BudE: Assistant to Parent a Child

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ABSTRACT

This paper proposes a robot to assist in the care of young children. Although a very challenging task, it is anticipated that the initial work presented here may be developed further to offer a viable and practical solution in the future. In the current presentation, the concept is introduced and the development and construction of the first prototype is reviewed.

1. INTRODUCTION

At some point, every family has members that cannot care for themselves. In an ever faster-paced society, caregivers and family members can often find themselves caught between keeping up with the world or caring for their loved ones. This work outlines the creation of an interactive robotic device that will not replace the caregiver, but will assist in the caring. The platform will be able to monitor the care recipient and alert the caregiver of an immediate hazard. Although the application of this platform can be suitable for the care of the elderly, the convalescent, and the physically/mentally challenged, we will concentrate our attention into care of very young children.

The robot is to be designed with three goals in mind:

1. Complete a minute-long song and dance. The song is to be played through the speaker attached and have motion components in order to look as though it was dancing.

2. Program the robot to detect and avoid obstacles with the on-board sensors.

3. Monitor a care recipient.

2. GOALS AND MOTIVATION

BudE will be a mobile interactive platform with the objective of assisting new generation parents to keep up with their parenting in times when other things demand attention.

In order to keep BudE moving and responsive to what it will be programmed, the design will have to keep track of a child while the caregiver may be distracted taking a call or preparing food. BudE has to be able to detect smoke, high/low temperatures, or if the child leaves a designated area. It must alert the caregiver if any of these occur.

2.1 Target Market

In the age of cellphones, Youtube and Instagram, parents can't help but to find themselves busier and busier, and babysitting can be expensive. Therefore, let the same technology be of assistance to care for those who matter most. It is very clear that technology is only going to continue to progress and become more efficient and effective in the way that it is used in the daily life, so having technology help parents will benefit them greatly.

2.2 Current Market

In the market, there are various products available that can help new parents, however these products have very high costs. Two of these products are Avatar by Ipal and Pepper by Softbank. Currently, the price range for either of this unit varies from 2500 to 3000 dollars depending on the selected features. With all of that money invested, there is still a few things that it will not do nor will detect for the busy parents.

Figure 1. Current Market Robot Child Monitor

Even though Ipal and Pepper seem to have it all, the truth is that the price for such a unit is not something most families could afford. Therefore, we are aiming to create a platform that will have the most important capabilities present in a platform like Ipal or Pepper, but at a fraction of their price. This will be accomplished by making it simpler to develop, manufacture, and easy to transport.

3. SYSTEM DESIGN

3.1 Design Concept

Shown in Figure 2, an overall idea was in mind from the very beginning. This was to produce a low cost and effective solution to the problem at hand, all while providing a very densely packaged and robust package. This meant that the robot will meet all of the requirements that are needed and have a long life in the use at home with the child. At the same time, it needed to have an appealing appearance so that a child would not mind having it around or following them.

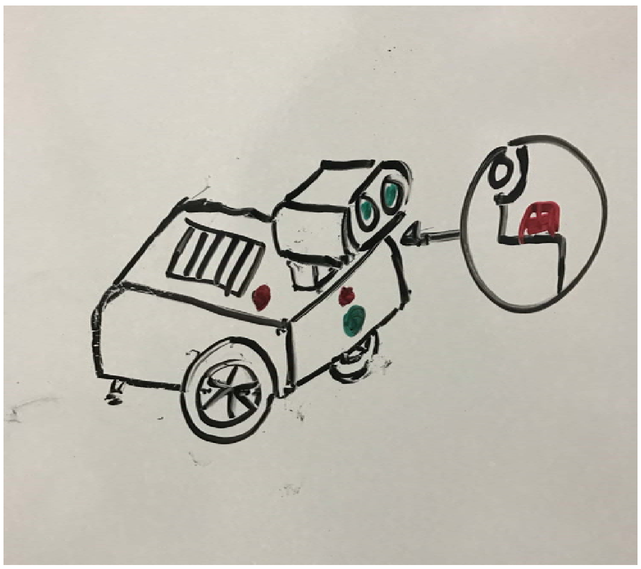

Figure 2. Hand Sketched BudE Concept

3.2 Proposed Solution

Due to time constrains, we chose to concentrate on the most common and dangerous hazards that can occur in a home as well as make sure that the platform is out of the way. Therefore, a selection of sensors for use were considered. This project used a temperature sensor, flame sensor, gas sensor, sonar, and IR sensor.

