Experimental Investigation of the Usfulness of Bracelet Trackers in Sports and Health Monitoring

Critical Evaluation of a New Handheld Activity Monitoring Device Class

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Abstract: In professional sports and medicine, the use of electronic devices for activity monitoring and controlled exercising is commonly established since many decades. Due to miniaturization of computer electronics, sports and health devices became popular for non-elite sports users during the last twenty years, many of these in the appearance of watch-like systems, e.g. as running computers or as versatile heart rate monitors. Technologically based on such devices and since few time, various vendors in the sports and health field started to offer bracelet-like systems, while making the customers believe that the continuous use of such devices in daily life can be considered even more fashionable and helpful. This paper compares the new wristband device generation with the established, well-working sports watches. Significant findings about the sensor quality together with observation of the enforced Internet-based user handling yield a rather critical reflection about the usefulness of the this new device class for sports and health activity tracking.

1 INTRODUCTION

The positive impact on human health, which is generated by regular, not too extensive sports activities, has been proven in scientific investigations during the last century repeatedly. For instance, stroke risks can be considerably diminished by following physical workout plans for men (Wannamethee and Shaper, 1992) as well as for women (Church, 2010). Also various other diseases can be relieved by weekly body exercises (Law et al., 1991). Consequently in modern world, scientists aim at education and motivation for increased physical activity already with the help of electronic tools from childhood on (Valentín and Howard, 2013) for overcoming problems like overweight as early as possible (Colagiuri et al., 2010).

In modern investigations, smartphones often are used in such concepts and research, because these devices can easily be programmed with specific software. On the other hand, the electronic device market offers a wide variety of tools for non-elite and popular sports (Fig. 1), often with functionalities closely related to health support scenarios like monitoring heart rate (HR) or blood pressure. Such physiological measures do represent also standard indicators for planning and tracing training units in professional sports (Arts and Kuipers, 1994).

Figure 1: Personal sports units: Left hand, an elaborated triathlon watch and a simplified HR monitoring sports watch are shown, while right hand an "active" smartphone with a sport sensor test software is visible.

In particular for endurance sports like running or cycling, wrist-like watches without or in combination with RF coupled additional sensors are well established and broadly in use today for exploiting fundamental knowledge about physical training effects (Hoppeler et al., 1985). E.g., triathlon represents a kind of sports, which asks for improvement and supplement even in three parallel disciplines, i.e. swimming, running and cycling. Fig. 1 shows accordingly a triathlon computer (left-most device), which looks like a wrist watch, and which can be connected via RF to additional sensors like

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footpods, turning rate for bicycle wheels and pedals, and HR chest straps.

Quite commonly, the meanwhile established handheld wrist devices in Fig. 1 are primarily worn during sports, while physiological measures are recorded by additional body sensors. The chest strap for HR sensing often is sensed being inconvenient or uncomfortable, a restriction that applies also if smartphones replace the wrist watch computers by the help of specialised apps. The idea of improving the UI with smartphone apps and by that implicitly also the efficiency of such sports trackers was investigated already in other work (Weghorn, 2015).

Figure 2: Four bracelets from different vendors are representing a new generation and style of personal sports and health trackers.

From the experience with the sports tools and from the availability of the built-in sensors for motion, orientation and acceleration from the smartphone segment, a new device class evolved, which appears more compact in the shell style of bracelets (Fig. 2). Technologically, such systems try to overcome the additional RF-linked sensors by integrated electronics. Heart-rate rate monitoring is performed by an optical measurement system, which is directed to the skin below the tracker bracelet, acceleration or movement activities are detected by semiconductor sensors directly inside the device. In consequence, such tools are feasible for all day use, and that is exactly, what they are being advertised for. A much broader customer ship can be attracted by expanding the use from monitoring and control during ambitious sports to a general and all-time tracking of people with interest in their health.

