Supplementary Material

MeshMonk: open-source large-scale intensive 3D phenotyping

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# Supplementary Data

**Supplementary Table 1.** Descriptive data for the validation sample used. These data are included only to describe the variation present in the sample and were not used as covariates in statistical analyses.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ID | Sex | Age | Height (cm) | Weight (kg) | Self-identified population | Camera |
| 61549 | F | 33 | 155.00 | 48.00 | Admixed African and European | 2006, 2-pod |
| 61587 | F | 20 | 158.00 | 43.00 | Italian | 2006, 2-pod |
| 61622 | M | 21 | 175.00 | 71.99 | Italian | 2006, 2-pod |
| 62102 | M | 22 | 178.00 | 60.01 | Polish | 2006, 2-pod |
| 62588 | M | 21 | 172.00 | 57.02 | Portuguese | 2006, 2-pod |
| 62633 | M | 41 | 176.00 | 76.02 | Portuguese | 2006, 2-pod |
| 62659 | F | 28 | 169.00 | 57.02 | Portuguese | 2006, 2-pod |
| 62677 | M | 24 | 175.00 | 65.00 | Portuguese | 2006, 2-pod |
| 62695 | F | 30 | 165.00 | 66.00 | Portuguese | 2006, 2-pod |
| 63096 | F | 20 | 165.10 | 57.15 | Irish | 2006, 2-pod |
| 63123 | F | 27 | 165.00 | 57.15 | Irish | 2006, 2-pod |
| 63151 | F | 43 | 165.10 | 69.85 | Irish | 2006, 2-pod |
| 63156 | M | 19 | 184.00 | 60.33 | Irish | 2006, 2-pod |
| 63173 | M | 19 | 180.00 | 66.00 | Irish | 2006, 2-pod |
| 131213 | M | 23 | 172.55 | 72.85 | Broadly European | 2013, 2-pod |
| 140241 | F | 33 | 160.70 | 57.40 | Unknown | 2014, 3-pod |
| 140268 | M | 19 | 179.00 | 103.80 | Mixed European and European American | 2014, 3-pod |
| 140679 | M | 62 | 166.00 | 63.30 | Mixed European and European American | 2014, 3-pod |
| 140721 | F | 26 | 165.00 | 101.30 | Mixed European and European American | 2014, 3-pod |
| 140739 | F | 73 | 169.00 | 83.00 | Mixed European and European American | 2014, 3-pod |
| 140956 | M | 21 | 168.60 | 70.80 | Broadly European | 2014, 3-pod |
| 141280 | F | 79 | 149.86 | 70.31 | Broadly European | 2014, 3-pod |
| 141527 | F | 66 | 170.18 | 97.07 | Mixed European and European American | 2014, 3-pod |
| 141563 | F | 24 | 154.94 | 52.16 | Mixed European and European American | 2014, 3-pod |
| 141706 | F | 63 | 170.18 | 81.65 | Broadly European | 2014, 3-pod |
| 141713 | F | 53 | 162.56 | 86.18 | Broadly European | 2014, 3-pod |
| 141869 | F | 25 | 152.40 | 46.72 | Mixed European and European American | 2014, 3-pod |
| 141875 | F | 55 | 165.10 | 62.60 | Mixed European and European American | 2014, 3-pod |
| 141913 | F | 20 | 162.56 | 68.04 | Mixed European and European American | 2014, 3-pod |
| 141979 | F | 65 | 157.48 | 54.43 | Mixed European and European American | 2014, 3-pod |
| 143007 | F | 27 | 156.40 | 62.40 | Mixed European and European American | 2014, 3-pod |
| 143076 | F | 19 | 181.00 | 68.40 | Mixed European and European American | 2014, 3-pod |
| 143093 | F | 18 | 179.00 | 65.00 | Broadly European | 2014, 3-pod |
| 143126 | F | 20 | 162.30 | 98.90 | Broadly European | 2014, 3-pod |
| 143162 | F | 19 | 170.00 | 75.70 | Broadly European | 2014, 3-pod |
| 143221 | F | 53 | 164.00 | 50.80 | Mixed European, Jewish | 2014, 3-pod |
| 143235 | F | 22 | 169.90 | 55.00 | Mixed European and European American | 2014, 3-pod |
| 143340 | M | 28 | 174.00 | 65.30 | Broadly European | 2014, 3-pod |
| 143578 | F | 23 | 161.00 | 78.20 | Broadly European | 2014, 3-pod |
| 143651 | F | 19 | 162.00 | 59.40 | Mixed European, Jewish | 2014, 3-pod |
| 143670 | F | 21 | 164.60 | 67.20 | Mixed European and European American | 2014, 3-pod |

