

Data set of labeled scenes in a barn in front of automatic milking system

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1 Introduction

This data set includes supplementary files to our article "*Deep learning image recognition of cow behavior near an automatic milking robot with an open data set*" (Leonardo Santiago Benitez Pereira, Olli Koskela, Ilpo Pölönen, Ilmo Aronen and Iivari Kunttu, in review, 2020). We acquired continuous video data over two-month period of cows in front of Automatic Milking Station (AMS). Each frame of the video is labeled as a single image belonging to one of classes described below.

This data set includes 253 files of video data having in total 1 526 473 labeled frames. The data set used in the article consisted of 280 videos, but for privacy reasons, 27 video files including persons were removed from this data set, but their Java Script Object Notation (JSON) label files are left for, e.g., temporal analyses.

2 Data acquisition and labels

Data was acquired with commercial security dome camera (VIO-D30, Blaupunkt GmbH, Ingress Protection class IP67) installed 3.3m the ground level and 3.3m left of the AMS. On October 25th, 2019, camera position was changed to 4.3m left of AMS with same height and rotated 3.4° horizontally towards AMS and 1.7° vertically upwards. Labels used in the study are presented in Table 1. Python software used to manipulate the data is described in section 3.

Table 1: Table of the classes used in labeling. Priority of the class decreases from top to bottom.

n	Name	Brief description
0	Human	There is a person in the image
1	Interaction frontal	Head on head/neck
2	Interaction lateral	Head on body, body on body
3	Interaction vertical	Head over head, head over body
4	Crowded	More than 5 cows in the interest area
5	Drinking	A cow is drinking water
6	Curiosity	Putting the head inside the storage
7	Queue	At least one cow is waiting outside the milking station
8	Low visibility	Night or twilight
9	Normal	Nothing, laying, pissing, etc

Ethical statement. During the research, cows were cared for according to the effective laws and regulations in Finland. We made no interventions towards animals. Persons were informed with signs upon entering the image acquisition area of the research data acquisition. Protocol to disconnect the image acquisition while visiting the area was given in the signs. Data including persons are not published.

3 Python codes

To manipulate the data set, following Python software was developed and is provided along here.

01 - Data labeling.ipynb

Functionality used to retrieve the videos from the web server and assign the classes to each frame. Fetches the last video from given hours on given days and converts using FFmpeg software. Then plays the video and retrieves the user input via pressing a key of the respective class. Video playback can be paused and the position in time can be translated back and forth.

`getVideo.py`

Subprocess of retrieving and converting the videos.

02 - data set exploration.ipynb

Plot some basic graphs of temporal variability in the data.

03 - CNN training and evaluation.ipynb

Training of the Convolutional Neural Network (CNN) used in our work. CNN was based on VGGnet architecture. The resulting CNN's are provided in trained networks folder.

04 - CNN vizualization.ipynb

Visualization of the activation maps of the trained CNN.

Pre-trained networks

The networks we trained in the study are provided in folder `trained networks`.

4 Video and label files

The data set used in the article included 280 files of video from the barn. Videos are named with their starting time in POSIX format and the conversion to UTC+3 time is provided in Table 2. Videos were originally acquired in DAV-file format but are converted to MP4-format using ffmpeg. We systematically chose ten videos from every second day of the experiment, but due to conversion failures, some videos were substituted with video from same hour but of next day as listed in Table 3. The systematic error in videos of October 30th is likely due to storaging issue.

Each frame in the videos is assigned to a class described earlier. The assigned classes are provided as pointer tables in Java Script Object Notation (JSON) files with respective names. Each line in pointer tables consist of a triplet, where first member is the video file name without extension, second is the frame number in that file and third is the assigned class label. Assigned classes are also merged into a single JSON-file named `pointer_table.json` and we provide the shuffled table used for the experiments in the article, named `pointer_table_shuffled.json`.

For privacy reason, videos containing persons were removed. These 27 files are listed in Table 4, thus, totaling 253 videos in this supplementary data set. The JSON label files of the removed videos are nonetheless included in this supplementary data, having 174187 additional labeled scenes for, e.g., additional temporal analyses.

