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Mechatronics in the Advancement of Transportation Security

Brian Linhares
Vaughn College of Aeronautics and Technology, Flushing, NY, USA, linhares_brian@hotmail.com

Chandra Mauli Nautiyal
Vaughn College of Aeronautics and Technology, Flushing, NY, USA, chandramauli.nautiyal@gmail.com

Dr. Hossein Rahemi
Professor and Chair,
Vaughn College of Aeronautics and Technology, Flushing, NY, USA,hossein.rahemi@vaughn.edu

ABSTRACT

The international community has been very sensitive about security since 2001. Governments throw money at the problem, yet a solution has not been found in which civilians feel at ease. While was brainstormed with public safety, public acceptance and efficiency in mind. Guard dogs, officers and military personnel can be found throughout the world guarding airports and other forms of mass transportation locations. But as previously mentioned, even with all of these resources, narcotics and explosives still manage to elude authorities. An autonomous robot with good public relations will provide security without a martial presence. Special sensors can work as a canine does; the sensors constantly take in air samples to find out if any specific explosive chemicals are in the area. This tactic is used by American soldiers in Iraq, but has yet to be properly introduced civilian applications. The idea would be to draw people closer, so the efficiency of the sensor would increase greatly. Also with several ultrasonic sensors, the robot will be able to move through a crowd without injuring or causing a disturbance.

Keywords: Design, Public Acceptance, and Efficiency

1. INTRODUCTION

Beneficial advancements have always had their military counterparts that can do harm to society. Our design came together with equipment that is currently available, creating something new and innovative. Security in airports and other forms of mass transportation is very important since those are locations that are more frequently targeted. Terrorists and drug smugglers all have one thing in common, they leave behind a trace that can be tracked with the right personel and equipment (The Times, 2010). Not all forms of explosives can be tracked easily but, then again, not every terrorist can aquire something an exotic explosive. It usually starts with home made, over-the-counter products which are put together to make explosives such as Triacetone Triperoxide, which leaves a miniscule trace in the air if exposed. Sensors exist that can detect specific chemicals in the air by taking samples continously but are less sensetive with distance. We determined that the next step to help resolving this problem would be to make it autonomously mobile.

Attaching a bomb sniffing sensor to a robot that can easily roam a preset location without interfering or worrying travelers will allow security personel to have another set of eyes on the floor. This would also permit a greater area to be endlessly scanned. The robot will have four screens on it that will feauture flight schedules and also commercials if required by the buyer to help reduce costs. This will also assist in not increasing anxiety by developing a sense of security amongst the travelers contrary to presenting a robot with weaponry or other intimidating attachments. Technologically advanced security aid could lead to several prosperous investments for the locality.

2.1 Design

The design of the robot is simplistic yet complex at the same time, the structure and components allow it to freely roam around without hindering anyone. Counterweights are placed at certain locations to prevent toppling over and ultrasonic sensors are placed in specific sections of the robot to prevent bumping into and also falling down a opening or flight of stairs. Aluminum sheets are used to reduce weight and protect internal components. Aluminum beams are used to provide a sturdy base and a aluminum pipe is used to support the top half of the robot. The processors and other important components are located in easily accessible positions to replace when necessary.

2.2 Mobility

The mobility of the robot is the foundation of its operation. The decision to apply tank treads to this mobile lab came from the basis that tight corners will not allow a simple rack and pinion system which is seen in automobiles to work. The application of the tank tread is to allow mobility in large and small locations also allowing manuverability over various types of terrain such as dirt and mud. Taking into consideration that various airports have smooth floors, the tank tread system is made of metal to withstand the tension put out by the motors but the top half of the belt that comes in contact with the floor has a rubber cap to allow better movement. Simply by placing a rubber cap on the metal belt, the additional friction created will aid in mobility.

The simplicity of the assembly also helps in future repairs that could easily be done by someone with simple automotive skills further reducing maintenance costs. This design demands that the belt be four inches wide and be able to sit on a two, nine inch diameter tracks placed 10 inches apart from center to center. The belt may be made out of aluminum links to help reduce weight but still maintain strength to withstand the tension created by torque and friction. The rubber caps that will be placed on the metal belt links can be attached in by a strong adhesive or by standard thin bolts.

