71. 2nd Duck Drive Endurance Test
UFO Doctor, August 27th, 2013

1. Introduction

The tiny DC Gear motor SGM12-N20 (SONTH, HK) was used to move a robotic duck. Two motors actuated the legs, equipped with webbed feet like a real duck.

The first outdoor swimming experiment was impressing, see video Nr. 69 below:
http://ufo-doctor.ch/descriptions/A_The%20Duck%20Project/69.%20Video%20My%20Robotic%20Duck,%20July%204th,%202013.MP4

However we observed a severe endurance problem:
After 0.45 h laboratory experiments at 5V supply the gear broke twice!
The reason was that we used the reverse mode, slowly moving the feet to the front and fast with full power backwards. This caused too much torque to the gear!

Now we test a better bionic drive with a much stronger SONTH gear motor:
SG13-50: Reduction Ratio 1/86, rpm 102, 6V, ca. 0.21A, stall torque 3 kg.cm

New longer leg, now 55 mm (for more propulsion force)

Speed result of the outdoor swimming test with 7.8V Lipo, payload 88 grams:
Normal mode 75mm/sec, Reverse mode 150mm/sec

2. Endurance investigation in laboratory conditions

- Reverse mode (this means webbed foot moves slowly forward and fast, with maximum motor torque backward)
- One webbed foot only, not foldable (left and right toe blocked)
- Power supply 5 to 8V with 0.4A current limitation, no EMC filter at motors
- Up to now 24 h without failure

2.1. Test Setup

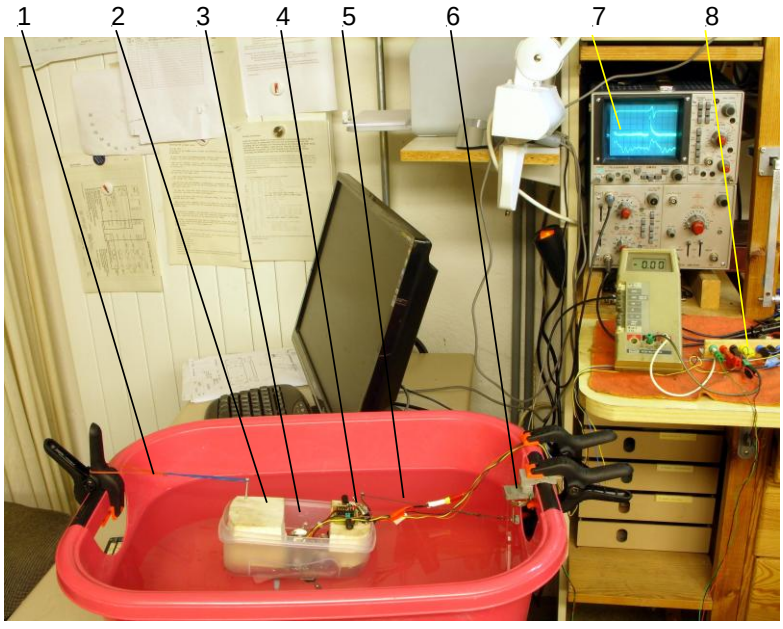
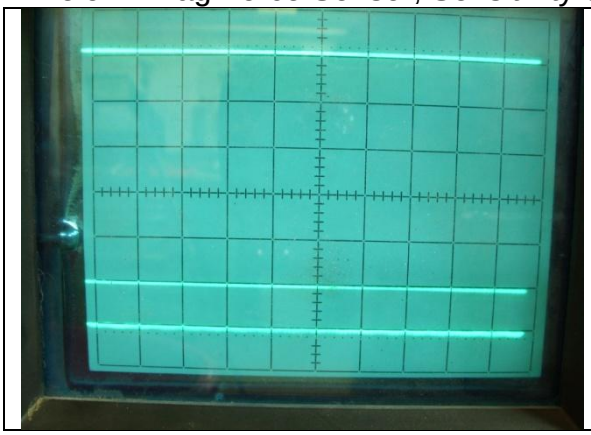


Fig. 2.1:
Overview Test Setup

1: Rubber string for force preload
2: Baby Duck in boot
3: Drive with angle Hall Sensor
4. Switch for Normal/Reverse mode
5: Thread connected to the drag force sensor
6: Drag force sensor
7: Storage scope
8: Terminal for motor and sensor cables

3. Test Results normal mode

- Time Scale: 0.1sec/Div
- Top: Synchronization: foot at full backward position, 2VDiv
- Middle: Current, Voltage at 1 Ohm Shunt, 50mV/Div or 50mA/Div
- Below: Drag Force Sensor, Sensitivity 0.56N/V, 0.5V/Div

