Techno-Economic Study of a Multitool Cultivator Mechanoid:

Automatic Tool Changers, AI and Ultrasonography to Redefine Precision Agriculture.

Inveginuity, The Garden RepRap. Open-Source Lab Design Book 0.8b

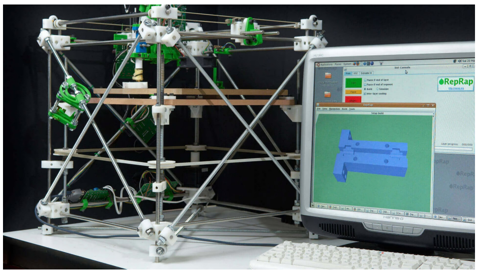
Competition info: inveginuity@gmail.com

What is the project?

Complex devices, quadcopters, radios and 3d printing, come from the garage hobby scene:

1999 quadcopter

2023



2005 FDM printer

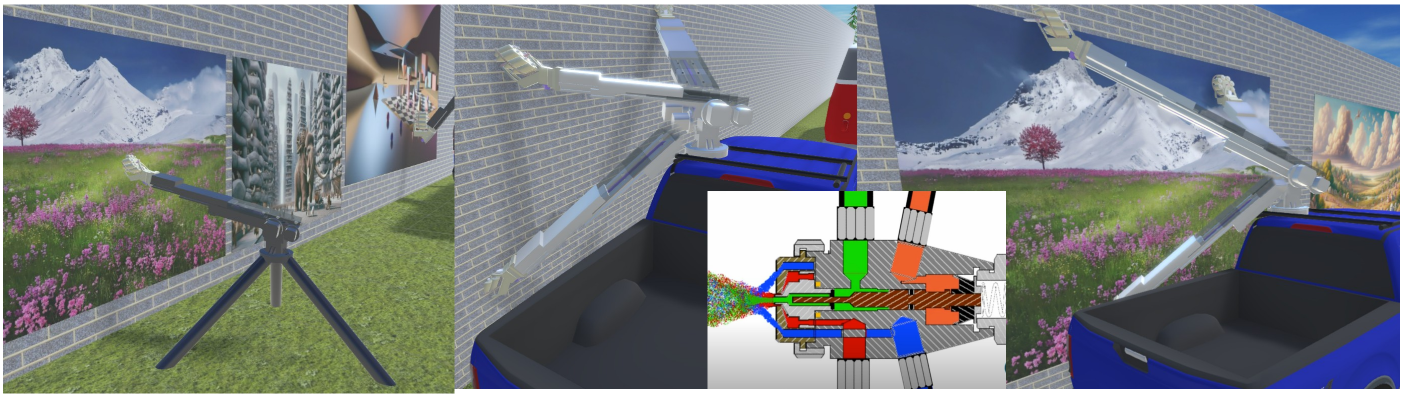
Garden robots, when they come, will flow from a collaborative project that networks research together.

This is an attempt at an open-source simian tool technology (telescopic) and a garden robot.

The fundamental difference here is the robot arm, which is a hybrid mechanism. It doesn't exist anywhere else except for this open-source research, based on RepRap 3D printer technology and telescopic linear slides, it is cheap, precise and you can build it yourself.

It is a mini telescopic crane that has higher force than articulated arms. It's not just handy for gardening, it can also be a wall art machine unlike any other.

Thus, a crafty sister project for the cultivator mechanoid is for wall art: It’s a mechanism that you can knock about, load into a car, throw grit on, and it’s fine for many different jobs, perhaps to add a dab of paint to rundown walls.



What’s the inveginuity?

It’s a rover that can complete 5-8 garden jobs. The tool system resembles a gun turret mechanism. Rather than shooting bullets in any direction, it rapidly moves tools backwards and forwards, to sow, weed and dig agroecology polycultures. There’s a hose under the arm to emit water from a tank in a chassis box.

Articulated arms are a silly piece of a garden robot, so we rewrote the rule-book based on technology used in pallet-moving-forks and fire-engine aerial apparatus.

It’s a kind of robot meant for small farms and country homes with land. You can rent one for a week if you want a food garden, and it will work 20 hours a day on complex designs.

You can also steer it around your garden by sliding your fingers on a smartphone and squirt water at people for a party trick. It’s a very expensive water pistol, mist fountain, massager, party drink waiter, singing flower delivery bot. It can work for you day and night with an infra-red camera, phone CMOS, AI mapping and 1TB storage. It analyses precise 2D and 3D maps of farm, garden and landscape design.

At the tool-end there is an automatic-tool-changer, like a food processor port with slow rotations, which can clip on different garden tools to care for food and flowers.

The tools are profiled and selected through 3D visualization and vector maths:

- **Seed depositor** – 8 to 20 variety seed patches at 20 m2.h
- **Foliage clipper** – for mowing weeds and foliage
- **Drill Digger / Auger** – also for uprooting entrenched weeds
- **Claw**
- **Hoe** – A simple trusty tool for abrading and dealing with slugs
- **A soil probe** – theoretical, current tech is dubious
- **A bore drill** – to core tubes of compost into the ground

Field bots will enhance human abilities with super-human ones, for back-straining, ground-level observations and errands 140 hours a week. They will print your designs as a physical flower bed. They will check seedlings every hour for slugs and bugs, map every plant, node and fruit in graphs and optimize precision harvests of chemical-free fruit and veg.

The research encompasses a diverse array of disciplines, mechatronics, biophysics, AI and wildlife. It is so varied and fascinating. As a hobby it is a good way to discover astonishing facts of science and technology. The following is a design guide for labs and university students. Hopefully it can prompt eco-friendly technologies to come sooner.

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Techno-Economic Study of a Multitool Cultivator Mechanoid:

Automatic Tool Changers, AI and Ultrasonography to Redefine Precision Agriculture.

Inveginuity, The Garden RepRap, Design book 0.8, by Ant Stewart

Intro: (deliberately over-complicated science-speak)

We assess the conception of AI enhanced garden robots using fluid mechanics to predict the flow of rainstorms and agrodebris. We find a confluence of state of the art technologies that merge into a cost-efficient robot, armed with an automatic tool changer and high efficiency implements. Specialized for organic farms, it copies human-sized plant interactions with eco-friendly resource efficiency.

Beyond the millions of robot lawn-mowers sold yearly, new robots are becoming necessary to impress the neighbors. We investigate when a new generation of farm-bots can manifest, and their future effect on 175 million farms in China, of 450 million worldwide, which mostly use chemicals to counter natural processes. Pesticides are weapons for fighting the forces of nature and ecology, rather than working with them.

With terabytes and gigaflops fitting in smartphones, the limits to field robots are now mechanical. Smartphone processors can discern 120,000 fauna and flora objects daily. Free software for AI and robots is advanced. SSDs tested by NASA in 2018 cost less than bluetooth earbuds.

The high cost of factory robots is circumnavigated, because digging and weeding tasks have 20 times lower precision and softer limits than assembly lines.

Ultrasound position sense is adapted from quadcopter swarming research, to offer precision to garden maps and tasks. Ultrasounds are frequencies used by cats and bats for targeting prey.

The most innovative finding of this study is a hybrid robot-arm mechanism that permits cheap field machines: Adapted from pallet-moving-forks and fire-engine aerial apparatus, a new kind of telescopic limb is found to suit gardening jobs with precision, weather proofing and physical power. It is already well used by companies in different formats.

We use 3D simulation for intricate studies of the robot shape and physics, resized, optimized and enhanced, through interactions in a virtual garden environment. Comprehensive 3D design permits the build of a real robot that reflects elaborate tests of forces and environmental effects found in a digital mirror.
The virtual ranges of motion and physical forces are compared to real-life gardening tools in varied climate conditions, for coherence with soil and atmospheric physics. The quantity of mathematical functions required for tool routines is added and compared.