# Supplementary Figures and Tables

## Supplementary Figures

## Supplementary Tables

**Supplementary Table X**. Standard deviation (mm) of landmark iterations along the x, y, and z dimension, averaged across images for each landmark. The means of each observer as well as the inter-observer error are reported in Table X of the accompanying manuscript.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Landmark* | *Standard deviation (mm)* | | | | | | | | | | | |
| *Observer AJ* | | | | *Observer JW* | | | | *Inter-observer* | | | |
| *X* | *Y* | *Z* | *Mean* | *X* | *Y* | *Z* | *Mean* | *X* | *Y* | *Z* | *Mean* |
| *Alar curvature left* | 0.2069 | 0.6795 | 0.9196 | **0.6020** | 0.1471 | 0.5472 | 0.6074 | **0.4339** | 0.1222 | 0.3752 | 0.4227 | **0.3067** |
| *Alar curvature right* | 0.2076 | 0.7503 | 0.9333 | **0.6304** | 0.1327 | 0.4612 | 0.5379 | **0.3773** | 0.1219 | 0.3369 | 0.5273 | **0.3287** |
| *Chelion left* | 0.8601 | 0.5386 | 0.4255 | **0.6080** | 0.6703 | 0.3527 | 0.3184 | **0.4472** | 0.5948 | 0.2965 | 0.3631 | **0.4182** |
| *Chelion right* | 0.8074 | 0.4917 | 0.5016 | **0.6002** | 0.7412 | 0.3465 | 0.3924 | **0.4934** | 0.4269 | 0.2712 | 0.1971 | **0.2984** |
| *Crista philtri left* | 0.5461 | 0.6676 | 0.2912 | **0.5016** | 0.4327 | 0.2984 | 0.1812 | **0.3041** | 0.5169 | 0.4584 | 0.1890 | **0.3881** |
| *Crista philtri right* | 0.5518 | 0.7146 | 0.3409 | **0.5358** | 0.4654 | 0.2520 | 0.1671 | **0.2949** | 0.6536 | 0.5698 | 0.1976 | **0.4737** |
| *Endocanthion left* | 0.9219 | 0.6269 | 0.6852 | **0.7447** | 0.5506 | 0.3861 | 0.3749 | **0.4372** | 0.5882 | 0.3286 | 0.3917 | **0.4362** |
| *Endocanthion right* | 1.1879 | 0.5003 | 0.6209 | **0.7697** | 0.5617 | 0.3647 | 0.4121 | **0.4462** | 0.4828 | 0.2689 | 0.3306 | **0.3608** |
| *Exocanthion left* | 0.6899 | 0.5058 | 0.5631 | **0.5863** | 0.5032 | 0.4039 | 0.4069 | **0.4380** | 0.3635 | 0.2705 | 0.2498 | **0.2946** |
| *Exocanthion right* | 0.7402 | 0.5897 | 0.6330 | **0.6543** | 0.4346 | 0.2882 | 0.3507 | **0.3579** | 0.3524 | 0.2374 | 0.2668 | **0.2855** |
| *Glabella* | 0.5627 | 0.8658 | 0.2998 | **0.5761** | 0.4532 | 1.1696 | 0.4414 | **0.6881** | 0.4175 | 0.6913 | 0.2536 | **0.4542** |
| *Labiale inferius* | 0.5214 | 0.6100 | 0.3782 | **0.5032** | 0.4183 | 0.3355 | 0.1987 | **0.3175** | 0.5355 | 0.8468 | 0.3749 | **0.5857** |
| *Labiale superius* | 0.4673 | 0.5861 | 0.2228 | **0.4254** | 0.2968 | 0.3757 | 0.1274 | **0.2666** | 0.3752 | 0.4534 | 0.1269 | **0.3185** |
| *Nasion* | 0.3302 | 0.9321 | 0.3471 | **0.5365** | 0.3132 | 0.8478 | 0.4595 | **0.5402** | 0.3891 | 0.8151 | 0.2772 | **0.4938** |
| *Pogonion* | 0.6464 | 1.2742 | 0.5419 | **0.8208** | 0.6220 | 1.1558 | 0.5000 | **0.7593** | 0.7110 | 0.7572 | 0.3278 | **0.5987** |
| *Pronasale* | 0.4185 | 0.7104 | 0.2491 | **0.4593** | 0.2994 | 0.4423 | 0.2053 | **0.3157** | 0.2896 | 0.4927 | 0.2147 | **0.3323** |
| *Subalare left* | 0.5524 | 0.3630 | 0.5900 | **0.5018** | 0.5157 | 0.3075 | 0.4553 | **0.4262** | 0.4764 | 0.2554 | 0.4697 | **0.4005** |
| *Subalare right* | 0.5767 | 0.3144 | 0.5739 | **0.4883** | 0.6422 | 0.3214 | 0.4909 | **0.4848** | 0.4979 | 0.3147 | 0.4723 | **0.4283** |
| *Subnasale* | 0.3765 | 0.6527 | 0.3219 | **0.4504** | 0.3342 | 0.7196 | 0.3546 | **0.4695** | 0.1766 | 0.5530 | 0.3143 | **0.3480** |
| *Mean* | **0.5880** | **0.6512** | **0.4968** | **0.5787** | **0.4492** | **0.4935** | **0.3675** | **0.4367** | **0.4259** | **0.4523** | **0.3141** | **0.3974** |

