FUNDAMENTAL EXPERIMENT FOR CONSTRUCTING IT-TOW

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The purpose of this study was to collect some baseline data which may be used for developing an IT-tow system by using a load cell. The pulling forces were measured in 3 tests, hold1 phase, hold2 phase, and drive phase. The pulling force decreased in drive phase defined as the phase the pullers are driven by opponent. This is because the pulling force in this study was defined as tension of the rope, and then pulling force measured in this phase is not produced by subject but produced by examiners side. If the IT-TOW is made by using the load cell, 2 machines have to exchange and reproduce the pulling force of each other. In case the load cell received 2 different pulling forces, pulling force produced by one side may not be measured with accuracy. To put IT-TOW into practice, the pulling force data must be exchanged and not be measured by a load cell, but defined by another system.

KEY WORDS: IT-TOW, remote sports, load cell, pulling force

INTRODUCTION: Information Technology has evolved at a rapid pace in the last decade. Computers obtained a high level of performance and residential broadband became widely used. They enabled us to exchange a lot of information in real time. With these developments in IT, various way to communicate in real time were born; chatting, video phone, or interactive video game. “IT-TOW” is the system which enables us to compete with competitors who are in other place by exchanging the force data or information online. Kano et al. (2003) designed a remote arm wrestling system and named such sports which enable players to have a game online with someone at distant locations ”remote sports”. Researching on remote-sports makes sports more accessible. For example, some Japanese tug-of-war teams can not compete or make practice matches due to of lack of competitors. To actualize IT-TOW it is necessary to investigate the pulling force in a match because IT-TOW systems will need to exchange the pulling force data. Pulling force was measured in many previous studies. Tanaka et al. (2004) and Liou et al. (2005) defined pulling force as tension of the rope measured by a load cell or tensile meter. Therefore, the purpose of this study was to collect some baseline data which may be used for developing an IT-tow system by using a load cell.

METHODS: A healthy female subject who didn’t have any experience with tug of war (22yrs, 162.0cm, 529.2N) volunteered in this study. Pulling force was measured in 3 tests, and 3 trials per one test. Pulling movement in tug of war can be divided into three phases; “drop phase”, “hold phase” and “drive phase”. It is considered that “drop phase” is the phase in which pullers put pull rapidly right after the start, “hold phase” is the phase in which pullers hold against the pulling of the opponent or pullers are driven by the opponent, and “drive phase” is the phase in which pullers draw the opponent into the own side with backward walking. In this study, hold phase was divided into hold1 phase and hold2 phase. Hold1 phase is the phase when pullers hold against the pulling of the opponent, and hold2 phase is the phase when pullers are driven by the opponent. The pulling forces were measured by a Load cell (TCLP-200KA, Tokyo Sokki Kenkyujo, Co., LTD, Japan) hooked on the experimental rope. The forces amplified by the Strain amplifier (6M46, San-ei Instrument Co., LTD, Japan) lead into the computer (Lavie LL750/2, NEC, Japan) using software (Wad system ISF-6E, DKH, Japan) which converts analog data into digital data and collects time series force displacement data.

Test1 Tug in Hold1 phase: One side of the Load cell was hooked on the wall, and another side was hooked on the experimental rope. A subject pulled the rope for 30 seconds with maximal voluntary power. Load cell was placed at height of 95.5 cm which was waist height of examiners in test2 or test3.

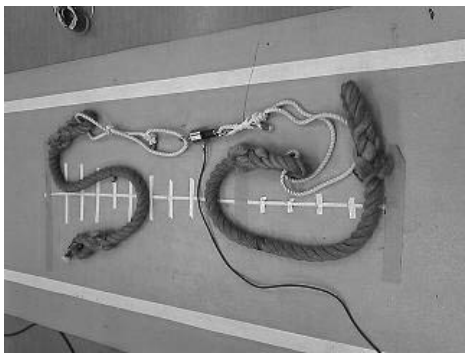

Figure 1 Load cell and experimental rope

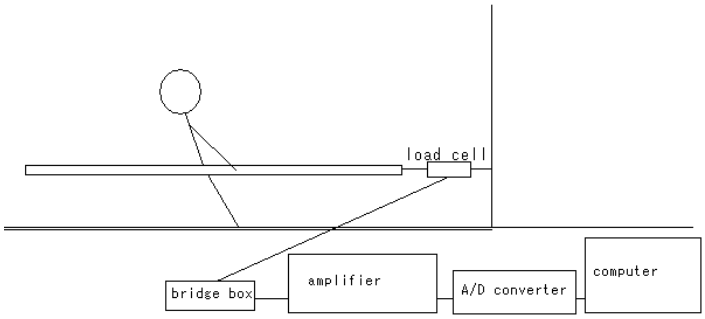

Figure 2 Setting at Test 1.

