Summary of the real-world benchmark data on watch alarm response time

03-09-2023

The real-world study was conducted over the period between December 21st with a trial by the first two participants, and resuming experiments from January 30th through March 3rd. In summary, a total of 31 participants, varying in gender, age, and school year from the NYU campus community participated in the experiment. While participant demographics were not collected prior to experiments, the research team plans to conduct a survey on all 31 participants on their basic demographics and basic questions relating to their prior knowledge or experience with VR or work experience in the construction or transportation industry, and report any feedback from the real-world experiment to draw implications on improving study design, methodology.

Raw Data Description

The raw data recorded on the server is stored in json format, where the following items are recorded in order: 'Timestamp', 'From' (the source of signal or response), 'Event' (note on the types and nature of event occurring during the experiment).

	Timestamp	From	Event
0	2022-12-08 14:37:53.101391	VR	Received car approaching alert, mode=3, id=1000
1	2022-12-08 15:53:05.098288	Watch	Start Simulation
2	2022-12-08 15:53:07.437488	VR	Received car approaching alert, mode=4, id=1004
3	2022-12-08 15:53:13.064067	Watch	Stop Simulation
4	2022-12-08 15:53:13.163635	Watch	Stop Simulation
...	...	...	...
2417	2023-03-03 16:17:46.166644	Watch	1398
2418	2023-03-03 16:18:00.004425	Watch	1398
2419	2023-03-03 16:18:01.272071	Watch	1398
2420	2023-03-03 16:18:07.359187	Watch	Stop Simulation
2421	2023-03-03 16:18:07.388183	Watch	Stop Simulation

2422 rows × 3 columns

Figure 1Raw data stored in server, since renewal in December, 2022

Data Processing

Because the same server is used for data storage for both VR and the real-world benchmark study, data was filtered by dates of time first to extract only the data recorded from the real-world benchmark study, conducted outside of campus building (MTC 6).

	Timestamp	From	Event	date_full
465	2022-12-21 10:45:55.646213	Watch	Start Simulation	2022-12-21
466	2022-12-21 10:46:01.850254	VR	Received car approaching alert, mode=1, id=1015	2022-12-21
467	2022-12-21 10:46:03.393368	Watch	1015	2022-12-21
468	2022-12-21 10:46:04.060460	Watch	1015	2022-12-21
469	2022-12-21 10:46:04.313220	Watch	1015	2022-12-21
...	...	...	...	...
2417	2023-03-03 16:17:46.166644	Watch	1398	2023-03-03
2418	2023-03-03 16:18:00.004425	Watch	1398	2023-03-03
2419	2023-03-03 16:18:01.272071	Watch	1398	2023-03-03
2420	2023-03-03 16:18:07.359187	Watch	Stop Simulation	2023-03-03
2421	2023-03-03 16:18:07.388183	Watch	Stop Simulation	2023-03-03

Figure 2 Raw data filtered by dates of real-world study events

Any missing or odd data points occurring due to server error or mistrials in the experiments are omitted from the data, and sanity filters were applied so any number outside the realistic range or instance be removed from the dataset. Duration of each experiment were calculated by subtracting between timestamps for start and end times recorded. Any trial recorded with duration less than 30 seconds was eliminated from the dataset. Any datapoints below and beyond 50% range from the mean are removed as outliers for both (i) vehicle travel time between start point to warning zone, and (ii) user naturalistic response time to watch alarms.

Open dataset description

The raw data from the server was further processed at the user level, well all user data were marked by ID number randomly assigned to each user to anonymize the datapoints. For total of 31 user data, all timestamps recorded were marked by trial number and alarm number, as multiple alarms will

signal to user at each triggering event for total of three trials per user. A detailed documentation of the final recorded data is attached as 'Metadata' sheet in the final excel dataset.

Table 1Metadata column description

Column	Description
userID	Random ID number assigned to each participant
t1_alarm1_received	Timestamp of first alarm of trial 1 received
t1_alarm1_sent	Timestamp of first alarm of trial 1 sent
t1_alarm2_received	Timestamp of second alarm of trial 1 received
t1_alarm2_sent	Timestamp of second alarm of trial 1 sent
t1_alarm3_received	Timestamp of third alarm of trial 1 received
t1_alarm3_sent	Timestamp of third alarm of trial 1 sent
t1_alarm4_received	Timestamp of fourth alarm of trial 1 received
t1_alarm4_sent	Timestamp of fourth alarm of trial 1 sent
t1_start	Timestamp of trial 1 start time
t1_stop	Timestamp of trial 1 end time
t2_alarm1_received	Timestamp of first alarm of trial 2 received
t2_alarm1_sent	Timestamp of first alarm of trial 2 sent
t2_alarm2_received	Timestamp of second alarm of trial 2 received
t2_alarm2_sent	Timestamp of second alarm of trial 2 sent
t2_alarm3_received	Timestamp of third alarm of trial 2 received
t2_alarm3_sent	Timestamp of third alarm of trial 2 sent
t2_alarm4_received	Timestamp of fourth alarm of trial 2 received
t2_alarm4_sent	Timestamp of fourth alarm of trial 2 sent
t2_alarm5_received	Timestamp of fifth alarm of trial 2 received
t2_alarm5_sent	Timestamp of fifth alarm of trial 2 sent
t2_start	Timestamp of trial 2 start time
t2_stop	Timestamp of trial 2 end time
t3_alarm1_received	Timestamp of first alarm of trial 3 received
t3_alarm1_sent	Timestamp of first alarm of trial 3 sent
t3_alarm2_received	Timestamp of second alarm of trial 3 received
t3_alarm2_sent	Timestamp of second alarm of trial 3 sent
t3_alarm3_received	Timestamp of third alarm of trial 3 received
t3_alarm3_sent	Timestamp of third alarm of trial 3 sent
t3_alarm4_received	Timestamp of fourth alarm of trial 3 received
t3_alarm4_sent	Timestamp of fourth alarm of trial 3 sent
t3_alarm5_received	Timestamp of fifth alarm of trial 3 received
t3_alarm5_sent	Timestamp of fifth alarm of trial 3 sent
t3_start	Timestamp of trial 3 start time
t3_stop	Timestamp of trial 3 end time
vehicle_70ft_t1	vehicle travel time of 70 ft from start point to 30 ft point at trial 1
vehicle_70ft_t2	vehicle travel time of 70 ft from start point to 30 ft point at trial 2
vehicle_70ft_t3	vehicle travel time of 70 ft from start point to 30 ft point at trial 3
t1_duration	duration of trial 1 for each user in 'mm:ss' format
t2_duration	duration of trial 2 for each user 'mm:ss' format
t3_duration	duration of trial 3 for each user 'mm:ss' format
t1_duration_sec	duration of trial 1 in seconds
t2_duration_sec	duration of trial 2 in seconds
t3_duration_sec	duration of trial 3 in seconds