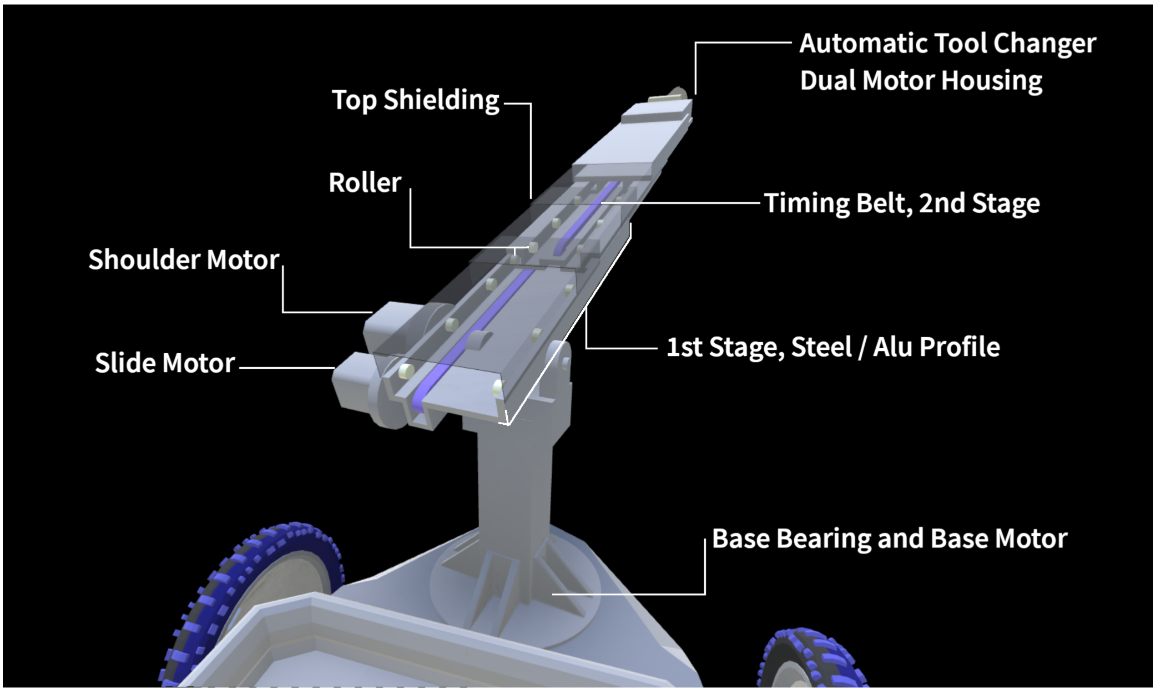
A new robot arm

We have found an innovative system that is adapted from established commercial equipment. Following a multivariate comparison of possible technologies, we adapted a synergy of mechanisms into a system that has fantastic reach because it is related to fire engines ladders and pallet loading forks, motioned by timing belts for power and precision. It is an esoteric hybrid of useful tech. (we studied all axis hydraulic, chain, cable, gear arms)

The mechanism is relatively simple. It is a telescopic beam that swivels like a turret gun, reaching around 360 degrees, up and down 75 degrees. It projects field tools 1,2 m forwards in the vector of aim. The simple motion is easy to program to add new functionalities, having only one (x,y,z) vector to find the tool position. It's suitable for community driven development to diversify for a myriad of functionalities.

Instead of researching an entire garden robot, hobbyists can create a wall artist version of the arm, through 3D printing and laser cutting.

A water tube can run under the first stage of the arm, regulated by a solenoid valve. The valve is angled down and can direct a water jet at 360 degrees, this is our first draft-

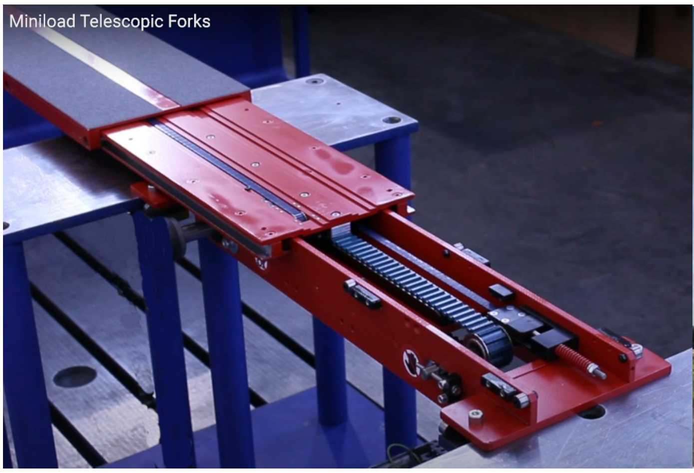


Many types of robot arm were considered including delta, cartesian, articulated, SCARA, rigid chain, hydraulic, timing belts. We studied irrigation routings, 12 tool sets, peak forces, precision, cost, complexity, availability, water resistance, wire routing, ease of maintenance and so forth.

The current complexity arms in agrobots results in awkwardness, risk and financial disadvantage. Fine gears milled from extreme alloys with micron accuracy aer heat-treated and daisy chained into precise, rapid, costly and sensitive indoor equipment, radically over-specified for agriculture. (spline tooth, epicycloidal, planetary, helical, hypoid, herringbone gear profiles).

Small pallet fork, 125 cm reach, very heavy max load of 110 kg. 12 kg is fine for this project. Image courtesy of EuroFork.

Timing belts are found outdoors in sawmills and car engines. Weatherproof and dependable, they are used in factories, printers and robotic limbs. The components are big and simple, with higher areas of contact and force transfer compared to small articulated gears that are currently used for fine agrotech.



The second image looks like a fire engine, however it is perhaps also a machine to 3D print a house. Indeed, a minute of research reveals a house printer from San Francisco in advanced development, very different from other house printer technologies (Which do you think is best, and easy work with? Can an engineer adapt an old fire engine into a house printer?)

The priority of this research is to inform that there is a lesser known arm mechanism from which agrotech can benefit. Many companies now building outdoor equipment with factory-style robot arms could be wasting money and reducing their prospects.

If this mechanism fails for this garden robot project, the rest of the research is moot because there is currently no alternative that makes financial and practical sense.
We would like some help for the project tasks, to process prototypes sooner.

A laser-cut steel and aluminum frame is possible. Steel inlays and components from the many interesting specialist rail slide companies can deliver custom adaptive field performance. Rail slides range from giant bridges on rivers to 0.1 micron lab sliders.

Laser-cut frames with timing belts gave an advent of precise 3D printers costing $250. ref
Compare that to articulated arm 3D printers which cost $5,000 - $100,000. Ref.

Agrotech can employ the same mechanical advantage:

	$2000 Hybrid Arm	$15000 Articulated Arm
Complexity	Simple roller bearings, timing belts, generic components.	Complex finely geared articulations using ult hard micromachined alloys.
Strength	**20 Kg Push/pull/**drill force. **12 Kg lift** force / 7 Kg lift at full extension.	**12 Kg on** all axes.
Precision	**2 mm:** botanically adapted	**0.1 mm:** over-specified, redundant
Weight	Lighter	Heavier
Axis Number	Less, like a turret-gun that projects tools telescopically in any direction.	more versatile, flexible for assembly tasks, harder to calibrate axes.
Field resistance	Reliable: Rubber and stainless steel. Simple big gears.	Risky: Fine motors and gears are vulnerable to accidents and humidity.
Maintenance	Amator-friendly, $1000 for 10 years service	Highly skilled $7000 for 10 years service.
load bearing mating surface	High: The rollers are rated 220 Kg individually (608-ZZ $4 all weather bearings).	Tiny: Arc of contact through many special individual gear tooth profiles, machined fron molybdenum-chromium-manganese.