Assuming an average customer without too deep of knowledge and insight in such technologies, the typical user faces a broad spectrum of vendors (Fig. 2), who are offering an even broader range of different bracelet devices. Commonly the price of such tools are in the order of 100 U$/Euros/GBP, and there were lots of commercial advertisements around the recent celebration periods, because this cost range is well feasible for personal presents.

The here assumed typical user cannot know, which device out of the many offers is the one, which best maps his or her own application desires, neither can this user know anything about the quality of such new tools, which came up in big mass in short time. On the other hand, feedback of average customers is exposed on famous Internet market places, out of thousands reviews a big part reports critical user experiences. Reports like (Van Arsdale, 2015) are rather typical, and they unveil that there might arise serious problems with the reliability of the new bracelet devices in respect to their advertised main purpose scope. Such observations seriously put the measurement quality of the new devices in to question.

Concerning the UI handling prospective, the tiny devices appear also interesting for research. For user inputs the units are typically equipped with just one mechanical input button, which is in some devices complemented by screen sensitivity to finger touches and finger wiping. For information output, a range is used from simple single LEDs, segmented LED number displays, OLED displays, and paper like LCD displays. Each vendor follows at the moment a unique combination of the hardware UI possibilities, which are primarily restricted by the surface of the devices. This may appear also confusing to a customer, who wants to select an appropriate unit.

Regarding this overall situation, in the research here the new bracelet device class should be investigated with scientific methods systematically. After putting a given selection of typical devices (Fig. 2) into operation (software installations + configuration), a measurement series was intended for investigation of their precision in movement tracking and in HR monitoring. For the mutual verification, the above discussed triathlon system was used, since its reliability was investigated and verified in former research already (Weghorn, 2014). As sideline result of the UI handling some indicative and critical findings about the usability of the Web-based assistive UIs and about privacy concern could also be derived here.

2 SETTING UP THE BRACELET TRACKERS FOR OPERATION

In this investigation, a systematic validation of the measurement quality was targeted for the four available bracelets, which are visible in Fig. 2. In particular the following aspects should be evaluated, because these reflect the primary use features of the devices:

Step counting – Precision of movement detection in walking and running.

HR monitoring – Accuracy of HR tracking, events and periods of possible signal loss.

As look ahead it shall be stated here already, that the exploration could not be performed to the full extend like in former, similar research (Weghorn, 2014). The reason for this was, that the systems do not grant reasonable or full access to their data scans; some of them are even are reporting data despite there is no physiological input available at all. It shall be furthermore stated here, that for legal reasons, the findings are described in an anonymous way, so that they cannot be projected to certain, particular product vendors.

Direct relevance for the handling viability of the devices - especially during all-day use - arise from their own physical dimensions. The weight and also the size (total volume of core device without watchstrap) of the given set of units was measured here and is listed in Table 1.

Table 1: Measures for physical dimensions of the different tracker devices.

		weight [gram]	size [cu. cm]
sports watches	*T*	*73*	*35.0*
	simple	*43*	*15.8*
smart phones	*sports*	*113*	*79.2*
	full+slim	*132*	*77.3*
bracelets	*A*	*28*	*9.24*
	B	*31*	*11.34*
	C	*27*	*7.33*
	D	*28*	*7.80*

The most compact bracelet devices do have either no built-in HR sensor (D) or no own display (C). Compared to a simple sports watch, the size and weight differences to the bracelets are not too big, while a fully equipped system like the triathlon watch computer T requires its considerably bigger dimensions for hosting all the electronic and rechargeable battery with long operational time.

In the beginning of the experiments, the systems had to be set up for operation. In general, this has to be performed by installing a communication relay software on one's personal host computer (similar to a device driver, but a rather elaborated one with autonomous Internet communication) and by registering as user on a Web site of the vendor. For the latter, entering personal data like passwords and e-mail addresses is mandatory and cannot be circumvented.

For acquaintance to the handling of the devices, arm position tests for proper HR sensing were tested. In accordance to the recommendations for the devices in their manuals, positioning and launch of using the HR monitoring on the display appeared appropriately efficient.

