

Contact person RISE
Tommy Vikberg
Division Built Environment
+46 10 516 62 64
tommy.vikberg@ri.se

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Katam Technologies AB
Bredgatan 4 A
21130 MALMÖ

Conformity of determined breast height diameters by use of Katam App and caliper

(3 appendices)

Introduction

Katam Technologies has developed a cell phone application (app), “*Katam Forest*”, for determination of the stem diameter at breast height (DBH). To get a third-party investigation of its conformity with measurements by using a caliper, RISE was hired. RISE is an independent, Swedish state-owned research institute providing objective investigations on a scientific basis.

Material and Methods

A cellphone compatible with the app was provided by Katam. The installed version of the app was *develop-5acf300d*. The manual measurements were performed with a computer caliper from Haglöf. In total, 150 stems were measured out of which 50 stems from each specie; Pine (*Pinus sylvestris*), Spruce (*Picea abies*) and Birch (*Betula spp.*) respectively. The breast height, which is defined as 1.3 meters above the ground, was estimated by knowing this point on the chest and standing close to the stem.

The data was collected in 9 different stands. Pictures from each stand can be found in Appendix 1. The number of stems measured in each stand for the different species is shown in Table 1.

Table 1. Number of measured stems for each stand and specie.

Specie	Stand 1	Stand 2	Stand 3	Stand 4	Stand 5	Stand 6	Stand 7	Stand 8	Stand 9
Pine	13	12	12	3	3	4	3	0	0
Spruce	0	2	0	1	13	16	18	0	0
Birch	0	0	7	16	0	1	2	15	9

The DBH of each stem was determined three times with the app by walking approximately the same route and perform three different recordings with the camera according to the instructions in a user manual provided by Katam, see Appendix 3. The DBH used as reference was achieved as the mean of two DBH measurements achieved by cross caliper. When running a play-back of the movies achieved with the app, results with obvious errors were excluded, those errors consisted typically of two small diameter stems that had been interpreted as one large diameter stem.

RISE Research Institutes of Sweden AB

Postal address
Box 857
501 15 BORÅS
SWEDEN

Office location
Laboratorgränd 2C
931 77 Skellefteå
SWEDEN

Phone / Fax / E-mail
+46 10-516 50 00
+46 33-13 55 02
info@ri.se

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In the evaluation of the result, each individual result from the app was compared to the reference DBH. No consideration was made upon how individual errors might cancel each other when estimating the volume of a stand, instead each individual measurement was considered.

Results

The presentation of the results is made for each specie separately. In Table 2 the root mean square error (RMSE), average deviation, and mean absolute error (MAE) between the DBH determined with the app and the caliper is given. The negative numbers for the average deviation implies that a smaller DBH was determined with the app than with the caliper.

Table 2. RMSE, average deviation and MAE for the DBH determined with the app in comparison to the manual measurements.

Specie	RMSE (mm)	Average dev. (mm)	MAE (%)
Pine	19	-9	6.5
Spruce	26	-14	9.5
Birch	15	-1	8.4

In Figure 1 to Figure 3, each DBH determined with the app is shown as a + for the three considered species. In addition, a solid line for $y = x$ is shown.

