**PEDESTRIAN TYPE IN EVALUATING FORCE-BASED SIMULATION CAPABILITY USING CAMERA-BASED DATA ACQUISISTION**

**Abstract:**

Force model has been studied widely to simulate micro level in crowd research. Its data acquisition for simulation capability almost relies on camera approach. However, pedestrians in different age can behave differently unlike interchangeable as camera approach. With the demand of measuring the effect of agent’s parameters in force simulation from previous papers and hyphothesis raised about pedestrian type using different parameter, This study aim to compare the simulation capability difference in two scenarios on critical observations including … . This work emphasize that applying real-time crowd simulation in difference venues such as kindergarten, or industrial, or elderly hospital should use different parameters to measure precisely the force effect to particular pedestrian over a period to understand when and where the pedestrian change its behaviour leading to combinatorial crowd behaviour. Another approach for data acquisition regarding different pedestrian type is discussed then.

1. **Introduction about force model**

This is force measure effect repulsive, not physic force. It was invented by observation and manipulating. By latest version in survey crowd motion simulation (Hooregdon, 2013). CA also good, but it not mentioned in this because … as (mentioned by). We studied here with the aim three types of people as (Hooregon, 2013).

Crowd Modelling importance.

**2- Literature Review on the model’s parameters being averaged by data acquisition on camera approach**

This literature review only considers on studies investigating on the interaction force between agents.

**Desire force**:

* 1. Camera let **desired speed is maximum speed of that pedestrian and constant** in time [Johansson, 2008]. [Cross Walking, 2014] each pedestrian has the same desired speed constant in time. It’s computed by average speed people crossing the road without disturbance with a standard deviation. In [Moore, 2011 & Mehran, 2009], treating pedestrian crowd as the collection of interacting particles. Each pixel as a particle. Particle’s desired force is extracted by desired velocity of particle’s flow (grouping neighbour particles over time t) and current particle’s speed. Neighbour particles are particles starting and ending the same direction. This study simulates particle’s desire force rather than simulating pedestrian’s desire force. It’s used to detect panic rather than for constructing crowd simulation model.

Another thing is it’s work well in outdoor, but indoor, it needs a velocity direction pointing to target (exit gate) and it’s must be changed over time.

* 1. Identify desired goal? at the end of trajectory ? calibrate ???. In fact, it must be the exit gate as in simulation environment. Suppose, we have well calibrate and exit gate is wide enough to camera capturing width. [Johansson, 2008].
  2. Reaction time: in [Cross Walking, 2014], reaction time is considered as the duration from lower current speed up to average speed. In **average 2.2 s** for all people. In simulation from **Helbings = 0.5 – 1** [Helbing 1995, 2000].

**Interaction force**:

1. Alpha can be discovered by camera as in [Johansson, 2008] through velocity dependence of ellipse in calibration. A,B, lamda are found through calibration process when tracking pedestrian’s trajectories in the same frame.

Videos were recorded at different place. Each video is separated into frames, and trajectories of pedestrians in each frame are detected for calibrating the force of one pedestrian alpha inside that frame. Each frame can generate a broad range of A,B, lamda.

Similarly, each video yield the broad range of A,B, lamda. It was optimized through EA with the finess function coming from distance error. The combination of these parameters at A = 0.42, B = 1.62 are used for further simulation. However, it stills confused when we consider desired speed is constant before calibrating this combination. Furthermoe, A,B, lamda are then used the same for simulation.

In simulation [Helbing, 2005] **A=3.0 , B =0.2, lamda = 0.75**

1. **Cut-off distance** is the same and **constant** for camera approach for simulation as in [Johansson, 2008].

**Repulsion from walls**:

There is no study on camera data acquisition for force from obstacle.

**Pedestrian Type**

-(Daamen and Hoogendoorn, 2012) study considered the different agent’s parameter in through calibration as follows. Pedestrian types include ,(children, adults, disable –3 blind folded people, elderly people). Each type wears different colour cap. Several situations had been experimented including school, building, in peak hour. On top, there have digital camera and infrared camera to observe the LED light for trajectory tracking on each above type.

Young people: reaction time, and free desired speed higher than adult. Interaction distance shorter than adult. Interaction strength higher than adult.

Calibration is performed by likelihood maximization (same meaning with minimizing error). heterogeneity might play an important role in pedestrian behaviour.

(Ko, 2013) calibrated social force model by the maximum log-likelihood estimation method to describe parameters in statistic ways.