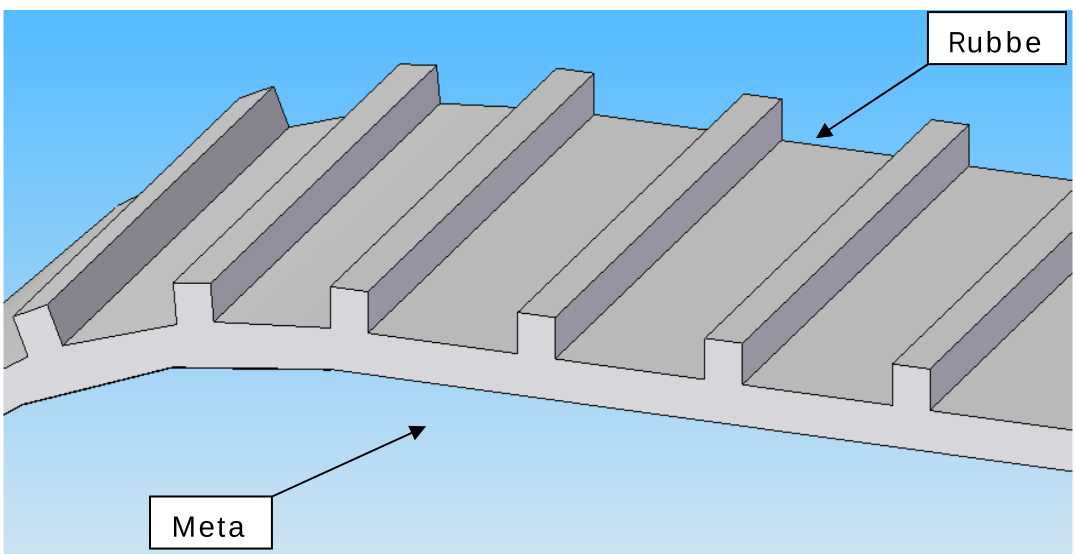


Figure 1: Track Assembly

2.3 Frame and Electronics

People tend to bump into things when they are in a hurry, especially if they are late. This factor helped contribute to the shape of the frame and locations for the electrical components due to the nature of its purpose. The frame is set to have a low center of gravity to prevent it from toppling over. This was accomplished by placing most of the electrical componnets inside of the base excluding the four LCD screens and the chemical sensor located among other smaller components inside of the the top half. Power distribution to the top half is done by running electrical wires through the six inch aluminum pipe that connects it to the base. This in fact protects the wiring from liquids and other foreign agents that may be corrosive and damage the components (Thomas L. Floyd 2007).

