Ubiquitous Computing - Technical Paper Analysis (2-page summary)

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Paper: “A Drone Agent to Support a Clean Environment” by Obaid, Mubin, Basedow,

Unluer, Bergstrom and Fjeld

**Introduction**:

In recent years, a lot of robots have existed in human’s life, especially, the humanoid robot and mechanical human-shape model. It included Artificial Intelligence, mechanized production and human-computer interaction techniques. More and more people enjoy the convenience of robotization. It helps people do several domestic and industrial tasks. For example, the unmanned aerial vehicles, drones. The drones technique can be used in many fields, like the surveillance, war even military based operations. Using drones to protect the environment is an new technology which includes social application and human-drone interaction. In this paper, the author discusses and evaluates how drones can detect waste in the environment and try to motivate a nearby people to put the trash in the nearest waste bins. There are two goals in this study, first, to confirm and make a general rule to the drones, with these series of rules, it can use in a social and public environment. Then, guide and motivate the pedestrians to find the waste and dispose it to the nearest dustbin. Secondly, it analyzes the interactive model of the drone to find the optimum way in which it can work effectively.

**Related work:**

There have been many related works on developing robots or machines that support human in keeping the environment clean. Obaid pointed out two products in specific, which are BinCam and Sociable Trash Box (STB). Both of them have released prototypes that encourage pedestrians to dispose trash. For BinCam, it was designed to improve and motivate youth behaviors in food disposal and recycling. Studies showed that BinCam design can effectively change a person’s disposal habits as it made use of social influence. Moreover, they invoked emotions areas such as a person feeling guilty for not throwing out the trash. All of these allowed a person to reflect on their disposal behavior and increased environmental awareness.

For the Sociable Trash Box, it is an interactive trash box that can attract and encourage children to have a proper disposal behavior. The STB uses a lot of motions such as leading the child to the object, twisting motions during trash collection, and bowing towards the child for collecting the trash. These are part of a fun tactic. Along with vocal interactions, STB has effectively motivated children in trash disposal behavior. However, STB is an on-ground device. Thus, it can only work with flat surfaces and trash that is easily accessible. Therefore, the Sociable Trash Box can work effectively only under certain circumstances. Because of this, this product does not work well in real-life scenarios. Moreover, both BinCam and STB focused on encouraging youth and failed to account for adults behavior and response. The writers used these two products as a lead-in on how their solution is better.

While the two existing prototypes have mobility and user problems, Obaid ’s solution accounted for these. This leads into proposing drones agents for keeping a clean environment. One of the main reasons for using drones is the mobility advantage against on-ground only devices. Drones can easily access any environment and detects multiple trash items. On the other hand, drones being used for trash disposal purposes have to be constantly active and having trash bins around. As a result, Obaid and his team chose drone agents as their solution. Their solution can identify trash location, request the user to pick up the trash with audio and visual interactions, then guide the user to the nearest trash bin. There are three interaction modes in the design. To determine the most persuasive mode, an online survey study was conducted which will be discussed below. The writers compared the existing solutions to their drone solution. Not only this shows that they have done research on competitors, but drones are also a better and unique solution. In addition, it considered all limitations on existing prototypes in the market. However, it would be great if Obaid could shortly describe or criticize on other existing solutions other than BinCam and STB. This would give a more all-rounded research on related work.

**Study/ Solution:**

An online study was conducted with 82 participants. The participants were provided a video of the human robot interaction. Each video showed a drone directing a user to trash using different method to persuade a user. The first method was using light, the second was using light, and the final video was using light and sound. A questionnaire was provided to the participants to rate the effectiveness of the drones which consisted of rating on a 1 to 5 basis: compliance, friendliness, perceived persuasion, and sensibility. User were selected from a variety of major excluding those with robotics and human-robot interaction experience.

The results show that most users thought the drone that used light and sound to persuade a user to pick up trash was more effective. The rating was a 3.75 compared to 3.25 for light, and 3.0 for sound on a 1 -5 rating. The authors also broke down the results based on developing and developed countries which showed that developing countries rated all categories significantly higher than developed countries. There were a few concerns from participants regarding drones in the environment including: privacy, distraction, and effectiveness. Some people did not feel they they wanted to be watched and wanted to be notified if a this type of drone was in the area. Others felt that drones would be very distracting especially in cities. They also felt that it would cause sound pollution and add complexity to the already complex environment. Finally participants felt that trash directing drones would not be accepted by society. Most did not feel people would listen to the robots and did not wanted be pressured to pick up someone else’s garage. Participants also noted that these drones would be helpful for educational purposes and would be very hard to integrate into society.

**Conclusion:**

Further work is needed on this subject to implement drones that direct user’s to clean the environment. We believe that this solution is not feasible because users would not want to be told what to do. The paper did however point out the flaws to their solution and accepted the fact that more research is needed. I think using an actual drone instead of having the user watch a video would be better for the user study. The data from the user study was presented very well making it easy to comprehend.