Note. With the gray-scale videos, the lighting of the AMS flickers coinciding with the color channels of the camera. This flickering is not a malfunction and is only due to the frame rates.

With the test reported in the article, in unbalanced experiment from the shuffled table provided with the complete data set, the results presented here are based on first 80000 entries used for training, following 10000 for validation and then following 10000 for testing. In balanced experiments, the lines in respective shuffled table were 1 to 24950 for training, 24951 to 37425 for validation and 37426 to 49900 for testing.

5 License

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Table 2: List of video (*.mp4) and JSON (*.json) files and their UTC+3 times.

id	file name	UTC+3 time stamp
1	1569124740	2019-09-22 03:59:00
2	1569135540	2019-09-22 06:59:00
3	1569143040	2019-09-22 09:04:00
4	1569153660	2019-09-22 12:01:00
5	1569160860	2019-09-22 14:01:00
6	1569164640	2019-09-22 15:04:00
7	1569167940	2019-09-22 15:59:00
8	1569175140	2019-09-22 17:59:00
9	1569182520	2019-09-22 20:02:00
10	1569236340	2019-09-23 10:59:00
11	1569297720	2019-09-24 04:02:00
12	1569315420	2019-09-24 08:57:00
13	1569322800	2019-09-24 11:00:00
14	1569326340	2019-09-24 11:59:00
15	1569333540	2019-09-24 13:59:00
16	1569337140	2019-09-24 14:59:00
17	1569340740	2019-09-24 15:59:00
18	1569347940	2019-09-24 17:59:00
19	1569355080	2019-09-24 19:58:00
20	1569394800	2019-09-25 07:00:00
21	1569470400	2019-09-26 04:00:00
22	1569481140	2019-09-26 06:59:00
23	1569488400	2019-09-26 09:00:00
24	1569495600	2019-09-26 11:00:00
25	1569499140	2019-09-26 11:59:00
26	1569506400	2019-09-26 14:00:00
27	1569509940	2019-09-26 14:59:00
28	1569513540	2019-09-26 15:59:00
29	1569520740	2019-09-26 17:59:00
30	1569527940	2019-09-26 19:59:00
31	1569643140	2019-09-28 03:59:00
32	1569654000	2019-09-28 07:00:00
33	1569661200	2019-09-28 09:00:00
34	1569668340	2019-09-28 10:59:00
35	1569671940	2019-09-28 11:59:00
36	1569679200	2019-09-28 14:00:00
37	1569683040	2019-09-28 15:04:00
38	1569686340	2019-09-28 15:59:00
39	1569693540	2019-09-28 17:59:00
40	1569700980	2019-09-28 20:03:00
41	1569816180	2019-09-30 04:03:00
42	1569827040	2019-09-30 07:04:00
43	1569833940	2019-09-30 08:59:00
44	1569841500	2019-09-30 11:05:00
45	1569845040	2019-09-30 12:04:00
46	1569851940	2019-09-30 13:59:00
47	1569855540	2019-09-30 14:59:00
48	1569859380	2019-09-30 16:03:00
49	1569866340	2019-09-30 17:59:00
50	1569873540	2019-09-30 19:59:00
51	1569988740	2019-10-02 03:59:00
52	1569999780	2019-10-02 07:03:00
53	1570006740	2019-10-02 08:59:00