However, a truly do-it-all platform should also have face recognition, speech recognition/capable, and have the ability to interact with the user. The Pixie Cam could be implemented user tracking and following as a step toward these additional goals. Also, it would need to detect numerous gas/vapor hazards, extreme temperatures, unstable/dangerous objects, and it would need to alert the caretakers if any threat is detected.

Finally, the platform itself should not be a threat. Therefore, it must be capable of detecting objects in its path not to knock them down nor to roll under someone's foot and become itself a trip hazard.

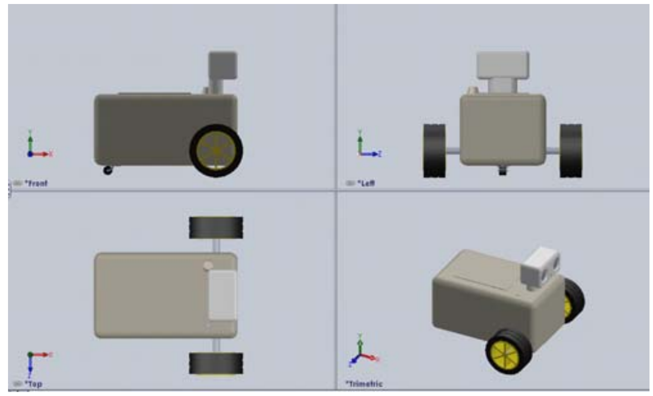

Figure 3. CAD Model of BudE Concept Design

4. MANUFACTURING

4.1 Component Selection

There are many different options when considering how to build a prototype robot ranging from a fully custom built frame and individually-selected components or utilizing available kits. Table 1 shows a sampling of kits that offer a distinct variety of products. For this particular application, the Thames and Kosmos Robotic Kit was selected due to the fact that many of the sensors that would have needed to be purchased individually were already included.

Table 1. Various Component Kit Description

	Thames and Kosmos Robotics Kit	Keyestudio Bluetooth Mini Tank Robot	SunFounder Robotics Model Arduino Car Kit
Prototyping Flexibility	Modular building blocks(similar to LEGOS), suitable for any size board	Ample spaces for extra sensors, suitable for Arduino UNO and Mega(w/ Modifications)	Tight in space, suitable for Arduino UNO board
Arduino Compatibility	Not compatible	Compatible	Compatible
Team Cost	Already owned (Christmas Gift)/$140	$99.00	$89.00

Even though this kit contained a programmable board, it was decided to incorporate a fully functioning Arduino board in order to have the full control to modify the robot as needed. This opened up the sensor options as shown in Figure 4.

Most of the names of the sensors shown below were used to make BudE be a fully capable robot that is there to truly take care of a child. These sensors include a HC-SR04 sonar sensor, flame detector, IR obstacle module, MQ-2 gas detector, DS18B20 temperature sensor and a speech recognition module. Combined with the proper calibration and programming, these sensors means that no matter the environment that the child is placed in at home, there will be a monitor for the situation.

Figure 4. Potential Sensors to Be Implemented In BudE

4.2 Prototyping

The prototyping stage was divided into three stages. The first stage was to assemble a frame sufficiently large to hold a battery pack, an Arduino Mega 2560, an L293D Motor Shield V1 board , and all the onboard sensors. The final structure had dimensions of 19.1 cm long, 13.3 cm wide, and 10.1 cm tall (not including height due to wheels).

The second stage consisted of preparing the Mega and L203D boards to accept all the wiring from the sensors and the servo motors as well as mating the boards with the structure and finding optimal locations for placing the sensors on the structure. One key aspect of this stage was the modification of the servo motors to allow use of the L293D Motor shield. This had to be done to remove the proprietary control boards included with the Thames and Kosmos kit shown in Figure 5. Another key aspect was the modification of the battery pack to produce an output voltage of 9 volts to meet the recommended operation voltage for an Arduino board of 7 – 12 volts. This is shown in Figure 6.