**3- Simulation scenarios between average agents from camera data acquisition approach with various agents’ attributes and analysis. Following scenarios was proved by force model**

3.1. Experimental Setup

This work is inspired by **(**Hoogendoorn, 2013) and (Weijman, 2013), (Sun, 2014) when lack the validation mechanism to measure the different affecting on interaction force’s formula. Python and C for various agent’s physical attributes. It was developed and customized based on

+**Scenarios**: Bottleneck uni-direction, bottleneck bio-direction. With information as follow

Uni-direction: 9m,2m,2m

Bio-direction: 9m, 1m, 4m, 8m.

+**Environment Simulation**: the width, length of above scenarios.

All pedestrians start in a designated area and try to escape a bottle neck egress in indoor building.

C**artesian**  coordinator is middle, and a unit is a metre, multiple with pixel factor

+**Environment Setup**:

**Pedestrian type**: young people, adult, and elderly. (We choose around based on Hoogendoorn, 2013)

**In desired force**: Each type has different Gaussian distribution in initial desired velocity, reaction time,. Desired speed pointing current position to target position is changed over time as in the theoretical model. C is constant for different type.

By camera approach, desired speed is the same for all pedestrian types and doesn’t change over time, reaction time is the same distribution.

**Interaction repulsive force:** is measured as the same theoretical force model

Each type has different distribution force interaction strength unit, interaction range, and cutoff distance.

By camera approach, agents have the same interaction strength unit, same distribution interaction range, and cutoff distance, lamda value = 0.75 as in [Johansson, 2008].

**Obstacle repulsive force**: is measured as the same theoretical force model, with information about U.

The same for any time when considering by camera data approach because there is no studies about this in indoor.

Show the distribution of three pedestrian types, and other information when considering the same between 3 pedestrian types.

3-2. Analysis

+**Observation comparing between 5 types: (average, total children, total adult, total** **elderly**, mix 40-40-30). Increase by population number, **run 200 times** and average on below result.

Escape rate at the exit,

Bottle neck shape,

Total average travel time of a pedestrian in that scenario

Total agent’s combinatorial force change over a period (newly observation) because desired speed increase, interaction increase, obstacle increase.

Consider on proposed two scenarios. When varying 5 types

-Average by camera, total young people, total elderly people, total adult people, and a mix with the rate 40-40-20 .when varying total population.

4- **Literature Review in Social force model’s variants**

There are also other studies aims to simulate crowd by utilising force model with a higher decision making for agents but it’s out of scope of this study.

2.1. Friction and Velocity dependence (Helbing 1995, 2000, 2005, 2007)

2.2. Group behaviour effects (Moussaid 2010, Xi, 2010)

2.3 Additional forces for specific scenarios

2.3.1 (Braun, 2006) assistant force in panic

2.3.2 (Zeng, 2014) cross walking

2.3.3 (Robert, 2009) force in tsunami

2.4 Constrains in force connection

2.4.1. Cut off distance (Xi, 2010)

2.4.2 Piecewise linear function based on distance (Heïgeas, 2003)

*-(Moussaid, 2012) for Heuristic Model*

*-(Wogum, 2013)*

*-(Kountouriotis, 2014) for Heuristic Model*

*-(Rivas, 2014)*

**5- Discussion**

Contribution in parameter acquisistion is useful for crowd virtual reality and crowd simulation in indoor building, for understanding force interacting to specific individual. Understand particular physical attributes of specific persons. Easy to simulate that agents in various infrastructure for layout design assessment, and help to define suitable evacuation plan based on current combinatorial force effecting on micro, meso, and macro levels. As well as force change of specific individuals, context-aware.

Find paper about telling disasters and simulation then. Especially in kindergarden, company or elderly hospital. It’s important to simulate correcsprondingly and find total force affecting specific person over the time. To help people aware precisely force different pedestrian types.

This paper raise an demand about need a method to collect data in real-time for each agents. Mobile needs. To measure the force affect to particular in long period to test whether that environment satisfy with him, or average on camera depending various building type, or measure real-time force in micro and meso, macro level.

**6-Conclusion**

**REAL-TIME SOCIAL FORCE MEASUREMENT BY ACTUAL CASE STUDIES**

Force changes over period

Simulation the model

Experiment setup with real case studies

Calibration parameters method as (Anderssion 2007), (Hoorgedon, 2013)

* what types of data are you going to collect
  + which of these are already used in current models, which not?
  + how do these strengthen current models?
  + which of these types of data could also be collected from video, which not?
* How can we collect more data (and relevant data) via mobile phone as opposed to video?
* How about real time data? Is there a chance to collect data in a real emergency situation where video cannot be set up in time.
* “Continuous” data collection in everyday situation can generate vast amounts of data

**DATA ACCQUISITION FOR MESO AND MACRO LEVEL**