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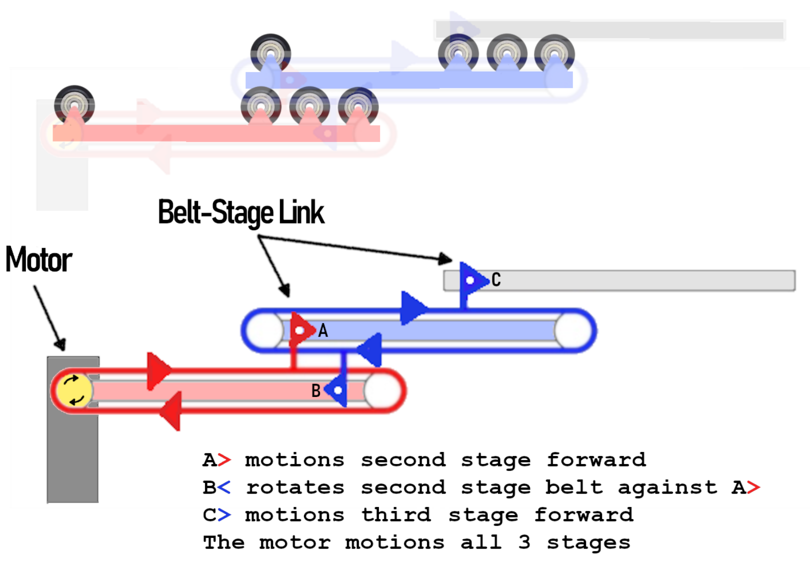
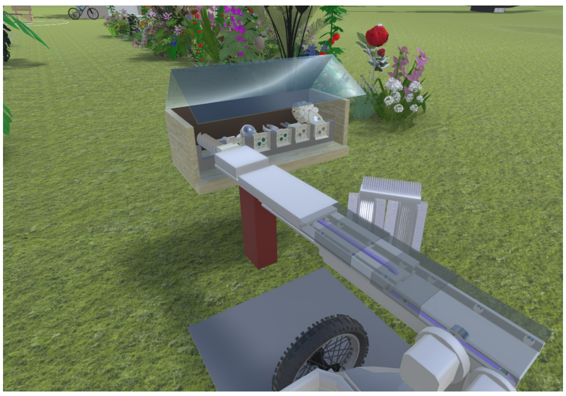
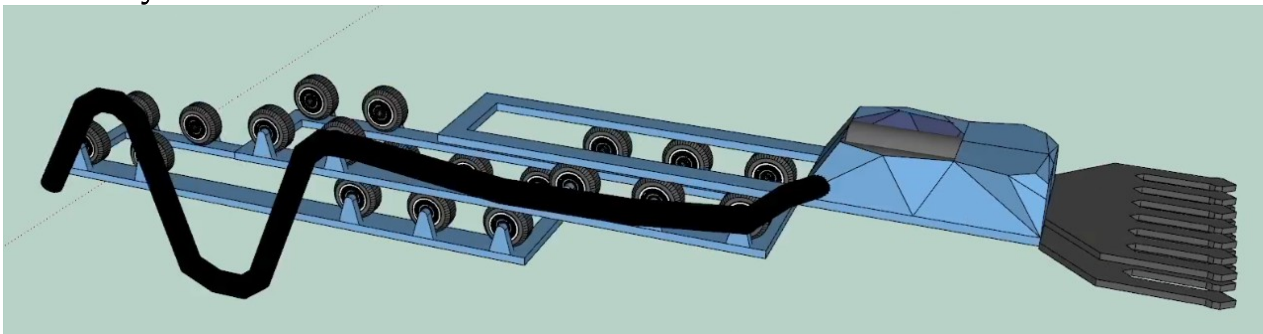




There is an automatic tool changer at the end, resembling a food processor coupling. Cameras and dual motors are at the wrist. Stainless steel wheels, V-wheels, poly-urethane and ball bearing tracks have different adaptive flexibility vs precision motion in linear slides.
Linear slides are used everywhere with hgh-tech ranges of equipment and many variant.

A cutaway schematic:



Demo of a telescopic pallet system [*here*]
Animated schematic of 3-stage cascade [*here*]

The maximum lift is limited by the shoulder motor, i.e. a max lift of 12 kg or 120 N · m is provided by a $180 NEMA motor at 1:40 ratio.

The prototypes must target intensive outdoor use. The shortcoming of the mechanism is that shield, bellows or a cover has to be tailored to prevent ingress of insects and weedwacker detritus. Wheel sizes and materials must be tested, drainage and brushes and other measures.

Cable sheath, Cable chain, Shielding can be copied from CNC bellow covers, which are shaped like accordion or nested guards.

Strategies for noise reduction in the robot arm include anti-backlash mechanisms, current control, pulse timing, low step angle, microstepping, quiet motors, elastomers, and software optimization for silent accurate motion. The shoulder motor can withhold a base volume of oil which relays heat away from the stator, so that essential motor can stay cooler with intense lifting.

There is no actuator redundancy in the arm, all 3 motors are strictly necessary for tool placement. The tools have an invariant built-in motor drives to switch them on and off in a given place.

The forward and reverse kinematic equations for the tool position have just 1 vectors from a pivot point. In science we measure a machine complexity as kinematic chains: sequences of motors, links and tools. in this design, the kinematic chain is very simple and there are no complex control algorithms.

This invention concerns any cascading or telescopic linear slide with a motorized tool on the end or a motorized multitool, and a hinged shoulder, using timing belts. An automatic tool changer can be used for multiple tools.

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Seed dispenser and mixed species

The seed dispenser is made of tubes that rotate on a carousel. The user inserts 8 to 20 seed varieties in the tubes. The robot travels and deposits seeds into precise food gardens and flower beds.

The seed dispenser can sprinkle biocontrol powder (chilli, ginger, diatoms, bacillus, garlic, oregano, coriander, cayenne, for millipedes that eat seeds and for slugs). It's a multi-seed printer for versatility. It can sow plants for market gardens, technical landscapers, farms and homes. Afterwards, the robot protects the seeds via surveillance scans, processing images at 3 frames per second for slugs and bugs.

Sowing 10 plants a minute, for plant beds of 12 to 30 m^2 per hour, it is accurate to 3 mm, and a maximum print size of a tennis court every day. The arm lifts over 5 kg of seeds (plus the tool). The seed carousel can be 3D printed with up to 20 seed tubes.

A pivot rotates seed tubes with valve rods. A preliminary sketch is on the left (insertion probe, cog shield and axes, easy caps for seed insertion). Fun AI illustrations are on the right.

The seed printer can tailor mixed crops that shade, balance and protect each other from fungi and insects, promote nutrient cycling, climate resilience, functional biodiversity and weed control (ref). Mixed crops are safe, especially for equatorial regions with high climate stress.

Human vision and memory are overwhelmed by mixed crop maintenance complexity. Computing can balance a structured profusion and safeguard every harvest item from weather extremes and pests.

Users can upload artwork to duplicate as a flower carpet, in a desired size and color, from a square foot up to a tennis court in size. (i.e. 20 color flower bed,   depicting a boat, a "Welcome" message),

Garden decoration programs can suggest complimentary seed mixes, tailor made landscapes, mediteranean, alpine, oriental, labyrinths, renaissance, straight, curved, generative, contemporary compositions of herbs, food and flowers. It aids low-budget planting of roundabouts, parks, restaurants, campuses, company spaces, homesteads and farms.

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Digging

A stainless steel screw is used to auger soil. The timing belts have 20 kg of push-pull force that can uproot entrenched weeds and prepare flower beds.

A digger is extremely messy so it doesn't even need to be cleaned, it should just be stored in a special compartment under other tools. The rotation motor can be vibrated to rattle and tidy away soil, as can the arm extension motor. The water jet under the robot arm's first stage can be used to spray and clean objects if necessary.

The rover suspension is unfortunately complicated by downwards digging force, so a stiff, lockable suspension system is necessary. Lockable suspension can be as simple as steel legs that flip up on a hinged mechanism, comparable to a fishing stool, cable driven.

Wood implanter

We would like the machine to drive wood underground, twigs and small logs. This boosts a soil's long-term organic carbon content and attracts organisms that aerate and enrich soil.

Bore drill

A cylindrical steel tube can dig cylinders of soil and replace them with cylinders of compost to maximize growth and minimize nitrogen losses.

