US011042028B1

(12) **United States Patent**
Welch et al.

(10) **Patent No.: US 11,042,028 B1**
(45) **Date of Patent: Jun. 22, 2021**

(54) **RELATIVE POSE DATA AUGMENTATION OF TRACKED DEVICES IN VIRTUAL ENVIRONMENTS**

(71) Applicant: **University of Central Florida Research Foundation, Inc.**, Orlando, FL (US)

(72) Inventors: **Gregory Welch**, Orlando, FL (US); **Gerd Bruder**, Orlando, FL (US)

(73) Assignee: **University of Central Florida Research Foundation, Inc.**, Orlando, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/146,691**

(22) Filed: **Jan. 12, 2021**

(51) **Int. Cl.**

G06T 15/08	(2011.01)
G02B 27/00	(2006.01)
G06T 19/00	(2011.01)
G06T 7/73	(2017.01)
H04W 4/029	(2018.01)
G02B 27/01	(2006.01)

(52) **U.S. Cl.**
CPC ***G02B 27/0093*** (2013.01); ***G02B 27/017*** (2013.01); ***G06T 7/75*** (2017.01); ***G06T 15/08*** (2013.01); ***G06T 19/006*** (2013.01); ***H04W 4/029*** (2018.02); *G02B 2027/0187* (2013.01)

(58) **Field of Classification Search**
CPC G02B 27/0093; G02B 27/017; G02B 2027/0187; G06T 7/75; G06T 15/08; G06T 19/006; H04N 4/029
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

10,007,350	B1 *	6/2018	Holz	G06T 7/246
10,403,050	B1 *	9/2019	Beall	G02B 27/017
2014/0002359	A1 *	1/2014	Weising	A63F 13/65 345/158

(Continued)

OTHER PUBLICATIONS

Welch et al., A Novel Approach for Cooperative Motion Capture (COMOCAP), International Conference on Artificial Reality and Telexistence Eurographics Symposium on Virtual Environments (2018), pp. 73-80.

(Continued)

Primary Examiner — Terrell M Robinson
(74) *Attorney, Agent, or Firm* — Anton J. Hopen; Smith & Hopen, P. A.

(57) **ABSTRACT**

This invention relates to tracking of user-worn and hand-held devices with respect to each other, in circumstances where there are two or more users interacting in the same share space. It extends conventional global and body-relative approaches to "cooperatively" estimate the relative poses between all useful combinations of user-worn tracked devices such as HMDs and hand-held controllers worn (or held) by multiple users. For example, a first user's HMD estimates its absolute global pose in the coordinate frame associated with the externally-mounted devices, as well as its relative pose with respect to all other HMDs, hand-held controllers, and other user held/worn tracked devices in the environment. In this way, all HMDs (or as many as appropriate) are tracked with respect to each other, all HMDs are tracked with respect to all hand-held controllers, and all hand-held controllers are tracked with respect to all other hand-held controllers.

10 Claims, 17 Drawing Sheets