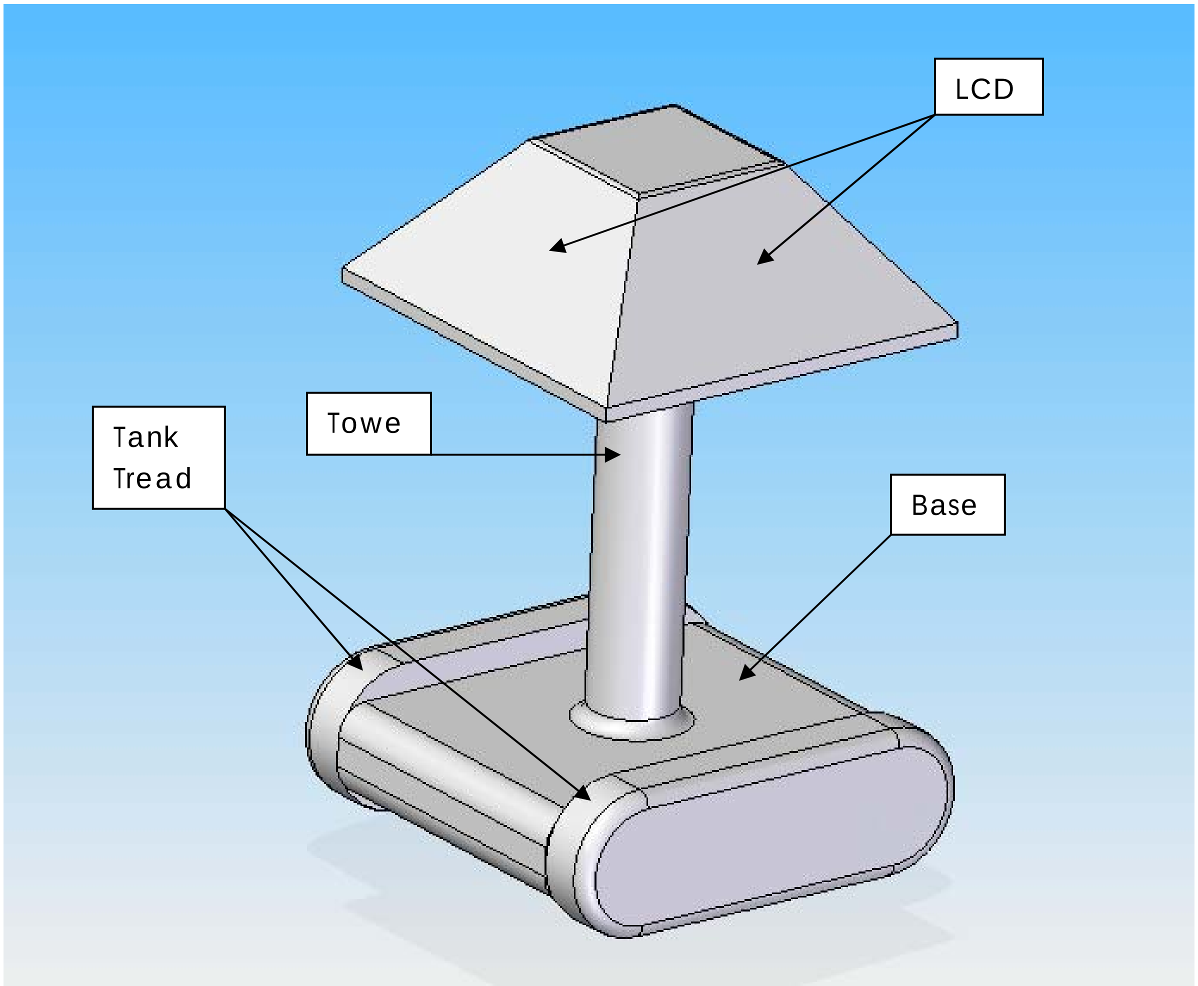


Figure 2: Frame and Electronics

The top half consists mainly of four LCD screens to display information and a chemical sniffer located underneath the top half platform. The screens are held together by aluminum sheets keeping it sturdy yet light to remain having a low center of gravity. With the addition of the chemical sensor, this should place the weight at approximately 25 pounds. The bottom half will consist of electrical components such as the 12 volt battery, processor, and the ultrsound sensors. The aluminum beams making up the rectangular frame will also have supports to place the motors that will power the tank treads. The center aluminum pipe will be held in place by three L shaped brakets that will be attached directly to the lower section of the rectangular frame. This allows that a second level of three L shaped brackets be connected to the pipe a little higher connecting it to the top section of the rectangular frame.

2.4 Sensors and Programming

Chemical sniffing sensors are innovative and are being used by the American military. The sensor that our group has found most interesting would be the Triacetone Triperoxide sensor. Since it can be made easily with readily available components, it is being widely used by terrorists. This explosive is usually used for shoe bombs and is extremely hard to detect through other methods such as fluorescent lights or absorb ultraviolet light. Therefore if further advancements are made, this sensor can be used which is will help in detecting specific chemicals that are suspect to investigation (Science Daily, 2010).

The robot will be autonomous requiring some form of sensor to prevent it from running into obstacles or falling down a flight of stairs. This is where ultrasonic, bumper, limit switches, and potentiometer sensors come into play, which are inexpensive and are very efficient (Vex Robotics 2010). The potentiometer is a analog sensor which collects info from something physically moving which in this case would be the motors for the tank treads. The following sensor would be the bumper switch which is activated through touch, activating a preset program which could allow the robot to back away in case it unfortunately hits an obstacle. Limit switches operate in the same form as a bumper switch but are much more sensitive.