Test2 Tug in Drive phase: Load cell was placed between the two experimental ropes. A subject grasped one side, and two examiners grasped another. A subject pulled the rope for 30 seconds with maximal voluntary power. The two examiners held against the pulling of subject for first 15 seconds. Next 10 seconds, two examiners were pulled by subject at 10cm/sec. Last 5 seconds, two examiners held against the pulling of subject again. 10 pieces of vinyl tape were put on the official tug of war lane every 10cm, and the pulling speed was controlled by the load cell passing the number of tapes per second.

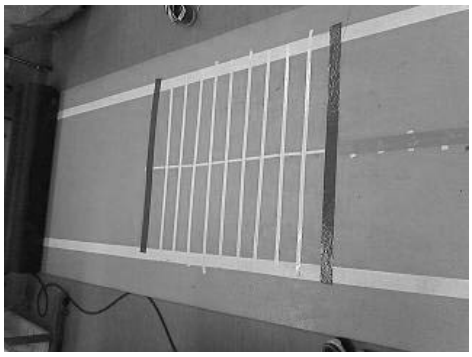

Figure 3 Vinyl tapes put on official tug of war lane

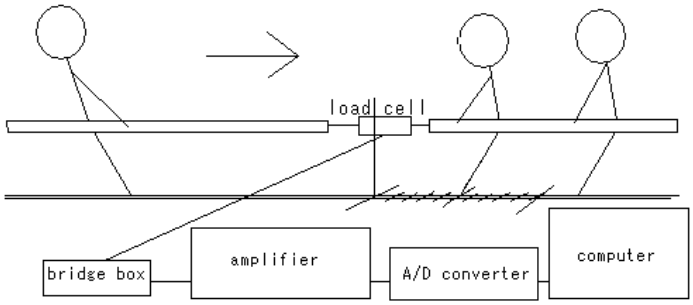

Figure 4 Setting at Test 2.

Test3 Tug in Hold2 phase: load cell was placed between the two experimental ropes. A subject grasped one side, and two examiners grasped another. A subject pulled the rope for 30 seconds with maximal voluntary power. The two examiners held against the pulling of the subject for first 15 seconds. Next 10 seconds, two examiners pulled the subject at 10cm/sec. Last 5 seconds, two examiners held against the pulling of subject again.

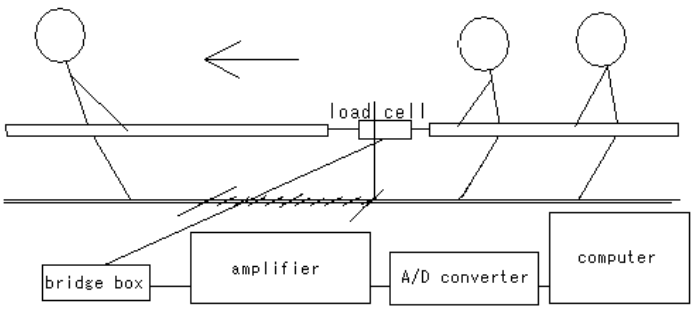

Figure 5 Setting at Test 3.

RESULTS AND DISCUSSIONS: Results are shown in Table3-table5. “Drop phase” was defined as first 5 seconds and deleted because of instability of the data.

Table1. Mean of pulling force in test1

Test1	Phase	Trial 1	Trial 2	Trial 3	Mean
5-15(sec)	Hold1	462.2	550.5	515.0	509.2
15-25	Hold1	453.6	522.4	470.4	482.1
25-30	Hold1	453.7	496.8	447.9	466.1

Table2. Mean of pulling force in test2

Test2	Phase	Trial 1	Trial 2	Trial 3	Mean
5-15(sec)	Hold1	451.1	441.7	428.0	440.2
15-25	Drive	360.3	396.1	381.3	379.2
25-30	Hold1	442.6	411.1	447.4	433.7

Table3. Mean of pulling force in test3

Test3	Phase	Trial 1	Trial 2	Trial 3	Mean
5-15(sec)	Hold1	473.1	493.5	487.2	484.6
15-25	Hold2	507.0	509.4	516.3	510.9
25-30	Hold1	500.8	489.6	495.4	495.3

CONCLUSION: Pulling force decreased in drive phase of Test 2. This is because the pulling force in this study was defined as tension of the rope, and then pulling force measured in this phase is not produced by subject but produced by examiners. If the IT-TOW is made by using the load cell, 2 machines have to exchange and reproduce the pulling force of each other. In case the load cell receives 2 different pulling forces, pulling force produced by one side may not be measured with accuracy like in test2 of this study. To put IT-TOW into practice, the pulling force data must be exchanged and not be measured by a load cell, but defined by another system.

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