The third and final stage was to develop, test, and debug BudE's software. This stage was divided into two smaller stages. One sub-stage was to develop and test the program for the individual sensors and later stage was to test the program using the full collection of sensors working together. The sensors are shown in Figure 7. Code from sub-stage one was reused and implemented in the final program.

Figure 5. Servo Motor Controller Modification (Proprietary Control Boards Shown)

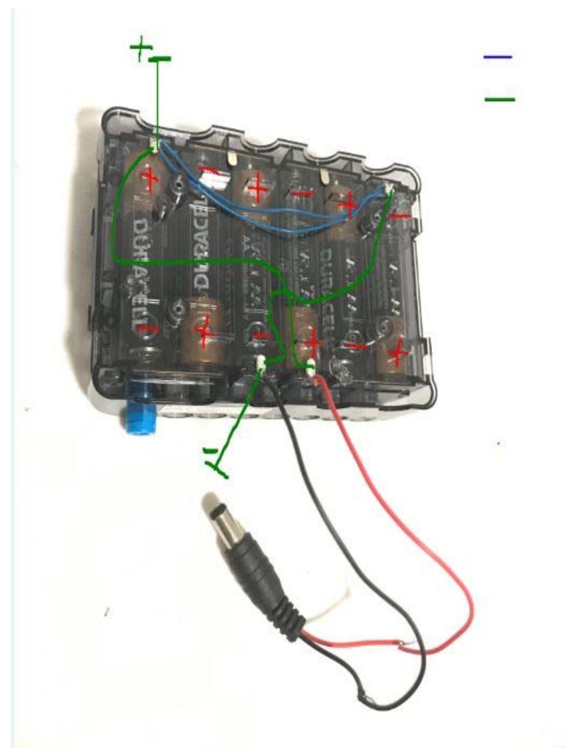

Figure 6. Battery Pack Modification (Old connection shown in Green)

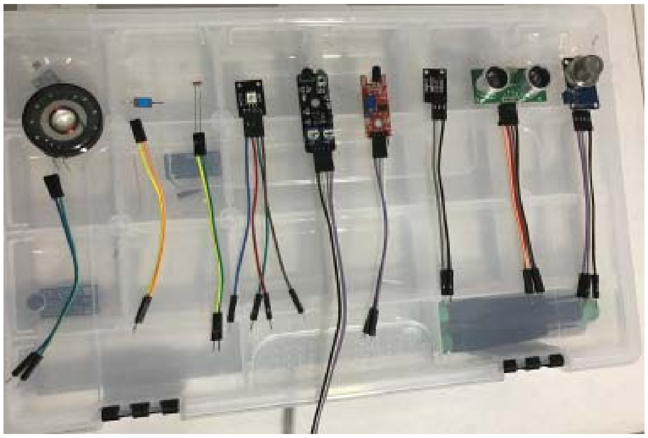

Figure 7. Array of Sensors for BudE (Left to right: Speaker, tilt switch [not used], Photoresistor, RGB LED, IR Obstacle detection module, Flame Module, DS18B20 Temperature Module, HC-SR04 Sonar, MQ-2 Gas Module)

4.3 Final Product

After research and trial and error, a working robot was produced. BudE sprung to life and met the criteria outlined early in this paper. The camera was not implemented due to time constraints, but all other sensors were fully functional. This made BudE a very capable robot able to provide the protection and surveillance that the child needs when adult eyes are not constantly on them. Figures 8-12 show the completed robot in multiple views showing all aspects.

When tested, BudE was able to turn on an LED light as well as an alarm that can alert the parents if a combustible gas/vapor is detected, if there is a visible fire, if the lighting in a room becomes poor, if temperatures fall below 15 degrees Celsius, or if temperatures rise above 35 degrees Celsius.