54	1570013940	2019-10-02 10:59:00
55	1570017540	2019-10-02 11:59:00
56	1570024740	2019-10-02 13:59:00
57	1570028460	2019-10-02 15:01:00
58	1570031940	2019-10-02 15:59:00
59	1570039440	2019-10-02 18:04:00
60	1570046340	2019-10-02 19:59:00
61	1570161720	2019-10-04 04:02:00
62	1570172400	2019-10-04 07:00:00
63	1570179840	2019-10-04 09:04:00
64	1570186800	2019-10-04 11:00:00
65	1570190580	2019-10-04 12:03:00
66	1570197600	2019-10-04 14:00:00
67	1570201380	2019-10-04 15:03:00
68	1570204800	2019-10-04 16:00:00
69	1570211940	2019-10-04 17:59:00
70	1570219140	2019-10-04 19:59:00
71	1570334340	2019-10-06 03:59:00
72	1570345200	2019-10-06 07:00:00
73	1570352340	2019-10-06 08:59:00
74	1570359540	2019-10-06 10:59:00
75	1570362660	2019-10-06 11:51:00
76	1570370340	2019-10-06 13:59:00
77	1570373940	2019-10-06 14:59:00
78	1570377720	2019-10-06 16:02:00
79	1570384860	2019-10-06 18:01:00
80	1570391940	2019-10-06 19:59:00
81	1570507440	2019-10-08 04:04:00
82	1570518120	2019-10-08 07:02:00
83	1570525140	2019-10-08 08:59:00
84	1570532340	2019-10-08 10:59:00
85	1570536000	2019-10-08 12:00:00
86	1570546740	2019-10-08 14:59:00
87	1570550400	2019-10-08 16:00:00
88	1570557540	2019-10-08 17:59:00
89	1570564800	2019-10-08 20:00:00
90	1570629540	2019-10-09 13:59:00
91	1570679940	2019-10-10 03:59:00
92	1570690740	2019-10-10 06:59:00
93	1570698120	2019-10-10 09:02:00
94	1570708740	2019-10-10 11:59:00
95	1570716000	2019-10-10 14:00:00
96	1570719540	2019-10-10 14:59:00
97	1570723140	2019-10-10 15:59:00
98	1570730340	2019-10-10 17:59:00
99	1570737540	2019-10-10 19:59:00
100	1570791540	2019-10-11 10:59:00
101	1570852740	2019-10-12 03:59:00
102	1570863600	2019-10-12 07:00:00
103	1570870800	2019-10-12 09:00:00
104	1570877940	2019-10-12 10:59:00
105	1570881540	2019-10-12 11:59:00
106	1570888800	2019-10-12 14:00:00
107	1570892400	2019-10-12 15:00:00
108	1570896000	2019-10-12 16:00:00
109	1570903140	2019-10-12 17:59:00

110	1570910340	2019-10-12 19:59:00
111	1571025540	2019-10-14 03:59:00
112	1571036340	2019-10-14 06:59:00
113	1571050740	2019-10-14 10:59:00
114	1571054340	2019-10-14 11:59:00
115	1571061540	2019-10-14 13:59:00
116	1571065200	2019-10-14 15:00:00
117	1571068740	2019-10-14 15:59:00
118	1571083140	2019-10-14 19:59:00
119	1571129940	2019-10-15 08:59:00
120	1571162400	2019-10-15 18:00:00
121	1571198340	2019-10-16 03:59:00
122	1571209140	2019-10-16 06:59:00
123	1571216640	2019-10-16 09:04:00
124	1571223720	2019-10-16 11:02:00
125	1571227140	2019-10-16 11:59:00
126	1571234340	2019-10-16 13:59:00
127	1571237940	2019-10-16 14:59:00
128	1571241720	2019-10-16 16:02:00
129	1571249040	2019-10-16 18:04:00
130	1571255940	2019-10-16 19:59:00
131	1571371140	2019-10-18 03:59:00
132	1571382240	2019-10-18 07:04:00
133	1571389320	2019-10-18 09:02:00
134	1571396400	2019-10-18 11:00:00
135	1571399940	2019-10-18 11:59:00
136	1571406900	2019-10-18 13:55:00
137	1571410980	2019-10-18 15:03:00
138	1571414340	2019-10-18 15:59:00
139	1571421540	2019-10-18 17:59:00
140	1571428800	2019-10-18 20:00:00
141	1572148800	2019-10-27 04:00:00
142	1572166740	2019-10-27 08:59:00
143	1572170400	2019-10-27 10:00:00
144	1572174000	2019-10-27 11:00:00
145	1572181380	2019-10-27 13:03:00
146	1572185100	2019-10-27 14:05:00
147	1572192000	2019-10-27 16:00:00
148	1572199200	2019-10-27 18:00:00
149	1572206400	2019-10-27 20:00:00
150	1572274740	2019-10-28 14:59:00
151	1572321660	2019-10-29 04:01:00
152	1572339600	2019-10-29 09:00:00
153	1572343200	2019-10-29 10:00:00
154	1572346860	2019-10-29 11:01:00
155	1572353880	2019-10-29 12:58:00
156	1572357600	2019-10-29 14:00:00
157	1572361200	2019-10-29 15:00:00
158	1572364740	2019-10-29 15:59:00
159	1572372000	2019-10-29 18:00:00
160	1572386700	2019-10-29 22:05:00
161	1572408000	2019-10-30 04:00:00
162	1572426000	2019-10-30 09:00:00
163	1572429120	2019-10-30 09:52:00
164	1572433260	2019-10-30 11:01:00
165	1572440400	2019-10-30 13:00:00