Using a special bore drill the robot can transport cylinders of compost and manure to implant into root extremities, providing months of fertilizer, for high-value organic harvests on a tiny labor cost. A farmer should be able to offload dung in mounds, so the robot can work a few hours every day implanting fertilizer on plants near the mound. A tube of 20*4 cm can transport 250 cm3 of dung, at a rate of a liter implanted every 15 minutes, 1 m3 every week.

Soil sensing probe

Probes are sold for basic measurement of soil, some of them can be useful after tests.

NPK, pH and humidity. Joining multiple sensors into one tool is compact. Soil tools should be stored in compartments under other tools.

Hoe

A durable tool to scratch weeds and other versatile jobs. A garden robot can work non-stop for 20 hours with a hoe to great effect. The robot should have mapped the ground elevation to within about 1 cm, so it can use basic mapping to apply the hoe while rolling forwards.

Perhaps some people would dispatch slugs with it. It is stored under other tools. A rotating hoe with varied edge shapes, wide and narrow, is possible, but it would not be priority use of early development time. A slowly rotating weed abrader is also possible, it has not been researched here.

Irrigation

The robot arm can emit water in all degrees of freedom via a hose under the first telescopic stage. The flow rate and nozzle are varied by a solenoid valve and the water pump current.

A flexible membrane tank has advantages compared to steel and plastic tanks. The surface tension is held by the membrane, so it prevents sloshing. Manufacture costs of bladder tanks are very low. A 40 litre tank can convey 1-3 m^3 of water daily.

The robot docks to a simple water valve to refill. Night irrigation is possible with an IR CMOS that costs $20. It extends daily work time significantly.

Water distribution is optimized from map of cumulative evapotranspiration.

A tilling shear bolted to the front of the rover is feasible. It was designed in the study's early stages.

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Weeding and Clipping:

The robot can work 22 hours per day weeding non-stop, so it doesn't matter if it is 40% as fast as a human. Weed strategies range from simple blanket mowing of non-essential plants, to complex selective management in varied and dense foliage. Broad and narrow weeding tools can be considered.

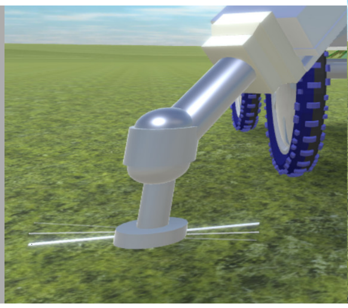
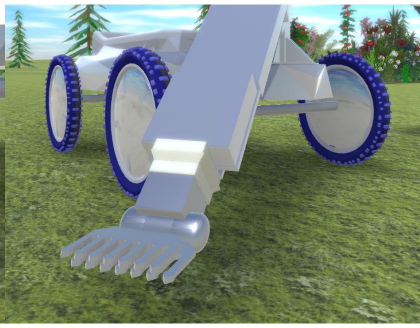
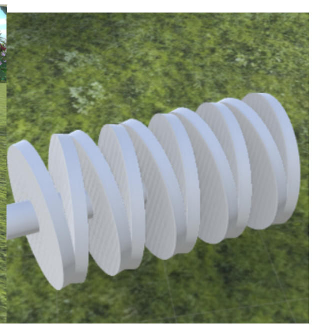
Physical tools:

- **A hoe** is a trusty and versatile hand tool that can be aimed with wide-view stereoscopy. If the arm vectors photos 20cm apart, it can precisely ID common weeds and scratch them from the ground.

- **Rubber disks** that pinche weeds and rotate them upwards, could be a faster precision weeding method than a hoe. Two German companies have recently patented rotating-wheel weedpullers for sugarbeet plantations, which catch tall plants in between rotating tyres. We propose a weed pulling mechanism based on a row of rotating disks which contact each other at an oblique angle, like a row of large epilator or rotating tweezers.

- **A cutting disk** can sweep away invasive seedlings that sprout numerously on wild plots. Either a weedwacker, jagged edge or a "twisted wire disks" are effective. Tiny weeds are fragile and profusive, they should be intercepted early. 30m2 per hour of new soil can be cleared using a cutting disk. Disks have durability advantages over clipper blades and have less oil requirements to extend durability. Heavy weeding with fast spinning disks like weedwackers result in cellulose projectiles.

- Miniature steel **hedge-clipper** blades are mass-produced as hand tools A related design can be refitted to mow through weeds at ground level, shape canopy and uncover obscured plants. Two motors totaling about 1.5kg are in the wrist. The clipper consists of just blades and a crank, which converts rotation to reciprocation. The stamped metal blades should be replaceable.



The above weeding tool list is long so tests and selection should happen to narrow it.

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A human can casually displace rotary weeders and small trimmers because their motions are simple. They have fast work-rates and versatility. A robot is advantaged with higher precision and gigabytes of interactive maps that includes valuable plant stems and foliage which must be protected.

Electrocution of roots requires two accurate probes to isolate bare ground and the weed stem, at very high voltage, so it is not studied here for garden use.

Computing weed management:

- Digitally map extensive zones of ground to the 1TB SSD
- Analyze foliage patterns against 220 ID types live and concurrently with 8 GB RAM
- Record weed locations and valued plant perimiters (with ultrasound trilateration precision)
- Tool path is optimized based on weeds detected

Motions and strategies should narrowed in prototyping, to maintain clear objectives.
The choice of tools and mixed culture scenarios is varied, it’s easy to divest effort from general research tasks.

The human brain is not very good at analyzing many leaf assemblages for a prolonged time, because humans are so good at a million other things. It overworks a small part of the brain which actually can get tired quite fast and defocused. A computer not only has far better memory abilities, it can work for 20 hours straight without mental fatigue. Robots can now become very good at dealing with weeds without herbicide. An open source multitask robot project can greatly help reduce the price and raise the performance roboweeding and of herbicide-free food.

Home

ATC and Tool Box

A simple automatic tool changer (ATC) is necessary for multi-tool gardening with economic advantage.

Central trade tools have multi-tool connectors (hand-drills, compressors, Dremels, CNC, computer USB, food processors) for versatility, adaptability, space efficiency, compactness and economy. Farms use 5 to 15 implements that hitch to tractors for tilling, seeding, baling and harvesting.

CNC tool changers are much faster than a garden robot, and higher precision. They rotate at 20,000 RPM and operate in the 50-micron range. Agrotech is in the 1cm range.
A cultivator mech tool port can be compared to to a food processor connector.

Advanced ATC reading:

A field robot ATC comprises:

- Auto-fastening latches on all sides, 70kg max load
- A flared edge to guide alignment
- Motor drive shafts for an 800W main motor and a 250W auxiliary
- Big and robust electrical contacts i.e. spring contacts, doubled for redundancy:
  - A 12v port, relay switched from the computer, 20A, 1.5 cm^2 terminals, dust tolerant
  - USB terminals, for LEDs, sensors (8 pin SMT spring contact array, 0.7 cm^2 pins)
- Machine-readable codes, to identify tools with 100% precision
- Grit mitigating edges and coatings, shields and seals
- A white color to contrast insects and particles for computer vision checks
- Holes for pressured water and air, for complex internal flows to dislodge potential snails and agrodebris

The tool station design is a study of fluid dynamics for the transport and shedding of tool residuum. Residues travel like a fluid from the ground and plants onto and through engineered components, and back the ground. A good design for real farming minimizes probability of snagging and building up, and facilitates rinsing, probably with the help of custom fluid mechanics.

The tool station requires careful attention so that all the precision surfaces stay clean,
so dirt is shed downwards through gravity, ATC couplings are requier minimal maintenance.

Dirty tools are segregated and stored in compartments under / away from precision tools.
The auger which collects agrodebris, should be vibrated by motor impulses and stored so that soil can drop to the ground, so the auger can be reconnected dozens of times in a week without recourse to water and brushes, because robot cleaning of an auger needs rubber spatulas, brushes or water. It's a hassle to compute and engineer. It's prefereable to just forget the tool in it's messy state in a well designed tool unit. Later research can find if tools to be be cleaned automatically.