The bracelet devices perform motion tracing in walking and running through their acceleration sensors from the forearm position. Of course this is only indirectly coupled to any foot stepping activity. Therefore, a manual step counting was performed with the devices. One hundred walking steps were counted, and the device display values were noted on a paper. While walking, the arms were either moved in synchronous swings to the walking cycle or the arms were intentionally damped in their movement. Several laps were conducted for devices A, B and D, and the maximum counting errors are shown in Tab 2. Obviously, the devices register two counts for each natural walking step with both feet.

Table 2: Values registered by the bracelet devices during the manual counting experiments with 100 walking steps.

bracelet	*A*	*B*	*D*
synchronous arm swing	167	203	200
damped arm swing	203	203	150

Complementary, it was tested, whether the devices are registering any body movements incorrectly as steps due to their forearm position. As listed in Tab. 3 a set of typical, gymnastic exercises was used for this experiment.

Table 3: Test of possibly incorrect step counting in typical gym workouts (sets of 20 repetitions were conducted).

bracelet	*A*	*B*	*D*
squats	counted	counted	no
dumbbell front raise	counted	no	counted
dumbbell lateral raise	counted	no	no
arm circling	counted	counted	counted

These observations about motion tracking suggest, that the bracelets can theoretically be used for endurance workouts in walking and running, if

Figure 3: The three devices T, A and B were used in parallel in the first activity experiment with four sets of stemming pull-ups. The upper part shows as reference the measurement curve for the professional triathlon system T indicating HR at resting start and at its maximum. The middle and the lower curve show the measurements of bracelets A and B respectively. These indicate a proper map of the resting phase, but totally wrong slope and peak values otherwise.

arm movement is performed with certain discipline and care. On the other hand, it is pre-programmed that an all-day use will generate totally wrong accumulation counts for so-called steps.

The use procedure for the bracelets has to be performed in the following functional sequence:

1. The user wears the bracelet; either on manual UI input or on automatically, the bracelet device starts detecting, measuring and recording physiological input data.
2. The user has to synchronize the device data (this also can happen automatically): Through an RF connection or a data cable the gateway ("device driver") on the personal computer extracts the data records from the bracelet and forwards it to the Web site of the vendor. That means, all data is collected in a kind of cloud system and is not under primary access and ownership of the bracelet user.
3. The user has to log into the vendor's Web portal for accessing his/her own data. Due to the limitations of Web page programming, the UI there has to be handled in an entangled way for accessing the information. Unlike announced by the vendors (with words in sense like "the user owns his data and has full access") only vague summaries of activity traces can be displayed and downloaded. Data plots, which are visible in the Web UI, are not presented in scientific style, and can therefore not evaluated in this way (refer to Fig. 4 to Fig. 6).

The software setup for first operation was started and performed only for three stand alone devices A, B and D, because the inconvenience of the handling prevented a quicker advance already in this very first stage of this work. Next, the devices were used outdoor in shorter sequences for learning the proper handling and the methods of extracting the captured data afterwards. It turned out, that device D cannot be used in the required way, because it doesn't allow any lap control.

Therefore, D excluded itself from the further extended screening. Also two operational bracelets are sufficient in the beginning, because during mutual verification one person can only wear two of such devices on both arms without mechanical disorder. On base of this, the first systematic experimental series had been started.

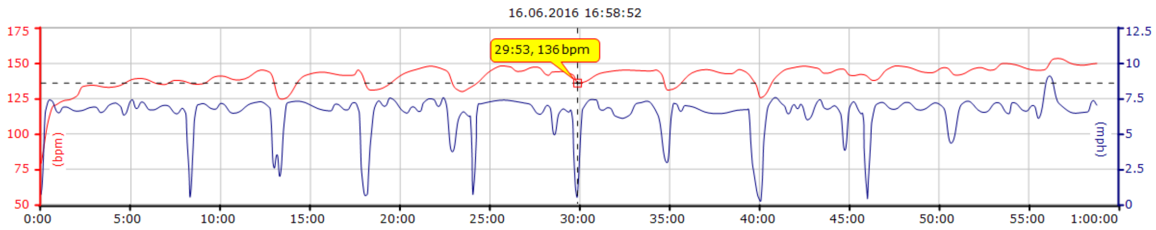

Figure 4: Reference scan of device T for a running experiment with a set of laps; this was carried out for statistically evaluating the measurement quality of bracelet device that are used in parallel. During the slow down phases, the devices were handled for starting and ending the individual laps.