**Supplementary Table X.** Standard deviation (mm) between manual landmarks and automatic landmarks trained using AZ’s three iterations (AutoAZ), JW’s three iterations (AutoJW), or all six iterations from both observers (AutoAll). Values presented are averaged across all images. The mean values for each landmark are presented in Table X of the accompanying manuscript.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Landmark* | *Standard deviation (mm)* | | | | | | | | | | | |
| *MLAZ-MLJW-AutoAZ* | | | | *MLAZ-MLJW-AutoJW* | | | | *MLAZ-MLJW-AutoAll* | | | |
| *X* | *Y* | *Z* | *Mean* | *X* | *Y* | *Z* | *Mean* | *X* | *Y* | *Z* | *Mean* |
| *Alar curvature left* | 0.1394 | 0.4469 | 0.5053 | **0.3639** | 0.1401 | 0.4517 | 0.5076 | **0.3665** | 0.1365 | 0.4473 | 0.5070 | **0.3636** |
| *Alar curvature right* | 0.1481 | 0.4352 | 0.5640 | **0.3824** | 0.1424 | 0.4114 | 0.5875 | **0.3804** | 0.1428 | 0.4175 | 0.5651 | **0.3751** |
| *Chelion left* | 0.9005 | 0.4832 | 0.4722 | **0.6186** | 0.8635 | 0.5094 | 0.4970 | **0.6233** | 0.8745 | 0.5046 | 0.4911 | **0.6234** |
| *Chelion right* | 0.7165 | 0.4469 | 0.3787 | **0.5140** | 0.7090 | 0.4560 | 0.3841 | **0.5164** | 0.7108 | 0.4536 | 0.3797 | **0.5147** |
| *Crista philtri left* | 0.6274 | 0.6664 | 0.3198 | **0.5379** | 0.6666 | 0.7251 | 0.3366 | **0.5761** | 0.6187 | 0.6772 | 0.3194 | **0.5384** |
| *Crista philtri right* | 0.7151 | 0.7700 | 0.3400 | **0.6084** | 0.7431 | 0.8217 | 0.3291 | **0.6313** | 0.6996 | 0.7646 | 0.3216 | **0.5952** |
| *Endocanthion left* | 0.6934 | 0.4443 | 0.4570 | **0.5316** | 0.7228 | 0.4660 | 0.3987 | **0.5292** | 0.6763 | 0.4437 | 0.4019 | **0.5073** |
| *Endocanthion right* | 0.7574 | 0.4410 | 0.4105 | **0.5363** | 0.7743 | 0.4747 | 0.4254 | **0.5581** | 0.7449 | 0.4650 | 0.4035 | **0.5378** |