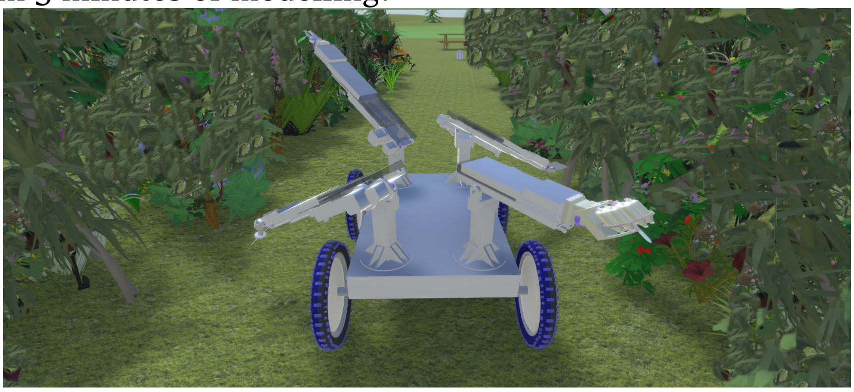
Open-source specifications for ATC connectors empower platforms, help innovation, diversify product ecology and choice, foster partnerships, encourage global adoption, lower price and prevent obsolescence.

It would make sense to design the ATC to be sprayed with a water jet by the owner, because it's an outdoor tool made for relentless work, some holes in the shell that can be plugged with a gasket are good to allow access and spray cleaning, ase well as small holes for drainage.
Car doors also have small holes in them for drainage, otherwise they fill with water.
The ATC has no voltage when disconnected from the robot.

The distribution of the gears in the male and female sides of the ATC work to achieve rotations and torqures similar to an 800w drill.

Extra implement holsters on the robot flanks can transport tools to avoid returns to the tool box.

Fun image from 5 minutes of modelling:



A four-arm farm bot, not within the scope of this study. Is a 2-arm rover reasonable?

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Geospatial Data Management

Photogrammetry, stereoscopy and ultrasonography are combined to provide robust geospatial precision.

Position sense is given by ultrasound emitters placed on posts in the garden.
The position signal emitter circuit is a radio receiver that triggers a speaker to emit an ultrasound pulse of 100 ms.

Costing $25 per unit in bulk they have a radial range of 30 m and convey 25 mm accuracy.
The ultrasound microphone capsule can be placed on the arm pivot and/or the arm cameras.

Two ultrasound beacons can cater to a garden the size of a tennis court.
Ultrasound attenuates by 0.5-1.5 dB/m at 19-40KHz, hence 30m range. A few minutes of ultrasound chirps are emitted daily. Cats and dogs are indifferent to the sound.

Minimum system requirements for the computer board include 8 cores and 16GB of RAM, a configuration chosen to accommodate two simultaneous object identification processes, each utilizing 4GB of RAM. For high ID confidence and neural performance 4GB per ID task is required. In 10 nanometer silicon, suitable Single-Board-Computers (SBCs) are rated for 7 watts peak, cost $200 and process ID higher than [1.5FPS](#) (frames per second).

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Advanced GIS reading:

Only 110 objects can be compared concurrently on a CPU thread. 12GB RAM running 24/7 in delayed processing, is limited to a few thousand different types of object, without network processing. Fortunately 2000 object descriptors should permit 98% of precision field tasks, including 1000 plant objects, 500 animal and 500 misc. 10,000 species can be network-processed through an entry level PC. Millions of species can be checked using AI cloud services.

Gardens harbor animal communities that peak seasonally: mantis, capricorn, big moths, vulnerable butterflies, bees, jumping spiders, mammals, birds. A field robot can track fauna species, locations, numbers, stats and images. Local ecology information can be shared to conservation groups and hosted in regional databases.

With AI, farm and garden owners can be informed of interesting species of animals, their benefits, nests and habitats, to encourage a balance of pest-reducing species like frogs and birds.

SSDs now cost $50 per terabyte, equivalent to 1 million 7 MP jpg photos, or 500 billion 16-bit numbers. They can save 2D and 3D maps of a garden space, growth rate, irrigation time, node count, height, fruit type, fruit size, color, insolation, shade, precipitation and evaporation, NPK, carbon content, and environmental data.

Garden robots will benefit from miniaturized GIS (geographic information systems), organized maps of all data. Databases indexed for fast retrieval store environmental maps that structure all useful of observations and sensor readings. Warning data to protect plants is given priority. Environmental resources are averaged and summed to finely maximize the resource synergy and the best use of land.

Low motion stereoscopy of dual photos is used for depth perception. The robot arm can use wide-perspective stereoscopy, a lot wider than the human eyes, for frontal task distances.

During the setup process, a user can steer the robot through the paths of the garden by radio-control, to provide faster acquisition of workspace limits. Digital map details vary over time, from coarse plotting to fine maps of harvest and botany information, predictive and summed thermal and environment readings. Once a robot has mapped the work zone it can navigate without much use of the sensors.

Mapping proficiency will let AI robots excel over humans to maximize resources and minimize waste. Every data type is methodically allocated to a vast array of instantly searchable databases. Databases include plant types, locations, sizes, growth rates, fruit metrics, projected product returns, fauna types, locations, quantities, temperature maps, nutrients, pests and amendments. Appropriate actions can balance and optimize biological economics.

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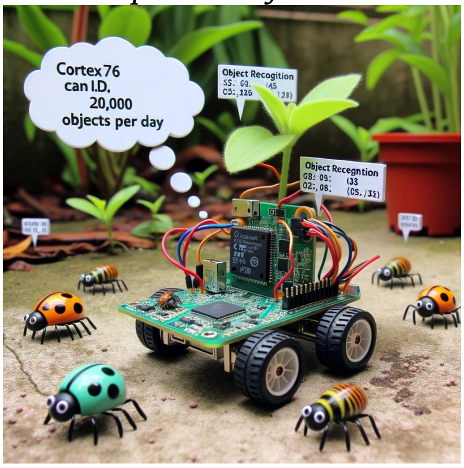
AI art is provided for amusement:



Photogrammetry via a robot arm is well researched and very precise. For extra precision, the ultrasound calibrates all the robot positions to prevent information drift. This double-accurate system of garden mapping integrates terabytes of data may be structured using low budget equipment and modern 8 core mobile processors.

A home system would be on-call 24/7 to deliver just-picked products from the garden, via a smartphone database or harvest list. The harvesting ability is slow, only for family use, not entire fields. A lunch request would take an hour to gather. i.e. an order sent from the office, to prepare herbs, fruit and vegetables, for an oven bake.

Radio Frequency RF localization has a range of 400 meters and low power use.
If semiconductors can achieve faster clocks that enable 2 cm RF signal tracking it will be a better option than ultrasound. Today RF is accurate to 15cm and is common. Graphene doped SoC has recently been produced in silicon factories, it can potentially run at 20 Gigahertz.

Because the object mapping is limited by 16GB ram, the robot can change to a new ID library in 4 seconds at any time, loading from SSD. Training a group of photos for ID takes many hours, so it is necessary to make many garden object libraries available depending on regions.

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Component List

for an open-source robot determined from online retail costs.