3 ENDURANCE EXPERIMENTS

In the following experiments, the bracelet devices A and B together with triathlon sports watch T were used. Where required, T was connected to a HR chest strap and also to a 3D footpod sensor inside the running shoe of the experimenter. Despite that the bracelets come with disclaimer, that the devices are not indented for this kind of use, one of the first experiments was a sequence of strength training.

Stability and tracking slope in HR sensing

The active part of the stemming experiment started after a resting phase at resting pulse as displayed in Fig. 3. After 30 seconds, the experimenter stood up (seen from the barometric altitude sensing of T visible in Fig. 3) and executed four series of arm pull ups with intermediate breaks. The weight load for the pull-ups was increased after the second set. Since all three devices T, A and B were worn in parallel, the following observations can be derived for this experiment on base of the reference scan from T:

- The constant, resting pulse was registered correctly by A and B.
- The maximum pulse value is neither detected at the proper time moment by A and B, nor is it correct in its absolute value.
- The curves are extremely distorted, only vague similarity to the reference is found.

This test yields first obvious indication, that the bracelet devices cannot follow a steady change of pulse, but they are able to detect values that are constant over a longer period only. The display style for the UI of the bracelets can also be commented as non-scientific and unprofessional. Furthermore, it requires a rather winding browsing sequence to get these graphs displayed on the bracelet UI systems at all.

Statistics about heart rate tracking accuracy by conducting series of running laps

For a field evaluation of the tracking accuracy, a series of running laps was performed. Within an "in and out cycle" one main lap on a cart track along a river was coped at an intermediate running speed of approx. 7 mph. This moving speed should incur an intermediate HR and also an intermediate foot tread rate. The starting and stopping of the laps had to be handled on the bracelets A and B in little complicate manner due to the limited input controls; therefore, the precision of the lap capture was in the order of one to two seconds, sometimes worse as seen from the lap durations in Fig. 6. The proper lap distance was tracked in parallel by the river landmarks and by the GPS display of device T.

In the first systematic series, devices T, A and B were worn and used. After warming up during reaching the start of the first testing lap, ten repetitions were performed by using device A in the "out" round and using device B in the "in" round of the lap course (Fig. 4). Handling all three devices in parallel was not possible in a reasonable way, so there is no direct comparison between A and B recordings available for this part.

After transferring the data captures of the used tracking devices to the host UI systems, the following turned out:

- The bracelet Web UIs do not release the data about the laps in a way that it can be efficiently used for a statistical evaluation. The UIs display only summaries of information, but no individual measures on the laps to the required deepness like it is know from the standalone PC software for device T, which was used in former investigations before many times.
- Device A ignored the manual lap control completely and merged the entire time (e.g. for the run in Fig. 4) into one overall output display only.
- As mentioned before, with device D no lap control is possible at all, and it doesn't have an HR sensor anyway.