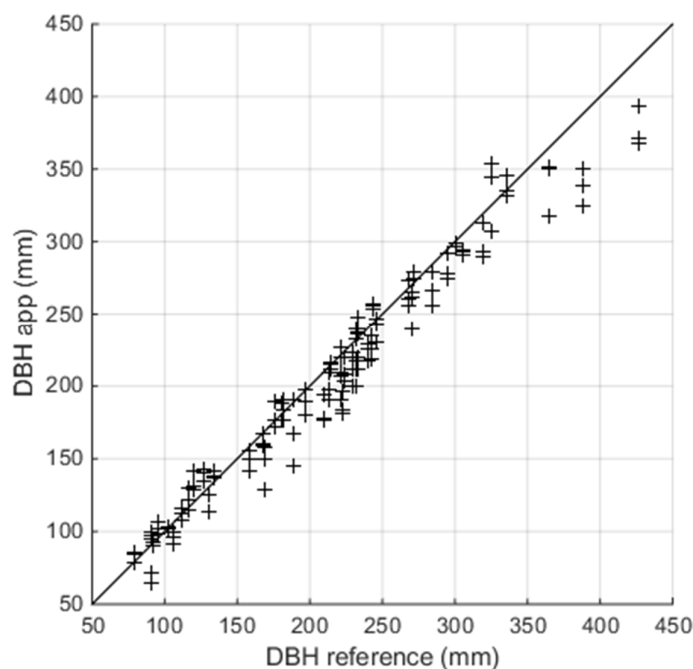


Figure 1. DBH for **pine** measured as reference and with the app. The solid line corresponds to $y = x$.

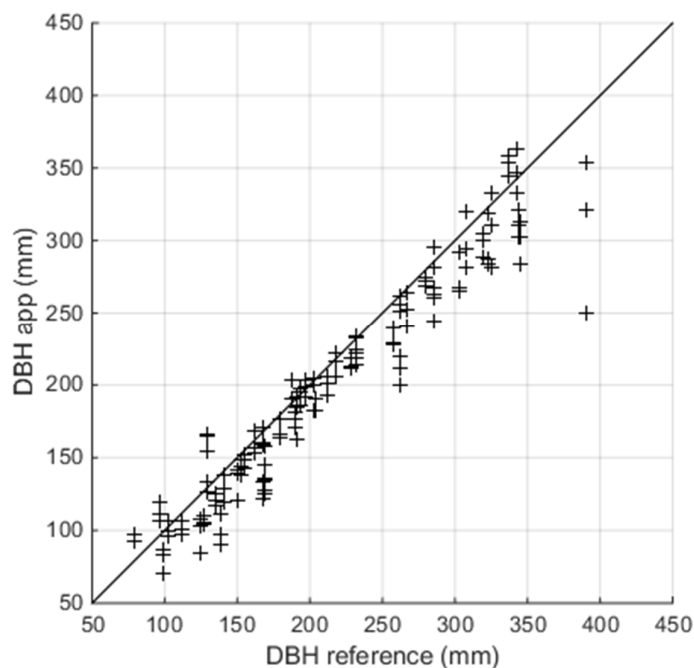


Figure 2. DBH for **spruce** measured as reference and with the app. The solid line corresponds to $y = x$.

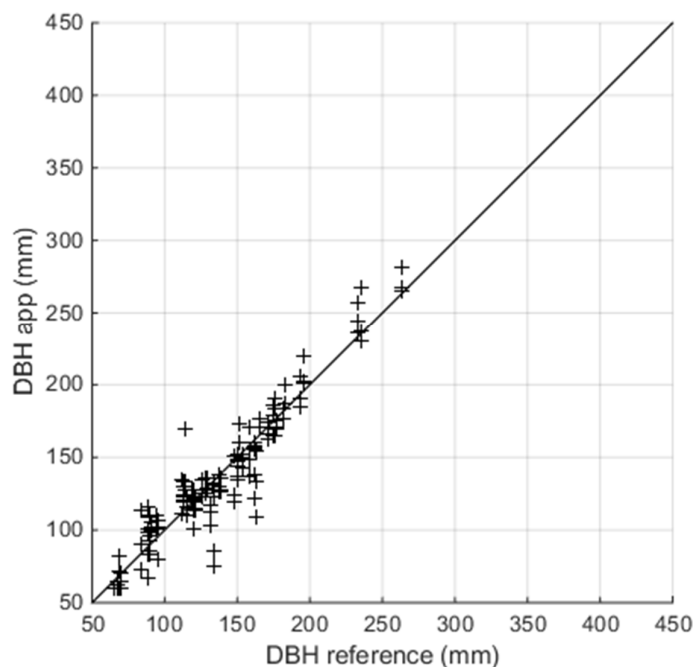


Figure 3. DBH for **birch** measured as reference and with the app. The solid line corresponds to $y = x$.

The spread in determined DBH between the three different recordings of the same stems, presented as a standard deviation, can be found in Table 3. It is important to notice that this

shows only how consistent the app was in the determination of the DBH of the individual stems.

