ToDo: Plant Robot to Support Habit Formation and Task Management

MEHRIELL ELIANA SIAJUAT ANG[†1] GABRIELE TROVATO[†2]

Abstract: Rapid urbanization in the 21st century sees a larger prevalence of depression and lower productivity amongst citizens. To improve mental health, it is our aim to develop a desk-top robot that would integrate green spaces and companionship into the user's everyday life, whilst allowing users to care for a plant and keep track of daily productivity. ToDo is a to-do list companion robot, equipped with a self-watering system that incentivizes Behavioral Activation therapy by only watering the plant when there are no overdue tasks, encouraging consistent task-fulfilment behavior.

Keywords: Human-robot interaction, Green spaces, Mental health, Productivity, Robotics

1. Introduction

There is a growing mental health problem in urban areas of the world, leading to a population in which depression is becoming increasingly common [1]. A possible solution for the mental health epidemic is increasing green spaces in compact urban areas [2]. While another theory proposes that by supporting patterns of active behavior, those with depression may improve their condition [3]. It is our goal to improve user mental health by adding both behavioral reinforcement and green spaces into a person's life using an emotional robot. ToDo is a companion robot that encourages the user to handle their green space by keeping its plant alive by encouraging positive behaviors.

2. Related Literature

2.1 Urbanization and Mental Health

The rapidly growing urbanized population is constantly surrounded by physical stressors that negatively impact their psychological health [4]. However, citizens cannot reject the notion of urban living as it is an appealing and sustainable lifestyle for many people in the age of global destruction [2]. Finding a solution to the mental health crisis may need to be found within the city and integrated into the users' daily lives.

2.2 Green Spaces

As societies become more rapidly urbanized, citizen well-being has become a challenge for populations, with green spaces being one of the determining influences for promoting better mental health [5]. The propagation of more green spaces leads to lower depression, stress, and anxiety [6]. One solution is to encourage urban sustainability, in which the human need for restoration must be integrated into the need for compact living [2]. To increase the quality of mental health through green spaces within cities, one must consider how to incorporate them within dense space confines.

2.3 Plant-Human Robotic Interaction

In the field of 'plant-form' or pythomorphic robotics, a relevant study by Angelini et al. on the 'EmotiPlant', shows a plant companion that aims to reduce elderly loneliness by encouraging plant-human robotic interaction and guiding them into taking better care of their plant [7]. A similar study, presenting a 'Pet Plant', verifies that users feel a deeper emotional connection with a pet plant if there is an 'emoticon face' in the system [8]. When developing a mental health solution with plants, it is integral to add elements of interactivity and humanity to boost connection.

2.4 Behavioral Activation and Horticulture Therapy

Behavioral Activation Therapy proposes that combating depression means adding more positive reinforcement into a person's life, while Horticultural Therapy uses the act of caring for plants to improve mental health [9]. A study has integrated these practices together to form an expressive robot that encourages young people to care for their plants, yielding positive results [9]. This study opens the possibility for development of similar plant robots that could also encourage positive mental health through simple task management.

3. Initial Prototype

Derived from the Filipino word 'todo' (meaning: to give it one's all, to the max), ToDo encourages you to finish your all your tasks in time to keep your plant alive. The initial hardware prototype consists of a PLA 3D-printed shell equipped with a Jetson Nano Developer kit controller. The system connected to the Developer Kit consists of a Touch-screen LCD screen, a 5V submerged pump, a 3-relay module, a water level sensor, and a small white LED. There are two separate systems that work simultaneously once ToDo is opened. The first is the water level sensor that is connected to the white LED; it exists to remind the user when there is no water inside the water tank. The second is the system that connects the pump with the Jetson nano. The small pump and relay is connected to one of the Jetson USB ports which controls the pump. ToDo boots up and launches its programs automatically, once plugged in. To use ToDo, the user must use the touch screen to input their new task's name and their deadline down to the second, which will be added to the existing to-do list. If there are any undue tasks, the pump will

†1 The Hong Kong Polytechnic University Department of Mechanical Engineering
†2 Shibaura Institute of Technology, Tokyo, Japan

switch off and will turn on only when all tasks are completed after two days, simulating a reward system that remains dormant until a set time of every two days. The user can toggle two windows, the to-do list app window, and the animation window. The animation window aims to encourage positive reinforcement and companionship by mimicking human expression through a hand-drawn smiling cartoon that appears when tasks are being completed. Herbs are the chosen subjects for the prototype due to their edibility and regular watering schedule, but other plants may be used as well, as the code can be changed to control the frequency of the user's watering schedule. The LED grow lights are connected to an external voltage, allowing the user to control their own LED use. Blue light is used for indoor plant-growth systems due to its positive qualities [10]. The current prototype includes three lighting options: blue, white, and a white-blue mix.

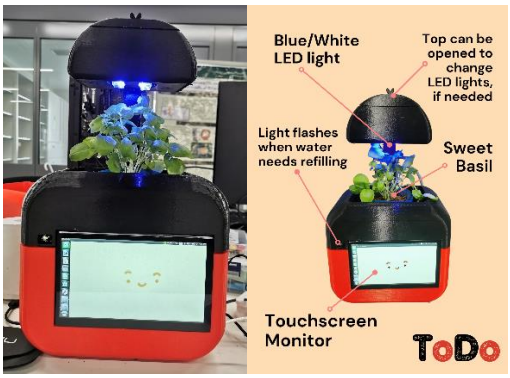

Figure 1a (left) and 1b (right). ToDo's prototype and features.

4. Limitations and Future Work

Succeeding prototypes would need improved wire management, cooling systems, and a more compact body to save space for smaller desks. It would also be more appealing for the plant to integrate itself into the robot shell more effectively and to explore different shapes to maximize user connection and friendliness. The software should orient towards interactivity. Having an interactive expression would boost user connectivity to the robot, as seen in the 'Pet Plant' study [8]. More expressions should be programmed in, in which the robot could be disappointed, excited, or disgusted according to the user's progress. The display interface could also be improved with a focus on readability for elderly users. Moreover, further studies should be conducted regarding the experimental effects of ToDo on user behavior. To measure ToDo's effects quantitively in comparison with other products, an impact analysis should be conducted in a sample of users. Students will be evaluating the effects of ToDo, a regular to do list, and having no productivity tool. Their self-reported mental wellness and productivity, based on a numerical scale, will be compared after the use of different habit formation tools. Although there are similar robots in the field, there is little research on the effects of how to-do plant robots affect human behavior. As ToDo enforces pressure for the user to keep it alive, its impact on mental health could differ greatly from the effects of regular emotive plant robots.

5. Conclusion

In this article, we presented ToDo, a robotic companion that encourages productivity among urban citizens. This robotic companion aims to improve mental health by incorporating greenery into user's workspaces, as well as developing a sense of connection between plant, robot, and human. ToDo's self-watering system and integrated to-do list app could potentially push users to be accountable for the plant's and their own wellbeing through the use of habit formation. Future developments of the prototype would focus on space reduction, increased interactivity. Furthermore, ToDo's effectivity as a productivity tool and a mental health enhancer should be further explored through impact analysis and user testing studies.

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