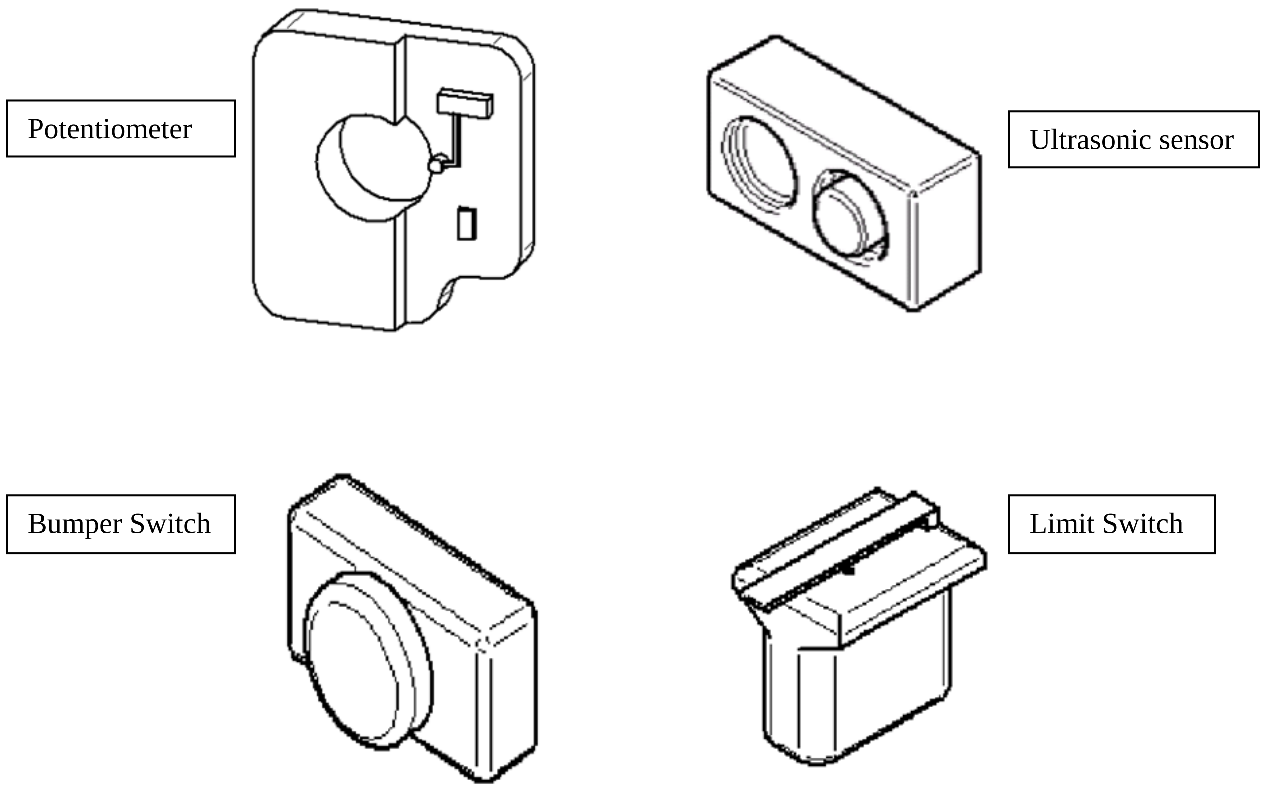


Figure 3: Sensors

The ultrasonic sensor is a key feature in this design since it will prevent the robot from falling down stairs and would also prevent any collisions with obstacles by sending out an ultrasonic wave and picking up how fast it returns. If the ultra sonic sensor produces a value lower than a preset value than this will indicate that an obstacle is near. Sensors can be mounted using small bolts that are 1/8 of an inch in diamter and about ¼ of an inch in length including the head. Since the bolt will be attached directly to the sensor, no nuts are required. Our Mechatronics group constructed a small robot with all four of these sensors and noticed that whenever one sensor did not pick up something, the other would act as a back up. This greatly increased its success in not bumping into any obstacles that we laid out for it. Here is a section of our program:

```
Autonomous
#include "Main.h"
void Autonomous ( unsigned long ulTime )
{
    unsigned int limit = 1;
    unsigned int loop = 1;
    unsigned int light1;
    unsigned int light2;
    unsigned int light1_dark;
    unsigned int light2_dark;
    while ( loop == 1 )
    {
        limit = GetDigitalInput ( 5 ) ;
        if ( limit == 1 )
        {
            SetMotor ( 2 , 127 ) ;
            SetMotor ( 3 , -127 ) ;
        }
        else
        {
            SetMotor ( 2 , 0 ) ;
            SetMotor ( 3 , 0 ) ;
            Wait ( 2300 ) ;
            SetMotor ( 4 , 100 ) ;
            SetMotor ( 5 , 100 ) ;
            SetMotor ( 6 , -100 ) ;
            Wait ( 2700 ) ;
            SetMotor ( 4 , -100 ) ;
            SetMotor ( 5 , -100 ) ;
            SetMotor ( 6 , 100 ) ;
            Wait ( 1600 ) ;
            SetMotor ( 4 , 0 ) ;
            SetMotor ( 5 , 0 ) ;
            SetMotor ( 6 , 0 ) ;
            SetMotor ( 3 , 127 ) ;
            SetMotor ( 2 , -127 ) ;
            Wait ( 1000 ) ;
            SetMotor ( 3 , -127 ) ;
            Wait ( 500 ) ;
            light1 = GetAnalogInput ( 2 ) ;
            light2 = GetAnalogInput ( 4 ) ;
            if ( light1 = 0 )
            {