166	1572444000	2019-10-30 14:00:00
167	1572447600	2019-10-30 15:00:00
168	1572451200	2019-10-30 16:00:00
169	1572458400	2019-10-30 18:00:00
170	1572465900	2019-10-30 20:05:00
171	1572667080	2019-11-02 03:58:00
172	1572685140	2019-11-02 08:59:00
173	1572688920	2019-11-02 10:02:00
174	1572692400	2019-11-02 11:00:00
175	1572699660	2019-11-02 13:01:00
176	1572703200	2019-11-02 14:00:00
177	1572706920	2019-11-02 15:02:00
178	1572710640	2019-11-02 16:04:00
179	1572717480	2019-11-02 17:58:00
180	1572725040	2019-11-02 20:04:00
181	1572840240	2019-11-04 04:04:00
182	1572858000	2019-11-04 09:00:00
183	1572861780	2019-11-04 10:03:00
184	1572865200	2019-11-04 11:00:00
185	1572872400	2019-11-04 13:00:00
186	1572876000	2019-11-04 14:00:00
187	1572879600	2019-11-04 15:00:00
188	1572883200	2019-11-04 16:00:00
189	1572890400	2019-11-04 18:00:00
190	1572897600	2019-11-04 20:00:00
191	1573012800	2019-11-06 04:00:00
192	1573030800	2019-11-06 09:00:00
193	1573034520	2019-11-06 10:02:00
194	1573038000	2019-11-06 11:00:00
195	1573045200	2019-11-06 13:00:00
196	1573048800	2019-11-06 14:00:00
197	1573052400	2019-11-06 15:00:00
198	1573056000	2019-11-06 16:00:00
199	1573063200	2019-11-06 18:00:00
200	1573070400	2019-11-06 20:00:00
201	1573185600	2019-11-08 04:00:00
202	1573203600	2019-11-08 09:00:00
203	1573206600	2019-11-08 09:50:00
204	1573210800	2019-11-08 11:00:00
205	1573218000	2019-11-08 13:00:00
206	1573221600	2019-11-08 14:00:00
207	1573225200	2019-11-08 15:00:00
208	1573228800	2019-11-08 16:00:00
209	1573236240	2019-11-08 18:04:00
210	1573243320	2019-11-08 20:02:00
211	1573358640	2019-11-10 04:04:00
212	1573376400	2019-11-10 09:00:00
213	1573379940	2019-11-10 09:59:00
214	1573383780	2019-11-10 11:03:00
215	1573390860	2019-11-10 13:01:00
216	1573394400	2019-11-10 14:00:00
217	1573398000	2019-11-10 15:00:00
218	1573401600	2019-11-10 16:00:00
219	1573408800	2019-11-10 18:00:00
220	1573416000	2019-11-10 20:00:00
221	1573531140	2019-11-12 03:59:00