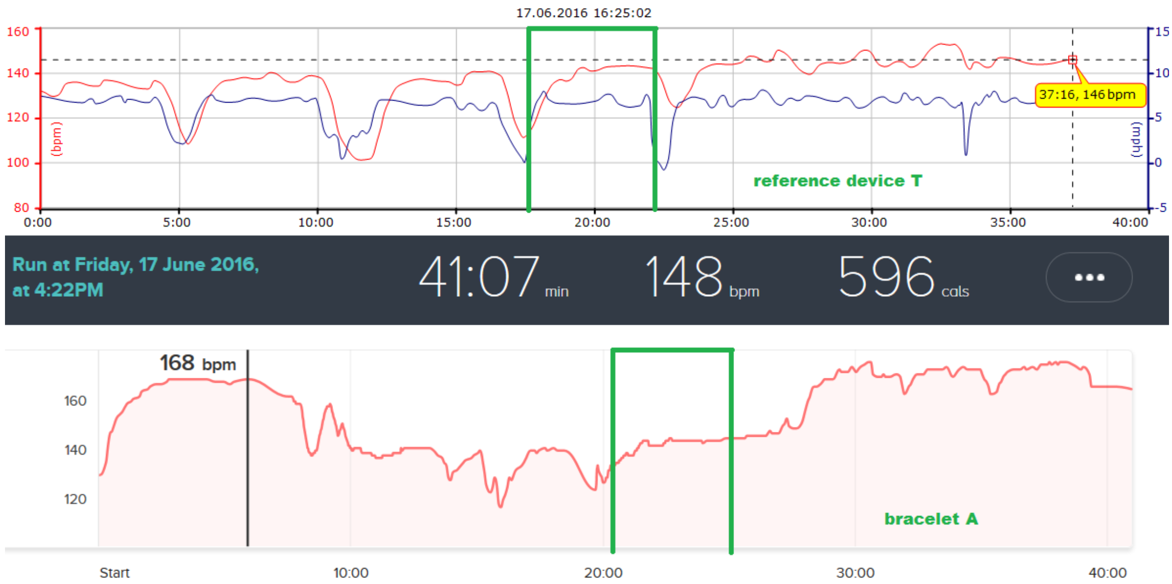

Figure 5: Just one single lap should be recorded with bracelet A by attaching it only to its regular forearm position during the green time window. This lap was started and stopped on device A by the defined button presses, but in its evaluation UI, the record shows the full time of the excursion; even for the walking time to the starting way point a data curve is displayed despite A was worn inside a side pocket, totally detached from skin. Obviously, the bracelet software blindly invents data points for phases, where it assumes activity, despite there is absolutely no physiological input.

This first running series has to be therefore considered as fail, because the bracelet UIs do not provide the desired data content for enabling any deeper analysis. As consequence, it was decided to record only one single lap with device A and extract this immediately from the device for preserving more detail information. This method - of course - invokes a much higher experimental overhead, because at least five laps should be collected for obtaining reasonable statistics.

In accordance to this, the next approach was started with a follow-up experiment: Device T and B were put into their regular arm position, while device A was put into a side pocket, clearly detached from any body or skin contact. The experimenter walked approx. 3 mins to an appropriate starting point for further tests and started running for approximately 17 mins from there. During this, three laps of 1/2 mile each plus intermediate breaks were applied. As Fig. 5 shows, bracelet A recorded data already during the walking time despite it was neither worn properly, nor started manually. For this reason, a time gap between the two curves in Fig. 4 arises.

Furthermore, the bracelet A software system blindly invented data scans despite there was absolutely no physiological input; this is exposed in the curves before and after the activation window in Fig. 5. The HR measures in these phases are - of course - completely wrong and much too high, which can be derived from the reference scan on device system T. Only during the activation window of the intended lap, the curves between A and T are aligned to a reasonable degree.

A hardware/software systems, which invents data randomly and exposes the impression that the system is working correctly despite it is not, clearly can be excluded as serious device. This applies especially, if sensitive data like human HR is to be detected. Further investigation about HR tracking with bracelet A can by that be derived being totally nonsensical, further research was therefore stopped at this point with unit A.