t1_rt1	response time to alarm 1 of trial 1
t1_rt2	response time to alarm 2 of trial 1
t1_rt3	response time to alarm 3 of trial 1
t1_rt4	response time to alarm 4 of trial 1
t2_rt1	response time to alarm 1 of trial 2
t2_rt2	response time to alarm 2 of trial 2
t2_rt3	response time to alarm 3 of trial 2
t2_rt4	response time to alarm 4 of trial 2
t2_rt5	response time to alarm 5 of trial 2
t3_rt1	response time to alarm 1 of trial 3
t3_rt2	response time to alarm 2 of trial 3
t3_rt3	response time to alarm 3 of trial 3
t3_rt4	response time to alarm 4 of trial 3
t3_rt5	response time to alarm 5 of trial 3

Descriptive Statistics

The following statistics were drawn from experiment data from a total of 93 real-world study trials, while some data points were taken out due to server error or mistrials recorded and left unchecked in the dataset. Ambient noise data as well as heartrate of each user by at second interval were measured and stored as data during the experiments, which will be analyzed later to test any correlations between user heartrate, ambient noise, weather conditions, etc. on worker response time to alarm signals.

	N**	Mean	St.Dev	Min	max
Vehicle Speed*	82	7.558 (mph)	8.632	2.34	71.986
Travel time of 70 ft	82	8.729 (sec)	3.94	0.663	20.39
Response time	203	2.438 (sec)	0.933	0.525	5.649
Trial duration	85	61.46 (sec)	21.23	25.019	124.501

*Vehicle speed is calculated using Travel time calculated for travel distance of 70 ft

** Number of datapoints are not consistent as outliers were removed by applying a 1.5 quarter range to the raw dataset; rounds of trial was not used for sampling and all trials were treated independently.

Table 2Distribution of experiment duration

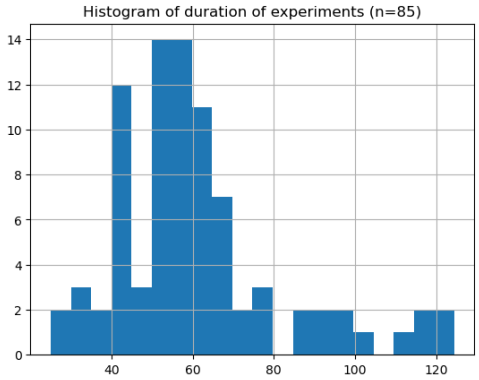
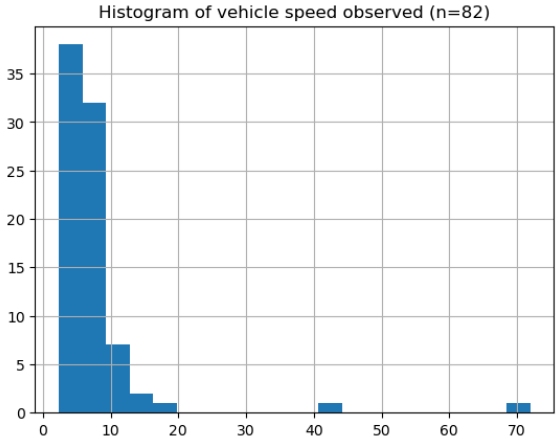


Table 3 Vehicle speed observed in trials (n=82); Logscale plot of vehicle speed observed in trials



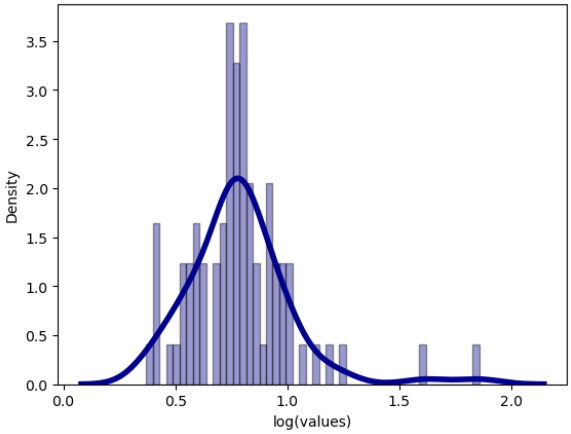


Table 4Response time to alarms distribution; and logscale plot of alarm response time distribution