	Fig. 3a: Calibration Motor switched off Preload Drag Force Sensor: 0.95V or 0.53N

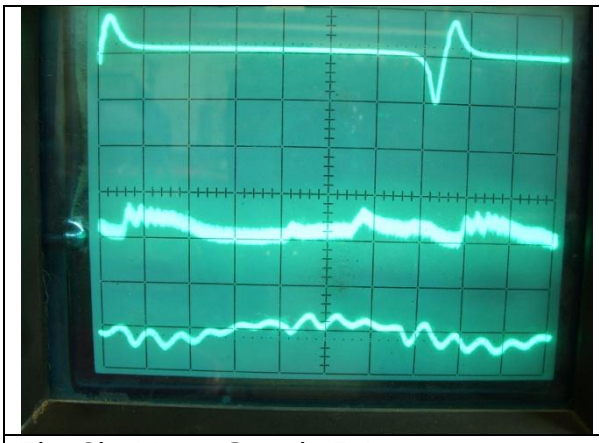
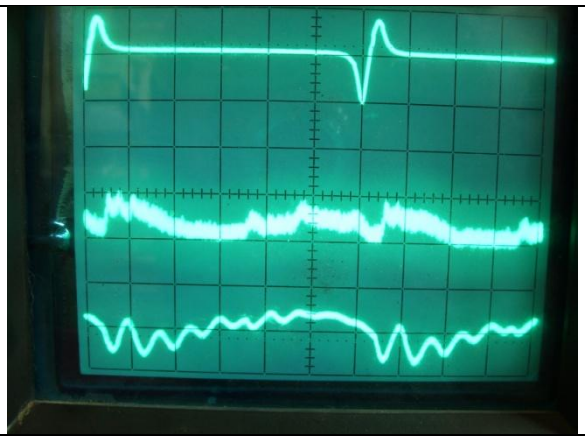
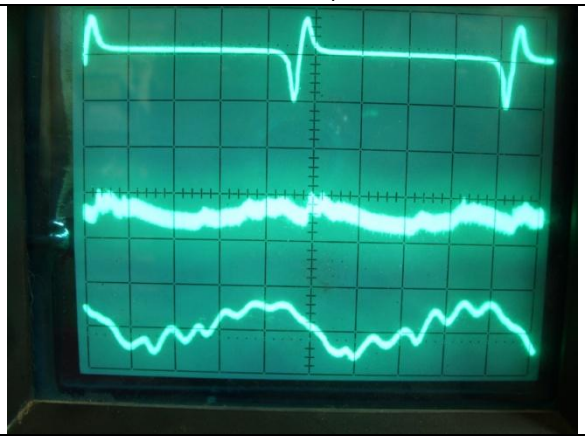
	

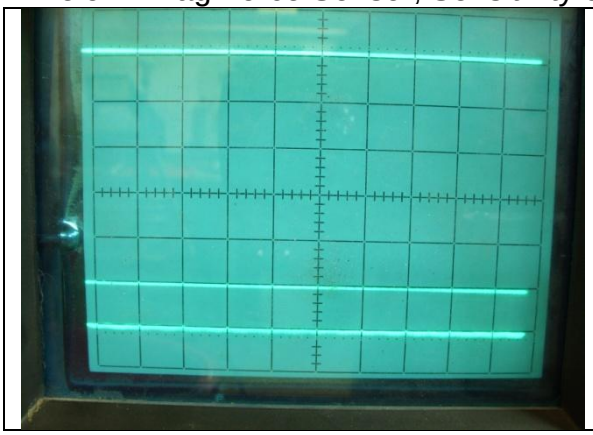
Fig. 3b: Motor Supply 5V Max Current: 75mA Max Stroke force: 0.15V, 0.08VN	Fig. 3b: Motor Supply 6V Max Current: 80mA Max Stroke force: 0.2V, 0.12N
	
Fig. 3c: Motor Supply 7V Max Current: 100mA Max Stroke force:0.3V,0.17N	Fig. 3d: Motor Supply 8V Max Current: 100mA Max Stroke force:0.3V, 0.17 N

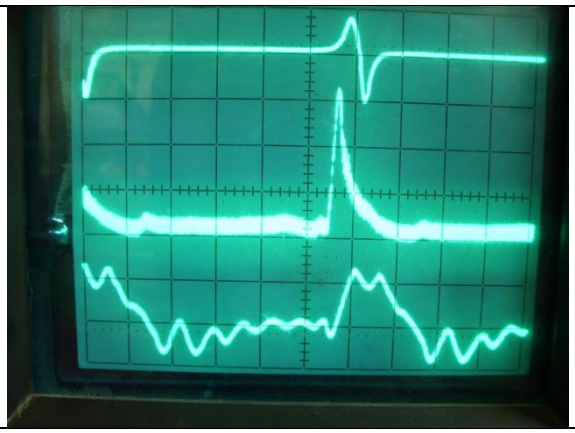
Comment:

The fast forward movement of the leg consumes current and creates negative propulsion forces, is not good at all!