For bracelet device B, the situation arises much less erroneous. Although no detail scans about the HR curves can be extracted in its Web UI, Fig. 5 tabulates the number results for the five laps that were recorded in this experiment with device B. As explained before with Fig. 4, 20 laps have been captured with device T in total, while A and B were used alternately and in parallel to T. Fig. 5 shows the result records for T that corresponded to the B using slots. Overall, the averaged and maximum HR values for the five laps show, that there is only a maximum difference of two beats/minute between the two different systems, while most values are almost identical or within a difference of just one count. This implies, that pulse capture with device B

Activity Type	Start	Distance	Time	Avg Speed(Avg Pace)	Max Speed(Best Pace)	Avg HR	Max HR	sumStrokes	Avg Strokes
Running	Thu, 16 Jun 2016 5:49 P...	0.59	4:23	7:29	5:22	146	151	--	--
Running	Thu, 16 Jun 2016 5:38 P...	0.58	4:27	7:38	5:29	142	148	--	--
Running	Thu, 16 Jun 2016 5:27 P...	0.59	4:30	7:37	4:57	141	146	--	--
Running	Thu, 16 Jun 2016 5:16 P...	0.57	4:23	7:40	3:31	139	145	--	--
Running	Thu, 16 Jun 2016 5:06 P...	0.58	4:25	7:37	5:23	139	144	--	--

17:07:10	0.50 mi	4:23.30	8:50 /mi	6.8 mph	7.5 mph	140 bpm	144 bpm	87 U/Min.
17:17:04	0.50 mi	4:21.62	8:46 /mi	6.8 mph	7.7 mph	141 bpm	145 bpm	85 U/Min.
- 17:28:46	0.50 mi	4:28.91	9:01 /mi	6.7 mph	7.5 mph	142 bpm	145 bpm	85 U/Min.
- 17:39:00	0.50 mi	4:25.64	8:54 /mi	6.7 mph	7.6 mph	143 bpm	147 bpm	86 U/Min.
- 17:49:52	0.50 mi	4:21.54	8:46 /mi	6.8 mph	7.3 mph	147 bpm	150 bpm	88 U/Min.

Figure 6: Upper part shows the output table of the Web UI for bracelet device B, which lists a series of five lap traces out of the full set in Fig. 4. Interestingly, the stride counting is not reported, but the covered distances and derived moving speeds are shown. With device B, the distance measure systematically is to high, because again all laps covered 0.5 mi as validated by GPS and landmarks. The lower table is a mosaic from the corresponding running details, which were simultaneously recorded with device T and were displayed by T's standalone software for personal computers.

seem to work appropriate for slow variations of this type of measure.

Statistics about motion tracking accuracy

Since the Web UI of device A doesn't allow to record and display a set of laps individually, a test on movement tracking was performed by manually handling this bracelet through its one button input. In this way, it is possible to read the actual step counting and total distance on the tiny number display. A series of five walking laps with 0.5 miles each was collected (Tab. 2), and the intermediate counting values of device A were written on a paper. By mutual verification with T and with the knowledge from former experiments on this kind of research (Weghorn, 2014), the step counting was found to be appropriately precise for this sensor concept.

Based on an internal conversion factor for the step size, which cannot be modified, the device registers systematically too low a covered moving distance (in average 0.415 mi instead of 0.5 mi) with some intrinsic error bar, which is caused by the natural variation of step size during walking. This means, that with device A the moving distance has high repetition quality, but shows also a considerable absolute error, because the lack of any calibration procedure. The latter is standard for sports computers like T.

Table 4: Hand written protocol of five movement tracking laps of 0.5 miles with device A.

lap no.	*1*	*2*	*3*	*4*	*5*
steps [counts]	753	703	725	730	718
distance [miles]	0.70	0.61	0.67	0.68	0.66

Furthermore, it turned out as side observation in the test series of Tab. 4, that device A registered floor levels while moving the arm up and down for reading the values from the display. This suggests that the floor level counting is also performed in a nonsensical way, and its result is worthless.

In contradiction to the situation with device A, the Web UI of device B lists individual laps out of one bigger activity as these are launched and terminated through the bracelet input menu. Fig. 5 shows a set of five lap runs, from which it can be derived that the covered distance is registered as systematically too high. In consequence, the moving speed is also wrong inversely. For unknown reasons, the Web UI does not show the counting of the foot steps, so it cannot be validated, whether the distance error refers to a wrong step length parameter, which also cannot be calibrated in this device. There is a time gap of approx. one minute in Fig. 5 between the recordings of device B and T, but the latter system is based on GPS and therefore absolutely precise.