Table 3. Standard deviation for the determination of the DBH of individual stems with the app.

Specie	Standard deviation (mm)
Pine	9
Spruce	11
Birch	9

Further analysis can be performed by considering the complete dataset which is found in Appendix 2.

RISE Research Institutes of Sweden AB
Department Building and Real Estate - Production Systems and Materials

Performed by



Tommy Vikberg

Examined by

Mats Johansson

Appendices

Appendix 1



Figure 4. Stand 1.



Figure 5. Stand 2.

Appendix 1



Figure 6. Stand 3.



Figure 7. Stand 4.

Appendix 1



Figure 8. Stand 5.



Figure 9. Stand 6.

Appendix 1



Figure 10. Stand 7.



Figure 11. Stand 8.

Appendix 1



Figure 12. Stand 9.

Appendix 2

Table 4. Measured data for Pine.

Stand	Specie	App 1 (mm)	App 2 (mm)	App 3 (mm)	Cal. 1 (mm)	Cal. 2 (mm)
1	Pine	220	227	209	226	218
1	Pine	215	216	211	224	206
1	Pine	293	294	291	300	310
1	Pine	167	160	159	167	169
1	Pine	226	219	235	240	245
1	Pine	217	226	229	231	250
1	Pine	274	279	275	276	267
1	Pine	275	292	278	291	299
1	Pine	220	208	203	220	227
1	Pine	125	113	113	130	132
1	Pine	299	299	297	294	307
1	Pine	198	189	180	203	192
1	Pine	243	230	246	248	244
2	Pine	290	293	313	320	318
2	Pine	211	240	239	245	220
2	Pine	191	198	209	207	219
2	Pine	91	100	96	106	107
2	Pine	65	65	71	90	91
2	Pine	183	181	196	222	224
2	Pine	239	262	265	268	272
2	Pine	191	207	220	219	225
2	Pine	200	212	223	229	230
2	Pine	211	220	236	233	234
2	Pine	178	176	194	203	216
2	Pine	142	150	156	157	161
3	Pine	116	112	108	113	110
3	Pine	177	189	172	174	178
3	Pine	140	143	135	131	124
3	Pine	129	141	131	120	120
3	Pine	184	190	177	188	176
3	Pine	97	99	95	93	88
3	Pine	177	188	188	184	177
3	Pine	98	107	102	95	97
3	Pine	103	103	102	104	101
3	Pine	137	141	138	135	132
3	Pine	93	90	93	90	93
3	Pine	85	84	78	82	76
4	Pine	200	217	233	237	227
4	Pine	129	150	158	161	176
4	Pine	145	167	191	188	190
5	Pine	253	256	257	244	243
5	Pine	240	237	248	227	239
5	Pine	307	354	344	324	326
6	Pine	371	393	368	412	441
6	Pine	325	339	350	385	392
6	Pine	352	350	318	351	379
6	Pine	266	256	279	278	290
7	Pine	332	335	346	327	344
7	Pine	115	122	130	115	119
7	Pine	273	256	261	260	276

Appendix 2

Table 5. Measured data for Spruce.

