical field of view measurements reported and corroborated across the camera development community. A device value is accepted only where independent sources agree, and development testing against installed cameras of known specification has confirmed the documented platform behaviours above, which the simulation accounts for. Where the evidence for a device is thin or the sources disagree, the device is flagged as unsupported rather than silently approximated. An honest "not yet supported" beats a confident wrong answer.

How each supported device is characterised internally is proprietary and not published in this paper. The commitment that matters to the user is this: no device is marked supported without documented, corroborated field of view evidence behind it.

6. Camera Database: Methodology and Accuracy Tiers

A geometrically perfect simulation of an incorrect specification is an incorrect simulation. Database quality is therefore treated as primarily an accuracy problem, not a content problem.

Why this deserves emphasis: during development, an independent spot check was run on camera records in some widely used commercial CCTV design tool. A significant number of the sampled camera models contained incorrect specification data. The calculation frameworks behind tools of this kind are well established and mathematically sound; the failure mode is not the maths, it is the specification records feeding it. Errors of this kind are silent. The tool renders a confident coverage polygon from a wrong number, and every downstream design decision inherits the error. FOV Pro's position is that specification confidence has to be visible per record, not asserted globally.

6.1 Sourcing and verification

- Manufacturer datasheets are the primary source. Specifications are extracted from original manufacturer documentation into structured records, never harvested from resellers, aggregators or third party listings.
- Every record carries provenance. How it entered the database, and from what source, is tagged on the record.
- Extracted records pass through duplicate control and consistency checks, including the geometric consistency checks described in Section 4, which catch datasheet errors that a transcription-only pipeline would faithfully reproduce.
- User submitted cameras are quarantined from verified data until they have been independently checked against manufacturer documentation.

6.2 Accuracy tiers

Each camera in the database carries a visible accuracy tier, shown as an A, B or C badge in the interface and available as a filter. The tiers describe the provenance and completeness of the specification data behind the record, always referenced by letter rather than colour:

Tier	Meaning
A · Datasheet	Sourced from the manufacturer's full engineering datasheet, with horizontal field of view, vertical field of view, focal length and sensor format all explicitly published. Cross-checked for geometric consistency, and checked against physical hardware where it has been available. Highest confidence.
B · Marketing	Sourced from the manufacturer's product page or marketing collateral, where horizontal field of view and resolution are stated and the vertical field of view is derived using the geometry in Section 4.2. Reliable, though marketing figures are occasionally rounded.
C · Estimated	One or more values estimated: calculated from sensor format and focal length, or sourced where manufacturer data is incomplete or unavailable. Labelled in the interface and treated as a working approximation, not a design reference.

One further rule sits on top of data provenance. Cameras whose published horizontal field of view exceeds the widest phone ultrawide lens by more than a small margin (approximately 130° at the time of writing, reviewed as phone hardware evolves) are automatically graded C regardless of how good their datasheet is. The reason is physical, not clerical: the phone cannot see that region, so the outer boundary is extrapolated rather than observed, and the tangent geometry the extrapolation relies on becomes increasingly distortion-dominated at those angles. A field quoted at or near 180° cannot be rectilinear at all, since the tangent of a 90° half angle is infinite, and such figures describe fisheye projections rather than the geometry this model covers. Fisheye and extreme wide units are still listed where they matter to real projects, because designers still need to find and consider them, but they carry the C grade and the app presents their coverage as the working approximation it is, not as an observation.

Multi-sensor panoramic units are included where the heads deliver separate, unstitched streams: each head is a rectilinear camera in its own right and is recorded as one, with its own per-head field of view. What the database excludes is stitched panoramic output, where multiple sensors are blended into a single combined image, because the projection mathematics in Section 4 does not apply to a stitched frame and pretending otherwise would produce confident nonsense.

At the time of writing the database covers more than 1,000 camera models across 24 manufacturers and it grows continuously. Verification is prioritised over raw volume. A smaller database of graded, checked records is worth more to a professional user than a large one of unknown quality.

7. Known Limitations and the Accuracy Envelope

A tool intended for professional use has to state what it does not do. The following limitations are inherent to the current release and are published deliberately.