In summary, the movement distance tracking can be considered as comparably precise to the method based on the footpod sensors despite the movement is detected by the bracelet on the forearm, which does not have a 1:1 relation to foot stepping. The concept suffers anyway from an intrinsic problem, because in general step width is a varying value and not a fixed parameter.

4 CRITICAL DISCUSSION

The before described experimental results have shown, that the bracelet trackers are not feasible as single device solution for sports and health scenarios. Obviously, the established approach of additional - but somehow inconvenient - sensors like heart chest straps represents the more accurate and reliable method. It can be assumed that this is well realized by the vendors of the device samples B and D, who enable their devices to be linked with such additional, professional sensors. Since these firms develop and offer also systems like T since many decades, they are experts in this field of physiological sports sensing.

The replacement of the HR chest strap sensor for pulse detection by the optical reflection system can be considered as fail in all applications, where movement and quicker pulse variations apply. That also such an optical system suffers from signal detection delays is known from all finger pulse sensors, which are in use since a long time in medicine and in clinical environments (Fig. 7). Unlike the bracelets, these medical devices optically shine through the finger for detecting the vascular pulse contractions, which is a better then the possibly moving and by that unstable reflection method of the tracker bracelets. Despite this better construction the medical sensors typically require around a minute for synchronizing to the pulse.

The observation that one of the investigated bracelet tracker system invents blindly HR data in case of signal loss, appears almost unbelievable. This behaviour generates the illusion that the system is working, while it is in reality often incapable for its intended purpose. This represents a clear fraud by the responsible engineers and companies in this very sensitive application field of tracking human physiological conditions.

There is already research conducted, which tries to employ such systems in elderly care (Alsulami et al., 2016), and which needs to rely on the advertised properties of the bracelet devices in their concepts. In emergency situations, such sensors could therefore even lead to disastrous results, but it is also not new that researchers uncritically trust in the sensor quality of modern consumer devices (Valentín et al., 2013).

Regarding motion tracking, the registration of foot steps appear to work in most cases as precise and reliable as known from other, comparable systems (Weghorn, 2014). Unfortunately, there is no calibration of the foot step size in the tested bracelet devices, and therefore all come up with considerable

Figure 7: Optical pulse detection is standard in medicine, where monitors like the pulsoxiometers (right device) shine an optical beam through the finger. This yields better contrast than the reflection method of the tested bracelet trackers. Here again, the obtrusive unit (left device) enforces measurement of just any signal, which leads to a totally wrong result of 118 bpm in contradiction to the correct sensing value of 65 bpm.

measurement errors in tracing distances and velocities. Calibration of the stride length was standard from the beginning during the use of footpods with devices like T. This was introduced for providing reasonable functionality of such devices also indoor. Outdoor, such sports computers like also health and sports apps in smartphones are using GPS, which is clearly the better localization technology, and which is currently being introduced in improved versions of device B. All this will lead to bracelet constructions, which are constructed internally like the original computerized sports watches, while only the shell appearance remains different at the end of this evolution.

Of course, it is not possible to test the entire variety of available device on the market. Hence, it cannot be proven that there do not exist well-working bracelet devices anywhere. A counter-productive handling style and automatic mechanisms like lap data merge prevented the targeted experimental advance and deepness in this research. Independent of this, the major point can be addressed here sufficiently, that non-expert users are not able to distinguish the functional from the non-functional bracelets. The current amount of user feedbacks, which is exposed by the bigger Internet market places, show that there are, e.g., ten thousands of owners of device A and a big portion of them are complaining about the device. A fraction of them are addressing problems with measurement and tracking accuracy, but in sum all these owners are victims of a fraudulent product, although most of them may not be able to realize this themselves.