Stand	Specie	App 1 (mm)	App 2 (mm)	App 3 (mm)	Cal. 1 (mm)	Cal. 2 (mm)
2	Spruce	70	87	83	99	99
2	Spruce	117	120	125	135	135
4	Spruce	84	103	108	124	126
5	Spruce	126	154	133	125	134
5	Spruce	134	125	158	169	169
5	Spruce	240	229	228	253	263
5	Spruce	154	166	165	134	125
5	Spruce	347	333	363	351	334
5	Spruce	160	171	171	175	161
5	Spruce	185	162	192	187	195
5	Spruce	274	269	272	274	285
5	Spruce	119	106	111	97	97
5	Spruce	166	164	176	173	185
5	Spruce	186	195	198	196	192
5	Spruce	93	93	97	80	78
6	Spruce	311	333	281	336	314
6	Spruce	284	319	287	322	323
6	Spruce	200	220	212	250	274
6	Spruce	218	224	234	240	223
6	Spruce	265	292	268	297	308
6	Spruce	97	107	101	111	113
6	Spruce	119	138	129	141	141
5	Spruce	182	204	200	203	202
6	Spruce	281	320	294	322	293
6	Spruce	241	264	252	274	260
6	Spruce	250	321	354	385	395
6	Spruce	284	313	303	340	350
6	Spruce	303	321	311	338	350
6	Spruce	268	295	282	288	283
6	Spruce	214	222	232	237	226
6	Spruce	143	152	149	152	158
6	Spruce	358	354	344	338	336
7	Spruce	261	244	263	285	286
7	Spruce	190	182	191	207	201
7	Spruce	122	133	159	169	166
7	Spruce	216	206	222	223	214
7	Spruce	176	171	181	194	187
7	Spruce	90	97	111	140	137
7	Spruce	127	136	145	170	167
7	Spruce	305	288	300	310	328
7	Spruce	203	199	192	198	197
7	Spruce	206	193	201	220	205
7	Spruce	110	105	104	129	124
7	Spruce	139	121	141	151	150
7	Spruce	107	99	96	104	100
7	Spruce	168	157	153	165	159
7	Spruce	148	138	144	152	154
7	Spruce	262	251	256	259	265
7	Spruce	212	213	219	227	229
7	Spruce	203	190	203	191	184

Appendix 2

Table 6. Measured data for birch.

Stand	Specie	App 1 (mm)	App 2 (mm)	App 3 (mm)	Cal. 1 (mm)	Cal. 2 (mm)
3	Birch	187	200	187	181	186
3	Birch	244	257	236	235	231
3	Birch	186	179	165	175	174
3	Birch	60	60	60	66	65
3	Birch	110	96	92	90	90
3	Birch	114	122	115	120	122
3	Birch	265	281	267	261	266
4	Birch	64	70	60	68	71
4	Birch	127	132	131	132	135
4	Birch	67	83	83	87	91
4	Birch	143	152	150	153	155
4	Birch	101	120	115	118	122
4	Birch	160	160	173	153	149
4	Birch	60	72	82	70	68
4	Birch	165	184	190	180	172
4	Birch	120	123	128	118	119
4	Birch	99	102	105	92	90
4	Birch	185	191	206	193	193
4	Birch	120	123	124	121	104
4	Birch	123	125	134	127	124
4	Birch	119	130	133	116	111
4	Birch	101	102	110	93	96
4	Birch	106	80	102	98	93
6	Birch	202	220	201	204	188
7	Birch	109	133	154	165	162
7	Birch	174	166	162	173	170
8	Birch	114	119	128	122	119
8	Birch	157	155	160	158	166
8	Birch	230	267	237	248	223
8	Birch	136	127	126	138	139
8	Birch	144	137	134	150	150
8	Birch	103	117	112	133	131
8	Birch	151	124	119	151	145
8	Birch	171	169	175	179	175
8	Birch	138	130	126	142	134
8	Birch	85	75	123	133	135
8	Birch	149	152	147	149	151
8	Birch	138	122	158	157	168
8	Birch	136	127	129	129	130
8	Birch	176	184	184	179	185
8	Birch	176	176	171	167	165
9	Birch	123	116	110	116	115
9	Birch	116	101	98	88	89
9	Birch	113	90	73	83	84
9	Birch	171	148	137	154	164
9	Birch	62	65	60	68	67
9	Birch	134	111	111	111	113
9	Birch	136	128	125	126	131
9	Birch	109	86	83	90	90
9	Birch	169	128	133	115	113

Appendix 3



4. Recording technique

Creating good-quality recordings can require a little practice. We recommend that you start out by making short recordings (approx. 20 seconds) until you see that your recordings are of the required quality for processing.