4. Test Results reverse mode

- Time Scale: 0.1sec/Div
- Top: Synchronization: foot at full backward position, 2VDiv
- Middle: Current, Voltage at 1 Ohm Shunt, 50mV/Div or 50mA/Div
- Below: Drag Force Sensor, Sensitivity 0.56N/V, 0.5V/Div

	Fig. 4a: Calibration Motor switched off Preload Drag Force Sensor: 0.95V or 0.53N

	
Fig. 4b: Motor Supply 5V Max Current: 165mA Max Stroke force: 0.6V, 0.34N	Fig. 4c: Motor Supply 6V Max Current: 210mA Max Stroke force: 0. 7V, 0.4N

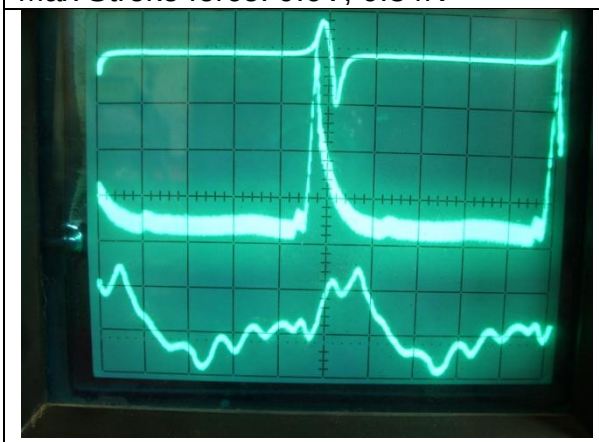
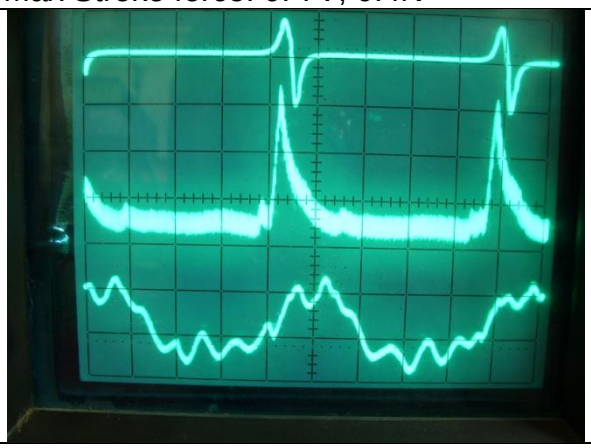

	

Fig. 4d: Motor Supply 7V Max Current: 250mA Max Stroke force: 0.75V, 0.42N	Fig. 4e: Motor Supply 8V Max Current: 225mA Max Stroke force: 0.75V, 0.42N

Comment:

Good performance! Minor negative propulsion forces if leg swings forward.
The maximum current is close to the specified continuous current of 210mA
Supply Voltage > 7V: no positive effect!