Despite all technical restrictions, the bracelet trackers can also be interpreted of having some positive effects. Although they may work imprecise or completely wrong in scientific or medical sense, the expanded marketing around these units certainly increases the awareness and interest level about health issues and sports in broader parts of the citizenships. Already through the desire of individuals in sharing and publishing their workouts with others, these people are motivated to perform more physical activities despite they do not have precise measures of their efforts. Like with placebo pills, this all can have some overall positive effect.

Another positive aspect is addressing the opportunity of a broader exploration of futuristic UI concepts. The four experimentation bracelets from Fig. 1 come up with various helpful concepts for UI handling. For instance, motion detection can assist or even replace classical input elements like push buttons. One of the devices, e.g., activates in this sense its display screen, when the arm is moved up. The other device is controllable by finger touches, while knocking and wiping actions offer a high dimensionality for obtaining a flat input control hierarchy. The different output display systems concepts will also teach, which method is acceptable in certain environments and which is not. Variant of the latter certainly will disappear from the market, like the LED number in one of the bracelets that is unreadable because the letters are too small and are not bright enough for being readable during daylight.

For non-technical bracelet users, the UI handling through the website of the device vendor may appear in the style of community pages. Also the concept of uploading and handling all data through a central instance on the Web follows the current data cloud philosophy, but the approach invokes several severe disadvantages. First of all, the UI system cannot be used at all without Internet connection. Due to the upload and download cycle, several instances on the personal computer of the user has to communicate login information, which makes the entire system more vulnerable to security attacks.

For the user it is also totally unclear, who all will have in the end access to the personal data in this system. In logic consequence to the limited motion tracking by acceleration sensors as seen above, the introduction of GPS traces in the bracelet will furthermore increase privacy concerns, because then details on location and places, where the user stays will go to a central Web instance. This appears even critical, because the trackers are indented for all-day use. The Web-based UI is appears also rather poor, if more than just vague summaries about the recent activities shall be displayed in detail. This all stands in full contradiction to the standalone software for devices like T, which grant full access to all details of individual workouts with very few selection actions on the UI. Another negative aspect is, that the bracelet vendors use their UI tools and the required e-mail for uninvited information and advertisement.

In total, the use experience of the different UI system in the experiments here has shown, that it is very complicate or partially impossible to access the information details of workouts or activity traces with the bracelet systems. All the findings here can be summarized in the sense that the bracelet devices in their actual construction and handling are not professionally usable, neither in sports nor in medical or health scenarios. For the latter - if fields like elderly care of emergency automatisms are to be addressed - such mal-functional systems could even cause disastrous consequences. For ambitious and professional sports tracking that the before established system concepts are still serving the requirements to a sufficient extend.

5 CONCLUSIONS

Modern electronics together with micro computer and sensor technologies provide opportunities for valuable handheld devices in sports and health applications. This has been shown over many decades also with the entry of economic commercial devices, e.g. for measuring blood pressure or monitoring and controlling sports activities. Such devices can be used standalone or together with a personal computer without Internet connection, while producing reliable measures and traces of the physiological activity information of interest.

For the new bracelet device class, which is also intended and offered for the related purpose of tracking body movement and HR, the vendors started to enforce a totally new UI handling concept. The user can not use the full capabilities of such devices without Internet access, instead all data has to be handled through Web based systems. Even more - at least some of the devices - do not seriously measure data, but invent data scans randomly with the goal of exposing always nice and indicative activity traces and functional plots in their overloaded Web screens.

Furthermore, the user is spamed via e-mail and while using the Web-based UI of the systems with advertisements of alternative products. The main benefit of the wristband systems seems to serve a new market not in the sense of seriously providing any reliable measurement tools for sports and health, but for earning quick and big profit with playful devices. These are strategically advertised like a fashion trend and come with general disclaimers about their usefulness as measurement utility.

For people, who seriously want to use electronic tools for sports and health tracking, the prior generation of computerized handheld devices appears at the current product state as the more appropriate one. In contradiction to that, the new bracelet class certainly will provoke confusion and misguiding in sports and health use, and in health emergency scenarios their application could even end in disastrous situations.

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