Cost	**Electronics = 1050**	
$100	Cameras	Imx206, 16 MP Sony CMOS 2x... 3.6 MP, 3x
$5	Microphones	3 microphones + SPDIF + manual switch
$200	Position tracking	4x Ultrasound beacons over garden, future price is 100
$200	Computer board	12 W, Octa core, 16GB DDR4, (i.e. Rock5, or 2*RPi5)
$50	SSD	1TB, 4 W
$25	Sim card IO	4G smartphone control, 10 mW. Sentry mode. placing orders.
$150	Other electronics	Wires, Controllers, outboards,
$100	Sensors	pH, NPK, humidity, accelerometers, gyroscopes
$225	Lithium + bms	1 KWh, 20 km range, 1200 recharges
$175	PSU	5V + 12v + 24v ...
	Vehicle = 870	
$150	Front Steering	Rack and Pinion, like on old cars
$125	18” wheels	4x BMX or solid steel hubs, tyres. (calibrated balance weight)
$250	Chassis and body work	Easy access compartments, double waterproof seals
$45	Water pillow	A bladder tank inside chassis compartment (cheap). Filter, pump, tubes
$225	Lockable Suspension	Perhaps just 50 for a 4 bar pivot hinge on a cable
	Arm frame, Tools = 2,175	
$950	Big Telescopic Arm	3 stage, dual belt drive, cascading long reach arm
$600	Automatic Tool Changer	Resembles a blender coupling surface with 2 actuators, 7x
$350	Essential tools	Auger drill, weed-wacker, pH sensor, hedge trimmer, seed dispenser.
$250	Tool docking station	Tool box on a post mount
$25	Brush set	$2 for a broom top
	Motors/Gears = 850	
$75	Steering motor 250W	
$150	4WD motor 500W	7 km/h, precise, high torque gears.
$200	Base bearing and motor	
$250	Shoulder motor	80Nm @ 5 rpm, 200 W, (i.e. Nema 42 stepper 35:1)
$50	Belt drive motor	
$140	Two wrist motors	
	Total cost ~ 5000	Home-assembly = $6000. China price = $7500. ES price = $11000

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Medium Size inveginuity Specification

Size	1200 * 1100 * 700 mm (L H W) models vary +/- 40%
Work cycle	140 hr / week (20hr / day) and IR
Max revenue	$4000 / year
Range	20 Km /day
Weight	50 Kg
Ultrasound mapping accuracy	25 mm, prior to stereoscopic adjustment
Task Precision (repeatability)	3 mm
Max payload	Wrist = 12 Kg , Chassis 75 Kg
Toolset	8 tool ATC
Irrigation	1m3 day nominal, 3m3 day max.
Connectivity	4G/Wifi/Ultrasound/GPS
Energy use	2kwh / day, $120 / year
Planned equipment MTBF	20 years with maintenance

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Prize logistics

A prize would stimulate innovation, increase visibility and recognition, encourage interdisciplinary collaboration, ensure peer review and quality control and disseminate knowledge to make practical solutions accessible to the general public.

Brief overview of a research agenda:

STAGE 1 - Power and stress tests for $1000 robot arms without ATC.
STAGE 2 - Power and stress tests for an Automatic Tool Changer arm.
STAGE 3 - complete robot challenge including arm, ATC, chassis and tools.

Field Bot Technical Objectives

1. Aim for $5000 material cost. For market viability, forces new thinking and innovation
2. Ultrasound based mapping is necessary for precise spacial memory, 2 cm res.
3. Robot arm costs $1200, telescopic, with 2 mm repeatability / accuracy (see component list)
4. Limit of 5-8 tools to achieve many jobs, to dig, weed, sow, water, cut and sentry
5. 10-20 year longevity, to withstand farm abuse. Easy maintenance and spares

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6. Generic state-of-the-art components (sensors, motors, electronics)
7. Logical progression of research targets, from unknown parts, to the most common
8. Fun projects like a graffiti robot arm to fuel research of garden robot mechanisms
9. RepRap project is the example for collaborative mechanical research
10. $2000 to $4000 revenue to owners from their garden soil

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11. AI used for object IDs. >16GB onboard AI, optional cloud and wifi desktop AI connectivity
12. DSP of sensors, foliage color, nodes, growth speed, shade, weather feeds, evapotranspiration, photogrammetry, stereoscopy, ultrasound trilateration, 40+ data types
13. Advanced engineering of key parts to mitigate agrodebris and humidity. Fluid mechanics
14. Very little programming necessary until unknown parts are researched and distributed
15. Rover is not necessary until small military UGVs used to advanced field tests

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16. ID and track: friendly species, foliage type, weeds, pest fauna, fruit and all objects
17. Friendly species and habitat management, possibility to map and share complex ecology data
18. Seek excellence in environmental data processing, GIS to constantly update maps into DB
19. Advanced sensor hub with 12+ sensors, coms, robust IO with smartphone/desktop GUIs
20. Unity3D 2015 code and web resources are example for easy inclusive scripting

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21. Mixed plants prioritized, tools to cosset individual plants, structure 20 to 150 cultivars
22. Chemical use avoided, through high labor attentiveness and AI targeting of pests
23. Advanced carbon and NPK enrichment of soil with compost coring tool, auger, legumes
24. Synergies from strategies of the wise old gardener for better bigger produce, resource cycling, climate risk adaptability, weed suppression, to relay harvests
25. Community boards are fully in control of data security and privacy filters
26. Users can completely configure tools and functionalities with access to all sensors and motors
27. Promote interest in science and technology
28. Find a cute design and comedy name like compostrat, nauticultron,

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Geoscience Objectives

Garden A.I. robotics can reduce pesticides, plastic, transport, energy, refrigeration, middle men, shelving and disposal by spawning local enterprise cost-advantage and raising employment.

Technologies create micro-enterprises that network local infrastructure and production. (i.e. photovoltaics, food delivery, ride-hailing, carpooling, accommodation, 3D printing, classifieds, Bitcoin and Fintech).

National food prices are linked to conflict, climate change, stock exchange and OPEC, resulting in food price insecurity. Garden robots reduce that insecurity and benefit rural families and freelancers. They can counter the biological inefficiencies of monocultures that rely on chemicals, through attentive AI and 140 hours per week of autonomous labor.

Today humanoid robots can run up stairs and scaffolds with tools and plant somersaults. Artificial Intelligence is mature.

Multi-task robots will do for food what solar panels can do for electricity. To supply higher value goods more efficiently through decentralized local networks and freelancing.

Factory methods for agriculture adapt unpredictably to fungi, bugs, plant biology and climate. Land and regulated pollution cost little, so market forces can promote farm expansion for bigger machines, simple biological methods and agrochemistry, affecting migration, crop risk, yields, biodiversity, extinction, unemployment, rural inequality, nutrient depletion, erosion, river endangerment, hunting revenue, rural tourism, plastic and chemical excess.

30% of new lawnmowers sold in 2022 were robots, 2 million units. Cultivator robots are quiet, unobstructive and they provide significant revenue, so they could see high adoption rates.

A lawnmower-sized robot suits country homes, hotels and restaurants, farms and landscape professionals. A broad user base. 42 million U.S. homes, grew food plants in 2021, yielding an average of $600 per household. ref. 640,000 Americans work in landscaping. There are 570 million farms globally. ref.

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Methods and 3D simulation

We built a rover in a 3D kinematic garden with gravity, collision and vehicle physics. Work speeds, tool forces and engagement angles were assessed with math functions and visually. The robot was tweaked to comply with with seasoned professional gardening and with University of Edinburgh studies of agriculture, soil science and environmental science.

The mouse precisely rotates the arm while keyboard controls operate the tools and steer the rover. The forearm can extend telescopically by 1.2m via the mouse wheel.

The 3D simulation triggered interest in robot arm mechanisms and slide systems, irrigation routings, tool kinematics, toolbox logic, gear force optimization, a detailed parts list, cost analysis, fertilizer (compost, dissolved, pellets), wheel types, sensor placement, suspension, energy use, food markets, socio economics and many other factors.

Handheld spectrometry was found to be expensive and inaccurate for soil science (it only retails for metallurgy and geology). Other tools were found to have simple motions which conform to resource optimizing chores of organic farm management. The seed dispenser appears to deliver high productivity. A bug vacuum flask, clam-shell digger, laser, high voltage weed shocker, pruning shears and a sawtooth disc all lacked efficiency.

A profusion of analyses from the simulation were unconvincing, and were thrown out, to select only the performant design.

Simple, practical maths was used to measure the simplest tool shapes and motion equations (a rotating drill to dig, wheels to travel, a reciprocating trimmer to weed, a tub tool to catch fruit, NPK probes to measure soil and other tools).