| *Exocanthion left* | 0.6328 | 0.4997 | 0.5774 | **0.5700** | 0.6326 | 0.5200 | 0.5626 | **0.5717** | 0.6337 | 0.5106 | 0.5644 | **0.5696** |
| *Exocanthion right* | 0.6335 | 0.4516 | 0.6015 | **0.5622** | 0.6438 | 0.4479 | 0.5971 | **0.5629** | 0.6416 | 0.4486 | 0.6024 | **0.5642** |
| *Glabella* | 0.4613 | 1.0322 | 0.3988 | **0.6307** | 0.4648 | 1.0058 | 0.4162 | **0.6289** | 0.4465 | 1.0095 | 0.4026 | **0.6196** |
| *Labiale inferius* | 0.5330 | 0.8428 | 0.4410 | **0.6056** | 0.5318 | 0.8800 | 0.4247 | **0.6122** | 0.4948 | 0.8029 | 0.4156 | **0.5711** |
| *Labiale superius* | 0.4887 | 0.6250 | 0.2171 | **0.4436** | 0.4781 | 0.6951 | 0.2603 | **0.4778** | 0.4748 | 0.6259 | 0.2283 | **0.4430** |
| *Nasion* | 0.3839 | 0.9325 | 0.3867 | **0.5677** | 0.3939 | 0.9081 | 0.3763 | **0.5594** | 0.3681 | 0.9002 | 0.3740 | **0.5474** |
| *Pogonion* | 0.6394 | 0.8707 | 0.3478 | **0.6193** | 0.6499 | 0.8607 | 0.3577 | **0.6227** | 0.5961 | 0.8578 | 0.3518 | **0.6019** |
| *Pronasale* | 0.3560 | 0.5650 | 0.2399 | **0.3870** | 0.3622 | 0.5407 | 0.2619 | **0.3883** | 0.3482 | 0.5338 | 0.2467 | **0.3763** |
| *Subalare left* | 0.6139 | 0.3424 | 0.5303 | **0.4956** | 0.6103 | 0.3511 | 0.5006 | **0.4873** | 0.5825 | 0.3388 | 0.4935 | **0.4716** |
| *Subalare right* | 0.5822 | 0.3728 | 0.5752 | **0.5100** | 0.5975 | 0.3857 | 0.5043 | **0.4958** | 0.5696 | 0.3691 | 0.5251 | **0.4879** |
| *Subnasale* | 0.2448 | 0.5265 | 0.3109 | **0.3607** | 0.2504 | 0.5592 | 0.2958 | **0.3684** | 0.2462 | 0.5250 | 0.2995 | **0.3569** |
| ***Mean*** | **0.5404** | **0.5892** | **0.4250** | **0.5182** | **0.5462** | **0.6037** | **0.4223** | **0.5240** | **0.5266** | **0.5840** | **0.4154** | **0.5087** |