

# MATHEMATICS BEHIND MEASUREMENTS AI-Powered Body Measurement Engine CEO BRIEF | May 2026

Three pillars powering automatic body measurement: Pose Estimation + Depth Sensing + Ramanujan Ellipse Geometry

## 1. POSE ESTIMATION — 17 Keypoints

AI vision model maps the human body to **17 anatomical landmarks** in real-time from a single camera frame.

### HEAD & FACE

- Nose • Left Eye • Right Eye
- Left Ear • Right Ear

### UPPER BODY

- Left / Right Shoulder
- Left / Right Elbow
- Left / Right Wrist

### LOWER BODY

- Left / Right Hip
- Left / Right Knee
- Left / Right Ankle

Output: 2D pixel coordinates (x, y) + confidence score per joint.

## 2. DEPTH SENSING — Pixel → Real-World

Depth map gives the **Z-distance** for every pixel — converts a flat image into a 3D point cloud.

### CORE CONVERSION

$$X = (u - c_x) \cdot Z / f_x$$

$$Y = (v - c_y) \cdot Z / f_y$$

(u, v) = pixel • (c<sub>x</sub>, c<sub>y</sub>) = optical center • (f<sub>x</sub>, f<sub>y</sub>) = focal length

### EUCLIDEAN DISTANCE BETWEEN JOINTS

$$d = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2 + (Z_2 - Z_1)^2}$$

Used for: Height, Arm length, Inseam, Shoulder width, Torso length.

## 3. RAMANUJAN'S ELLIPSE — Circumferences

Body cross-sections (waist, chest, hips, thigh) are modeled as **ellipses**. Ramanujan's Approximation 3 gives near-exact perimeter.

### STEP 1 — Compute h

$$h = (a - b)^2 / (a + b)^2$$

### STEP 2 — Perimeter

$$p \approx \pi (a + b) \cdot (1 + 3h / (10 + \sqrt{4 - 3h}))$$

a = semi-major axis • b = semi-minor axis

### WHY RAMANUJAN?

- Accuracy: error < 0.04% across all eccentricities
- No elliptic integrals — runs on-device in microseconds
- Replaces calibrated tape measure for 1990 contour readings

① CAPTURE  
RGB + depth frame

② DETECT  
17 pose keypoints

③ PROJECT  
2D → 3D world coords

④ MEASURE  
Lengths + ellipse fit

⑤ DELIVER  
Body profile JSON

LINEAR (Euclidean)  
Height • Arm • Leg • Inseam

WIDTHS  
Shoulders • Hips • Torso

CIRCUMFERENCES (Ramanujan)  
Chest • Waist • Hip • Thigh • Bicep

ACCURACY  
± 1 cm | < 0.04% formula error

**Bottom line:** A single phone camera + a 100-year-old equation = tape-measure-grade body data, instantly. No hardware. No human in the loop.