A methodical garden robot design process must:
- List all feasible tools.
- Score every tool’s mathematical and physical advantages using weighted indexing.
- prioritize research towards the most time-saving and least complex.

A weighted index sorts tasks. Highly complex errands like fruit harvest are thus delayed until after all errands ranked higher by complexity and labor economy are completed. Errand simplicity can be ranked by the number of math function calls a tool needs to complete a job, and errand importance is a weighted index of the time seasoned gardeners spend on them.

Functionality was favored over appearance, so the robot is aesthetically challenged. Unlike Wall-E, it is like a digger truck. A robot should be as cartoon-like as possible for a real-world project, family appeal shouldn’t be overlooked. A cute machine appearance is preferable. Later variants with two arms and googley eyes can have higher popular appeal.

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Computing and AI

Complex code is only written after an advanced mechanical design is agreed and distributed.

A single predefined computer board keeps the project simple. Chosen with at least 8 cores and 16GB RAM from, selected for best fitting with the AI, expansion, data ports and economics. A secondary SBC can use used as a sensor server and for operation status checks.

A workstation or AI cloud can be networked for remote processing at fast, high resolution. That can speed up development however it is impractical to base field work. A smartphone processor is central to simple and cheap inveginuitys.

Community driven development is cultivated by digital companies like Google, Nvidia, Microsoft, Fitbit, Raspberry Pi and Bose. It's pivotal to define an easy API which is well referenced.

Unity's early API is an example of an online language reference that empowers a creative development community. It defines all math functions, motor rotations, sensors, network, data types and conversions, array types.

The user community should have:

- A feature request voting page that is simple and effective
- A discussion forum with sections for all aspects of garden robotics
- A technical Q&A site without sections, just using tags
- A concise scripting reference with method and variable examples
- A general technical guide

Releasing community CAD files lets independent engineers contribute free research to a platform, with 3D printed tools and new variants. Giving free gifts is a very good way of requesting business. Open source companies are very popular, and profitable when selling products.

Free robot software exists for vision, sensor servers, error handling, testing, process stability, motor control, autopilot, real time control (Yolo v8, OpenCV for vision, ROS robot OS, PyPot, PCL, Ardupilot, Rviz).

An organized management of software development requires good planning and prioritization:

- Structured and coherent stacks (HW/OS/DB/API language/UI/Frameworks and libraries/monitoring and logging/security...)
- Component-centric design
- organized API (Application Programming Interface)
- sensor troubleshooting and data handling
- concurrency and real-time considerations
- testing and simulation
- error handling and recovery
- scalability and extensibility
- compliance and security standards

Pitfalls: inadequate planning, overemphasis on hardware, insufficient testing, over complication, lack of optimization, sensor bandwidth issues, memory bottlenecks, limited resource management, faulty error handling.

LLM can have complex and practical uses for garden robots at a later stage.

Countryside Facts

- Agriculture causes 80% of deforestation, 75% of species endangerment and 60% of water pollution. Info
- Farms employ 25% of the world's population. Web
- 4 companies control 80% of grain and soya supplies. They control prices. Img
- In Europe, 3 shops control 40-80% of food sales. Img page 16 source comité intra-ministériel.
- The US EPA spends 1.8 billion every year on pesticide decontamination. web
- The US has 2 million farms, avg 433 acres
- China has 200 million farms, avg 1.5 acres. source
- Up to 67 million birds are killed annually by pesticides in the US (EPA)
- Farms use 69% of extracted fresh water. web Aquifers are depleting. web
- 70% more food is necessary in future
- Agriculture is 4% of global GDP Img
- The use of pesticide has risen 26% in the past decade.
- France spends $370 million annually for work-related pesticide pathologies and effects.
- India has 105 million farms, avg 1.2 acres
- Farms generate 35% of the GDP of Ethiopia and Mali. List
- 233k to 370k farm workers in the global south commit suicide with pesticide every year, source: World Health Organization and multiple academic studies.
- Global food waste costs over $1 trillion every year
- The average American meal travels 1500 miles
- 4 companies control 65% of US food retail
- US farmers get 3% of bread retail price, 30% for groceries. Source

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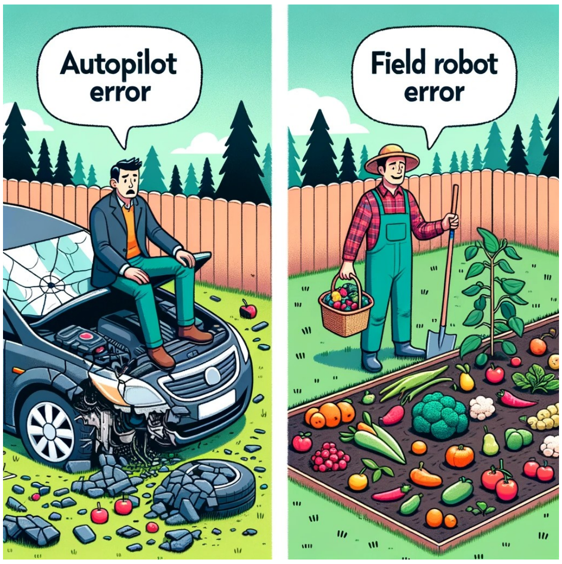
Autonomous Car vs Garden Robot Viability:

	Garden Robots	**Autonomous Cars**
Lab premises	Affordable and unregulated	City license, permit, insurance
Map Complexity	Small maps, 50 m field, static obstacles	Regions, 50 km, cities, relentless traffic
Reaction Time	Unlimited processing time	Less than a second
Error consequences	Broken pots, plant damage	Car accidents, medical costs, fatalities
Accident risk	Slow physics, 5 km/h, low risk	Fast roads, 100 km/h, high risk
Localization precision	Ultrasound beacons, 25 mm	GPS, 5000 mm
Computer vision	2 FPS identification, rare environment changes	>15 FPS identification, relentless new object
CPU and Programming	Tiny CPU, slow and easy algorithms CPU: 15 W, 1 Tflop, $200, generic	Huge CPU, complex algorithms CPU: 150W, 22 Tflop, $700, custom
Obstacles	1 novel obstacle per hour	15,000 novel obstacles per hour
Returns on investment	Can earn $1000-$5000/year	Accident prevention, insurance costs
Cobot job creation	Replaces superfarms, encourages small farms and gardeners. local, remote smartphone cobot interaction with flexible timing.	Millions of jobs at risk: (robot truckers, taxis tractors, busses) AV's require constant hands-on and supervision.
Research cost	A viable consumer product would cost at least $8 million to market.	$16 billion spent, no robot taxis, only semi-autonomy achieved due to risk severity.
Environmental impact	Landscape becomes varied, ecology diversification, mixed crops. Reduces packaging waste and transport, less energy intensive. Chemicals easily avoidable, positive effects on rivers, lakes, fisheries, amphibians, reptiles, insects and birds. Accelerates shift from fossil-fuel dependent heavy agriculture towards light and affordable lithium machines. Can identify and map beneficial fauna and enhance beneficial habitats. Reduce food waste through prompt local food production.	Raw materials and new components resultin from car accidents greatly reduced.

Autonomous urban driving is less computationally simple and feasible than inveginuitys.

Cars make split second, decisions, in vast and fast maps, using 5m GPS precision. A garden robot can take 5 seconds to track an object, it benefits from 2cm precision via ultrasound, in a static, sedate environment. Cars can never stop processing and mapping their environment as it changes relentlessly.

Tesla Full-Self-Driving 3 from 2019 used 72W to process fast moving objects at 15 frames per second in fast, large and perilous maps. As of 2024, cars don't legally use AI for steering and decisions. That is still hand-coded. AI is just for object ID.



Security

Unauthorized tilting and carrying are monitored by a gyroscope, ultrasound position, cameras and GPS. Multiple numbers can be called within a minute to provide images and warnings.

A company controlling garden cameras with a view of private property, family, cars and neighbors, will invite legal peril. Community elected rules and management of user data in secure software layers are essential.