                SetMotor ( 2 , 127 ) ; // turn off of line
                SetMotor ( 3 , 127 ) ; // turn off of line
                Wait ( 500 ) ;
            }
            else
            {
                SetMotor ( 2 , -127 ) ; // turn into line
                SetMotor ( 3 , -127 ) ; // turn into line
                Wait ( 500 ) ;
            }
            if ( light2 = 0 )
            {
                SetMotor ( 2 , -127 ) ; // turn into line
                Wait ( 500 ) ;
            }
            else
            {
                SetMotor ( 2 , -127 ) ; // turn into line
                SetMotor ( 3 , -127 ) ; // turn into line
                Wait ( 500 ) ;
            }
            if ( light2 = 0 )
            {
                SetMotor ( 2 , -127 ) ; // turn into line
                SetMotor ( 3 , -127 ) ; // turn into line
                Wait ( 500 ) ;
            }
            else
            {
                SetMotor ( 2 , 127 ) ; // Turn off of line
                SetMotor ( 3 , 127 ) ; // turn off of line
                Wait ( 500 ) ;
            }
            SetMotor ( 2 , -127 ) ; // forward
            SetMotor ( 3 , 127 ) ; // forward
            Wait ( 1500 ) ;
            Wait ( 1000 ) ;
            SetMotor ( 4 , 100 ) ; // up
            SetMotor ( 5 , 100 ) ; // up
            SetMotor ( 6 , -100 ) ; // up
            Wait ( 1500 ) ;
            SetMotor ( 4 , 0 ) ;
            SetMotor ( 5 , 0 ) ;
            SetMotor ( 6 , 0 ) ;
            SetMotor ( 2 , 127 ) ; // reverse
            SetMotor ( 3 , -127 ) ; // reverse
            Wait ( 1000 ) ;
            SetMotor ( 2 , 0 ) ;
            SetMotor ( 3 , 0 ) ;
            Wait ( 1000 ) ;
            SetMotor ( 2 , 127 ) ;
            Wait ( 1000 ) ;
            SetMotor ( 2 , 127 ) ; // reverse
            SetMotor ( 3 , -127 ) ; // reverse
            Wait ( 1000 ) ;
            SetMotor ( 4 , 100 ) ;
            SetMotor ( 5 , 100 ) ;
            SetMotor ( 6 , -100 ) ;
            Wait ( 700 ) ;
        }
        SetMotor ( 4 , 0 ) ;
        SetMotor ( 5 , 0 ) ;
        SetMotor ( 6 , 0 ) ;
    }
}
```