222	1573549380	2019-11-12 09:03:00
223	1573552800	2019-11-12 10:00:00
224	1573556400	2019-11-12 11:00:00
225	1573563600	2019-11-12 13:00:00
226	1573567200	2019-11-12 14:00:00
227	1573570800	2019-11-12 15:00:00
228	1573574400	2019-11-12 16:00:00
229	1573581600	2019-11-12 18:00:00
230	1573588800	2019-11-12 20:00:00
231	1573704000	2019-11-14 04:00:00
232	1573722000	2019-11-14 09:00:00
233	1573725600	2019-11-14 10:00:00
234	1573729200	2019-11-14 11:00:00
235	1573736400	2019-11-14 13:00:00
236	1573740000	2019-11-14 14:00:00
237	1573743600	2019-11-14 15:00:00
238	1573747200	2019-11-14 16:00:00
239	1573754400	2019-11-14 18:00:00
240	1573761600	2019-11-14 20:00:00
241	1573876920	2019-11-16 04:02:00
242	1573894980	2019-11-16 09:03:00
243	1573898400	2019-11-16 10:00:00
244	1573902000	2019-11-16 11:00:00
245	1573909200	2019-11-16 13:00:00
246	1573912800	2019-11-16 14:00:00
247	1573916400	2019-11-16 15:00:00
248	1573920000	2019-11-16 16:00:00
249	1573927140	2019-11-16 17:59:00
250	1573934400	2019-11-16 20:00:00
251	1574049600	2019-11-18 04:00:00
252	1574067600	2019-11-18 09:00:00
253	1574071200	2019-11-18 10:00:00
254	1574074800	2019-11-18 11:00:00
255	1574082000	2019-11-18 13:00:00
256	1574085600	2019-11-18 14:00:00
257	1574089200	2019-11-18 15:00:00
258	1574092800	2019-11-18 16:00:00
259	1574100000	2019-11-18 18:00:00
260	1574107200	2019-11-18 20:00:00
261	1574222400	2019-11-20 04:00:00
262	1574240400	2019-11-20 09:00:00
263	1574244000	2019-11-20 10:00:00
264	1574247600	2019-11-20 11:00:00
265	1574254800	2019-11-20 13:00:00
266	1574258400	2019-11-20 14:00:00
267	1574262000	2019-11-20 15:00:00
268	1574265600	2019-11-20 16:00:00
269	1574272800	2019-11-20 18:00:00
270	1574280000	2019-11-20 20:00:00
271	1574395200	2019-11-22 04:00:00
272	1574413140	2019-11-22 08:59:00
273	1574417040	2019-11-22 10:04:00
274	1574420400	2019-11-22 11:00:00
275	1574427300	2019-11-22 12:55:00
276	1574431200	2019-11-22 14:00:00
277	1574434980	2019-11-22 15:03:00

278	1574438640	2019-11-22 16:04:00
279	1574445600	2019-11-22 18:00:00
280	1574539080	2019-11-23 19:58:00

Table 3: Substituted videos due to DAV to MP4 conversion failure.

Failure	Substitute video	Failure	Substitute video
day 2019-09-22, hour 10	1569214740.mp4	day 2019-09-24, hour 06	1569373200.mp4
day 2019-10-08, hour 13	1570607940.mp4	day 2019-10-10, hour 10	1570769940.mp4
day 2019-10-14, hour 08	1571108340.mp4	day 2019-10-14, hour 17	1571140800.mp4
day 2019-10-27, hour 14	1572263940.mp4	day 2019-11-22, hour 19	1574528280.mp4
day 2019-10-30, hour 04	1572408000.mp4	day 2019-10-30, hour 09	1572426000.mp4
day 2019-10-30, hour 10	1572429120.mp4	day 2019-10-30, hour 11	1572433260.mp4
day 2019-10-30, hour 13	1572440400.mp4	day 2019-10-30, hour 14	1572444000.mp4
day 2019-10-30, hour 15	1572447600.mp4	day 2019-10-30, hour 16	1572451200.mp4
day 2019-10-30, hour 18	1572458400.mp4	day 2019-10-30, hour 20	1572465900.mp4

Table 4: List of videos removed from the complete dataset due to privacy reasons.

id	file name
1	1570186800
2	1570211940
3	1570352340
4	1571129940
5	1571249040
6	1571421540
7	1572170400
8	1572199200
9	1572274740
10	1572361200
11	1572685140
12	1572872400
13	1573038000
14	1573070400
15	1573225200
16	1573243320
17	1573552800
18	1573556400
19	1573581600
20	1573722000
21	1573743600
22	1573894980
23	1573912800
24	1573927140
25	1574107200
26	1574244000
27	1574247600