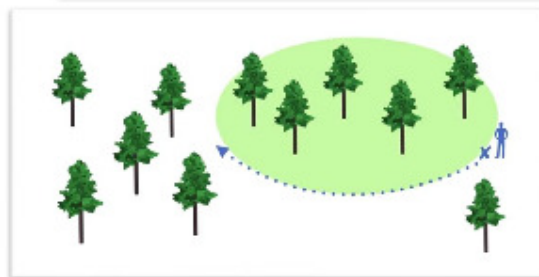
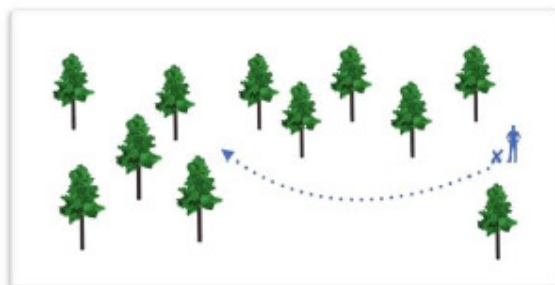
You need to move in the correct manner and direction, and the camera angle and distance to trees need to be within certain limits. See the instructions below.

Plan your route

When you walk between the trees you wish to measure you will be walking in one direction while aiming your smartphone 90° away from that direction, i.e., the camera should point to the trees. As this means your attention needs to be on two things at once, try to find a path that is not too uneven and without too much undergrowth.

Assuming a constant speed, the length of the path is, of course, related to the duration of the recording. Start out by walking a path of approx. 20m.

If possible, try to make your path curved, so that the survey area is captured more completely.



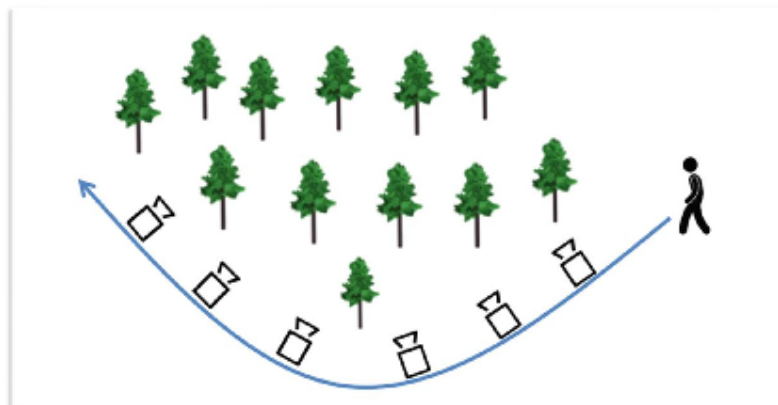
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Appendix 3

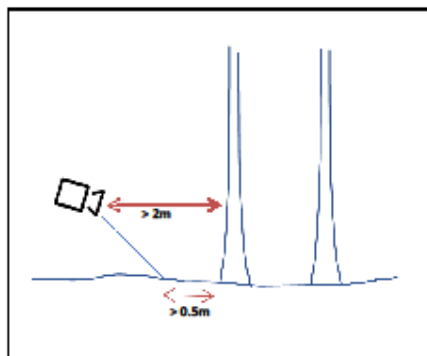
**Path direction and camera angle**

When walking the path, your phone/camera needs to be facing the trees, i.e., the camera angle should be roughly perpendicular (90°) to the direction in which you are walking.

**Distance and tilt**

For good results, the camera view needs to also include the ground. To achieve this, follow these recommendations:

- Try to stay at least 2 m (6.5 ft) from the closest trees.
- Hold the phone tilted slightly downwards, to record a little (0.5 m/ 1.5 ft) of the ground in front of the closest trees. When the angle is correct, the horizon will occupy the top 1/3 of the screen.



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Dokument

Conformity of determined brest height diameters by use
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Huvuddokument

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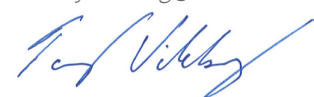
Signerande parter

Tommy Vikberg (TV)

RISE Research Institutes of Sweden AB

Org. nr 556464-6874

tommy.vikberg@ri.se



Signerade 2022-11-25 16:20:41 CET (+0100)

Mats Johansson (MJ)

RISE Research Institutes of Sweden AB

mats.johansson@ri.se

+46703765466

Signerade 2022-11-25 16:32:15 CET (+0100)

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