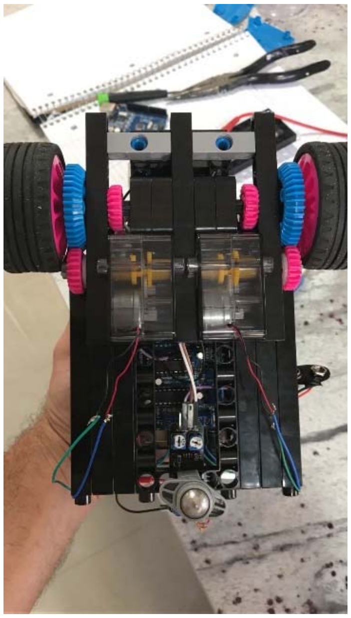

Figure 8. Underside Showing the Drive-train

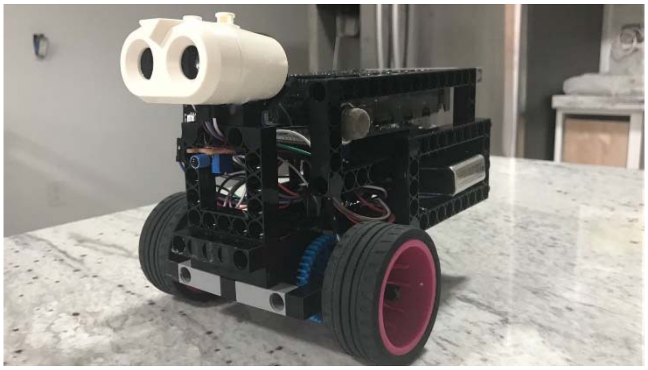

Figure 9. Right Isometric View of BudE Showing Front Sonar Sensor

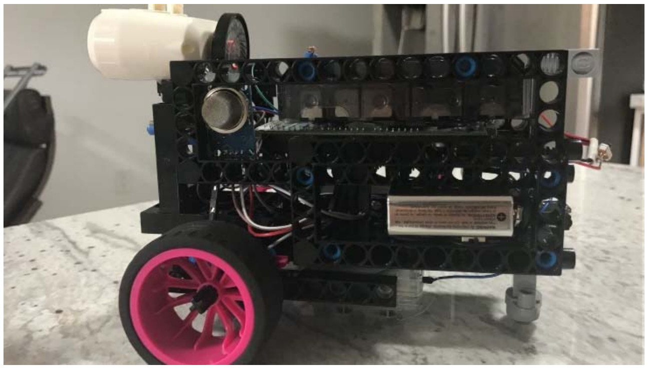

Figure 10. Right Side View of BudE

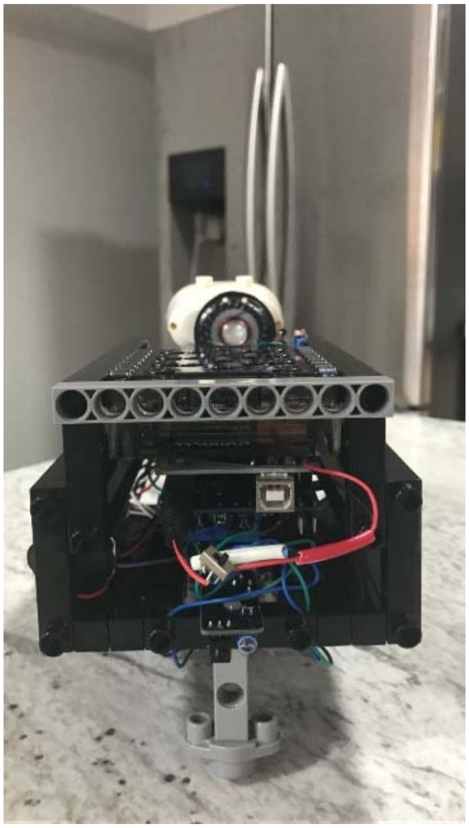

Figure 11. Rear View of BudE

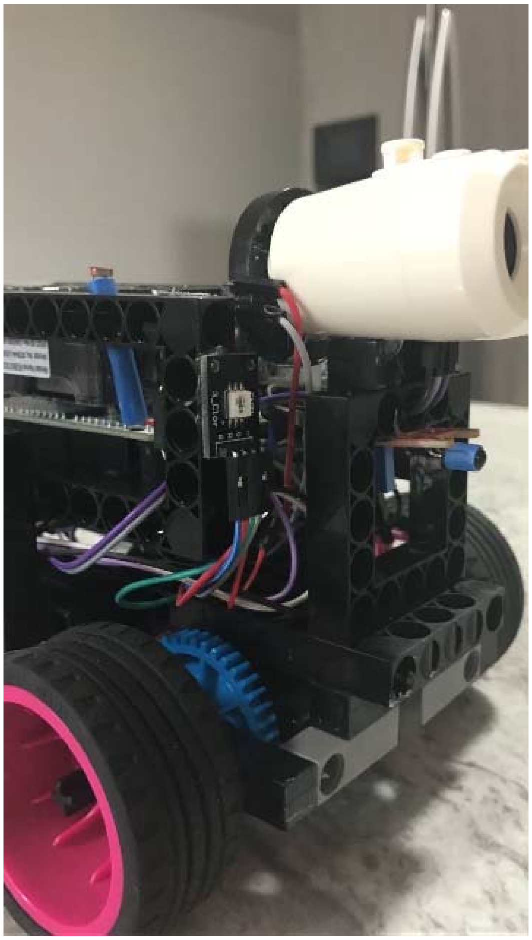

Figure 12. Left Isometric View of BudE

5. LESSONS LEARNED

As seen in most new projects, we have experienced several challenges as summarized below.

5.1 Coding Issues

As mentioned earlier, the programming of this robot was something that needed to be performed from the very beginning. Arduino tutorials [4] helped assist in this process. This was not a straightforward task since the robot is heavily covered by sensors – as each sensor requires its own specific verbiage and its own dedicated coding for proper use.

From the robot not moving at first to the robot starting to lounge forward and every small milestone in-between, coding ultimately proved to be the greatest challenge of this project.

5.2 Debugging

With every serious problem faced in the project, there was a resolution that allowed the project to succeed. For example, the motors would start BudE moving only to stop working in mid-operation. The cause was that the current drawn by the motors was too high, despite the voltage being within range. This caused the L293D Motor Shield V1 board to overheat and shutdown. The solution was to either obtain another L293D chip and solder it on top of the existing L293D to double the current capacity of the motor shield, or to use motors rated at a lower current. Since the board was not working properly for a motor within the specified voltage range by the manufacturer, our team decided to go with the second option and changed the drive-train to two geared servos rated at 2 volts with a resistance of 10.1 ohms; therefore, requiring only 198 mA. According to the motor shield's manufacturers website [5] the board could provide up to a constant 600 mA and a peak of 1200 mA. BudE was mobile again with torque to spare.

6. CONCLUSION AND DISCUSSION