5. Drawing of the Duck Drive

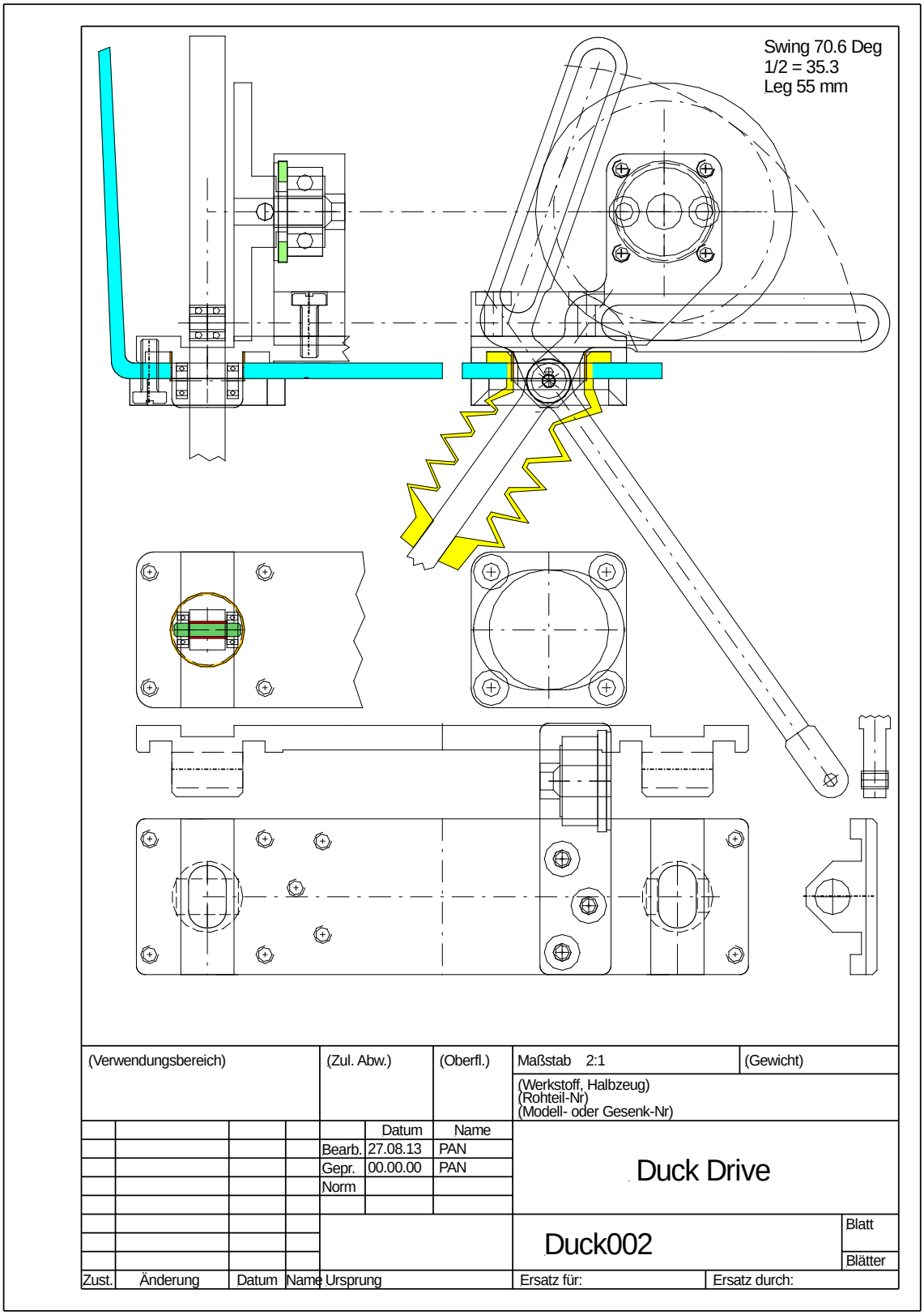


Fig. 5: Drawing of the duck drive

6. Journal Endurance Test

Test Subjects:
2nd Duck Drive , Drawing Duck002, Aug 27th, 2013
a.) SONTH Gear Motor SG13-050, reduction 1/86 , 6V
b.) Round bellow for bicycle and professional bellow F 1092 NBR
c.) General drive components
Test conditions (in water):
Reverse Mode, 6V
First with short legs 38mm, later with long legs 55mm
Period: 0.6 sec

Date: Aug. 2013	Start	Stop	Duration h	Material unter Test	Test results
19	11	21	10	Bicycle Round Bellow	Bicycle Bellow broken after 10h!
23	9.5	13	3.5	now F 1092 Bellow	ok
23	13	16.5	3.5		ok
23	16.5	20.2	3.7		ok
27	22.5	24	1.5	now long leg 55mm	ok
28	0	8.5	8.5		ok
28	14.5	18.75	4.25		Gear broken!
Life time long leg			14.25		Gear broken at max 210 mA
Number of Cycles			85500		Formula: Life Time*3600/0.6
Life time total			30.7		Motor and Bellow

7. Broken Gear-Wheel after 85500 Cycles

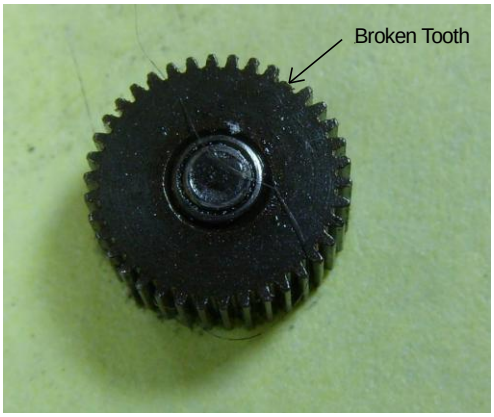


Fig. 6: Broken front gear-wheel of SONTH motor SG13-050 with1/86 reduction

Fig.7. Long legs with webbed feet. Excessive torque in reverse mode!

8. Preliminary conclusion

Pulsating torque, also within the SONTH specification for continuous full load current, will kill the gear after 85500 cycles!

We need to find a way to reduce the pulsating torque, e.g. by an elastic joint in the leg!