7.1 What FOV Pro does not model

- **Intra-frame lens distortion.** The simulation models the boundary of the field of view. It does not re-render the barrel or pincushion warp a real lens produces within the frame. Straight lines near the edge of a genuinely wide lens will bow in reality in ways the phone preview does not reproduce.
- **Resolution and pixel density.** A field of view match is a geometry match, not an image quality match. FOV Pro does not currently simulate the pixel density of the target camera, so a phone image is not evidence of what the camera will resolve at distance. A pixel density assessment capability, aligned with the updated criteria of IEC 62676-4 (2025), is under consideration for a future release and sits explicitly outside this paper's accuracy claims.
- **Photometric and environmental behaviour.** Infrared and low light performance, wide dynamic range behaviour, atmospheric conditions and depth of field are not modelled.

7.2 Conditions on stated accuracy

- The accuracy expectations below apply on supported devices, meaning devices with corroborated field of view evidence behind them. Unsupported devices are flagged in the app and carry no accuracy claim.
- Accuracy of presentation is strongest within the phone's optical zoom range, and the app marks true optical matches in the interface. Matching a long telephoto CCTV field, a PTZ at reach or a large optical zoom camera on a phone with limited or no optical telephoto forces heavy digital zoom: the on-screen image quality degrades drastically and bears no resemblance to what the CCTV camera's own optics will deliver at that focal length. The boundary geometry is a different story, and a counterintuitive one. Because residual error in the zoom chain is relative, the absolute angular error shrinks as the field narrows: a few per cent of a 4° field is a fraction of a degree. Spot checks during development have measured boundary error at maximum digital zoom at well under a degree. Treat long-zoom simulations as geometry only, but treat the geometry as sound.
- Simulation correctness is bounded by the specification record, which is exactly why the accuracy tier is displayed per camera rather than absorbed into a global claim. An A-tier record carries the highest confidence; a C-tier record is a working approximation and should be treated as one.
- Positioning aids (GPS and device sensors) are conveniences for documentation, not survey instruments, and carry the accuracy of the underlying phone hardware.

Within those conditions, a supported device, an A-tier camera and operation within the phone's optical range, the field of view boundary shown on screen is expected to sit close to the installed camera's delivered frame, with residual error dominated by installation tolerances and the datasheet itself. That is the claim this paper is prepared to defend, and it is deliberately narrower than the claim a marketing document would make.

8. Using FOV Pro Output in Formal Documentation

FOV Pro captures are intended to support pre-sales design, coverage communication and site documentation. Used correctly, a capture is a strong, honest artefact. Used as something it is not, it becomes a liability. The distinction:

What a capture represents: a geometric calculation of the field of view boundary of the specified camera model, at the specified focal length and aspect, from the physical position at which the capture was taken, at the time it was taken.

What a capture does not certify: delivered image quality; identification, recognition or detection capability at distance; compliance with the pixel density criteria of IEC 62676-4 (2025), the legacy DORI levels they supersede, or any other performance standard; behaviour under the site's actual lighting; or the final as-built result, which remains subject to installation tolerances and commissioning.

Recommended practice for handover and proposal documents is to caption FOV Pro captures with wording along these lines:

> *"Indicative field of view simulation produced with FOV Pro from the proposed mounting position. Represents calculated coverage geometry for the nominated camera and lens setting. Does not represent delivered image quality or certified performance. Final coverage subject to installation and commissioning verification."*

FOV Pro is designed to support engineering judgement, not replace it. Commissioning verification against the installed camera remains the authority on delivered coverage. The application's job is to make sure that what arrives at commissioning is not a surprise.

9. About FOV Pro and Makalen

FOV Pro is developed and published by Makalen Pty Ltd, an Australian company. The application was born of frustration: twenty-five years of watching the gap between datasheet and delivered frame cost projects time, budget and client confidence, and the conviction that the gap was a solvable geometry problem rather than an occupational hazard.

The developer's background spans installation and commissioning (from 2001), project management, sales engineering, business development and security consulting across commercial, enterprise and government environments, including extensive work with enterprise video management and access control platforms. That background sets the standard the application is held to. Its output is meant to be defensible in front of the most demanding audience its developer knows, which is other industry professionals.

Feedback on this paper, database corrections and field accuracy reports are actively sought. FOV Pro is available on Google Play and the App Store. Contact and documentation: www.fovpro.app and www.fovpro.com.au

support@fovpro.app

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