Being able to use new knowledge and implement it into a functioning program did not occur the first time. It took the team several weeks of coding and testing to reach the proper code. There were points that the robot would not respond, other times that it would get stuck in a certain subroutine, and at times that it detected nothing and seemingly did not know how to behave. However, perseverance helped us to develop better code that made the robot perform substantially better.

This project also has benefits that extend outside of the learning experience. At some point, many families will have children and become overwhelmed by the responsibilities. It will only be fair to allow the same technology that keeps us so busy to help with the caring for our loved ones.

This project aimed at the creation of an interactive robotic device (BudE) that would not replace the caregiver, but can assist in the caring. The platform developed in this paper is able to monitor the care recipient's environment and alert the caregiver of an immediate hazard or when the child needs assistance. BudE will be easy to manufacture, easy to transport, and will be accessible to most families.

7.1 Future Work and Improvements

Moving forward, it is necessary to work out some of the problems that the current setup has in order to create a more consistent product. There is also the need for further development of the use of the sensors to trigger their full potential. As it stands, some of the sensors are being used for very basic functions and can be put to better use by better analyzing and interpreting the collected data. A different model of smoke detector, the MQ-5 for example, can be used to detect other harmful chemicals in the air.

Not only do the sensors need to be tapped into for better use, but the overall mobility of the robot can be improved. Currently, the drive-train of BudE consist of motors nearly directly driving the individual wheels through limited gears. This decreases efficiency and increases the amount of code. Implementing a better and more refined gear box will allow BudE to move about better and have less of an issue with surrounding obstacles.

7. ACKNOWLEDGMENTS

A very big thank you goes out to the wife and child of Erick Bu Pons since the family and the child initially inspired this project. The entire project is formatted and geared towards making families' daily routines simpler and safer. Having a child at a young age today is no easy task and having them be the driving factor in a project is just as labor intensive.

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