Figure 4: Sensor Program

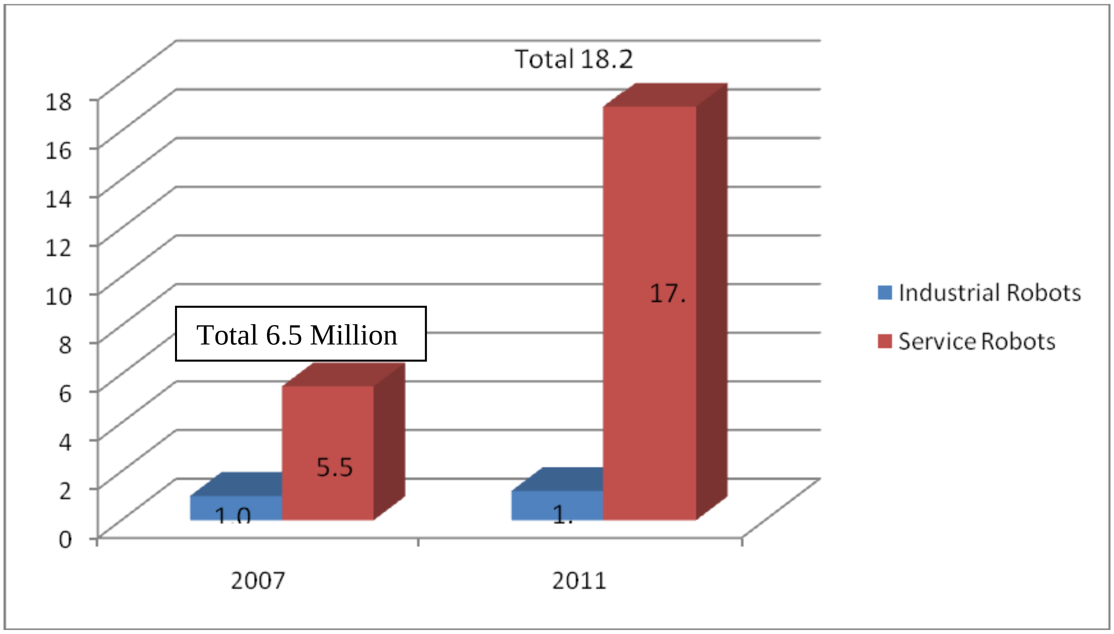
3. Public Acceptance

Due to the design, the robot will be a short term investment that will prove inexpensive to the buyer given that companies that will want to advertise their products more directly to travelers at an airport. The robot features four LCD flat screens which will be used to not only display flight information, but also ads. Ads will help reduce operating and maintenance costs that the airport will have per robot, which will in turn balance profit for the airport.

With the user friendly interface, the silent alarm feature, and the non-martial appearance, travelers will feel very comfortable traveling to and from airports more frequently, which will increase tourism, and airport revenues. Presently, travelers are met with hassling and sometimes less compelling searches due to security especially in America, and overseas in the Middle East. Passengers tend to get alarmed with the sight of military personnel patrolling with armaments. Our robot will allow passengers more peace of mind knowing that there is technology patrolling alongside security making it safer which is always a priority.

4. Efficiency

Table 1: Robotic Distribution



As shown in the above graph, the use of robots are skyrocketing in the military service due to the fact that the army has recognized the full potential of robotics. This alone should be relevent information when trying to figure out how to better prepare security at a civilian facility. Efficiency is nothing but a ratio of the input that you put in to the output you receive or a measure of time, cost and effort. Measures of an efficient information system include its productivity, processing time, operational costs and level of automations. Measures of efficient information products include the speed of processing, the functionality of the solution, the ease of use of the solution and output, and the cost of information processing.

The robot is fitted with sensors that can detect specific potentially hazardous material, without arresting or harassing anyone. This robot is compact and takes less space to store. As it has four screens which are inclined at an angle, passengers have easy access to gate or flight information. If a potential threat is noticed, it will automatically alert the security workers while following the scent from where the threat is coming. If an emergency situation arises, it is equipped with an alarm system which will start and will signal people to evacuate through the nearest exist via loudspeaker located on the base of the robot.

5. Conclusion

Artificial intelligence is the intelligence of machines and the branch of computer science that aims to create it. This robot can be classified as "the study and design of intelligent agents" where an intelligent agent is a system that perceives its environment and takes actions that will maximize its chances of success. John McCarthy, who coined the term in 1956, defines it as "the science and engineering of making intelligent machines." Our robotic agent accomplishes its goals autonomously without disturbing the public. This in turn shows that if there is a military counterpart to every beneficial creation then there must be a counterpart to every military creation that will be beneficial to society. The military have run successful tests showing that their bomb sniffing robots accomplished their set tasks, thus aiding soldiers in the battlefield. This field was founded on the claim that a central property of humans, intelligence—the sapience of *Homo sapiens*—can be so precisely described that it can be simulated by a machine. This raises philosophical issues about the nature of the mind and the ethics of creating artificial beings.

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