Users should select a security level for their field of use. An image filter scrubs privacy lapses as the first IO step, prior to botanical image tasks. Written and managed by the community and consumer group, vision filters mitigate discontent and litigation.

From beta testing onwards, a community should be offered a decision-making council, feature request votes, a discussion forum, a question/answer upvote forum and a code hub. To attracts many user fast to develop a good product, a company can empower the users very much right from the start.

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Rainstorm and agrodebris management:

Rocks are rarely black. Soil carbon is. Chalk and sandy soils are visually recognizable. It would be wise to train AI on thousands of images of soil, lawn and small plant images, with proper labeling, to photographically assess pH, NPK and carbon content from the soil photos, and from the tiny plant species that live in grass, moss, liverworts (marchantiophyta), nitrogen fixers and bioindicators. That is handy as a tool to use on smartphones and agrotech.

Garden robots will scan all sensors and weather feeds to schedule work optimally, including adaptive charge times, averaged precipitation and evapotranspiration. Damp times fit with entomology, photo mapping, weed control, slug control and charging. The robot can shelter to avoid bad weather.

Soil type is configured in the basic settings. Heavy clay is not within environmental tolerances, the types of soil that add a kilo of weight to a shoe after a few steps. Less than 5% of the world's soil has a high percentage of clay. The computer updates its map soil physics and organic data.

Difficult soil, i.e. chalk at an Alpine lodge, can be exploited with soil intelligence and high work rate, into a useful garden that saves a mountain of fuel and money, and is more authentic that going to the shop.

Color processing can detect dirt on white materials. Tools, brushes and ATC should be white, beige or silver.
The cameras scan tool colors to assess tidiness and rate the service status to send a notification when human cleaning is necessary (tools, wheels, brushes, transport tray).

Mucus oozing slugs are a problem for robot tools, that's what the hoe is there for, subject to test and studies.

All the tool recesses should be as round as possible so that they don't clog with dirt and are easy to clear. Strategically placed access ports for spraying with a water jet should be added where possible and covered with a rubber grommet, and should drainage ports. The ATC can squash an insect, fall on the floor or be hit by a ball.

The robot can propel water accurately, so it's debatable to devise a systems to deflect the flow for cleaning tools, i.e. a shower box where the robot can insert tools.

The ATC contains big low-voltage electrical terminals and rotating shafts which are disconnected when they are not on the robot.

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Minimal human maintenance should happen every week or two. A brush stand can have many grades of bristle for multi-stage cleaning. Broom heads for home and garden cost $1.50 in bulk, they are well suited to field robots. Coarse brushes can use natural materials found in the garden, straw, gravel, coppice, wood chips.

The tool end is able to vibrate vigorously because the motors can respond to pulse and sine signals, developers can find ways to use vibration to perform some garden tasks, including preening. The components should thus be considered for vibration wear.

A cheap tiny microphone can monitor metal frame audio like a stethoscope, to warn of mechanical vibration and quartz trapped in the roller wheels. It monitors the running noise of individual actuators for anomalies while prototyping dust seals and deflectors under duress. Chassis contact microphones cost $2 and are desired in retail robots for service checks. Lab grades of soil should be thrown at the robot to test the effectiveness of seals. Audio processing is a simple, low computation addition that can boost service considerably.

Environmental resistance and the effect of adhesive cellulose and dirt are a fantastically complicated topic and as many strategies as possible to avoid maintenance should be tested and added to the design. Some of them will work well, some of them not, only time will tell.

It took 50 years for cars and tractors to be weather proof against leaks and corrosion. Today it can take less time for garden robots to develop environmental resilience, however it's a primary difficulty and reason for skepticism.

Use examples to rent, test and buy inveginuitys

- A farmer wants to offer local restaurants a regular supply of precision products
- You have a restaurant and some land
- You own a rural hotel
- You have unproductive soil which needs a lot of work
- You want to reduce industrial plastic, transport and food
- You prefer organic food
- You are a big farm interested in logical progressions towards efficiency market gardening
- You are a small nursery with a few thousand ornamental plants
- You are a gardener and the work is getting physically tough, a robot can help.
- You manage a landscaping company
- You have difficult soil which needs a lot of work
- You want to save 3k on food every year with a 6k robot
- You have some land

Sister Project, Wall-Art Mechanism

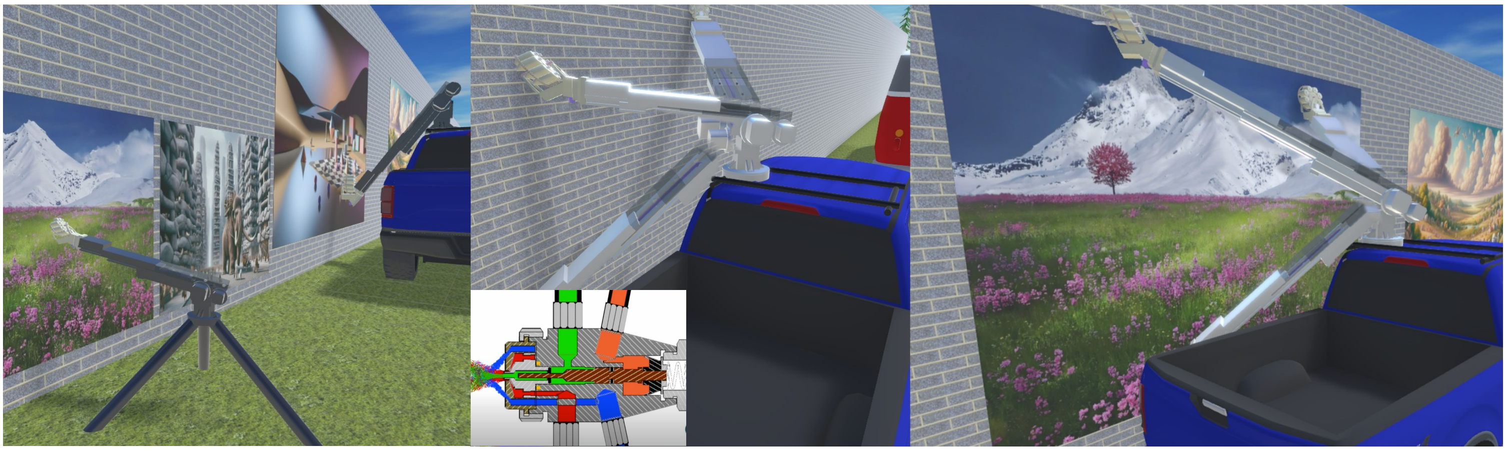
Have you seen a telescopic robot arm? Check the web, They're virtually non-existent. The designs are weird. The field is barely explored. The nearest commercial use is telescopic hydraulic crane booms with 3 to 45 ton hoisting limits.

Kevlar reinforced timing belts are favored for CNC, automatic gearboxes, cambelts, lawnmower drives, 3D printing, sawmills, photocopiers, articulated robots and 50 other common machines.

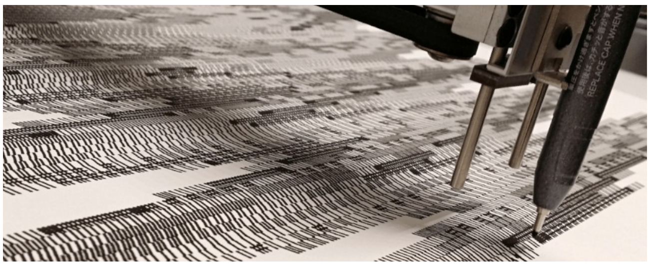
Let’s be the first to fabricate telescopic power limbs with them. Trial and error can reveal a new technology for home projects, with major advantages over other kinds of robot arm. It is a difficult job with interesting new challenges.

Wires can be hidden in a chain cable carrier to the side. The linear slide rail can use large steel wheels that are easy to access and tidy, resistant to paint, quartz and water.

What would it be used for outdoors? Artwork seems to be a popular occupation that city youth struggle with. Perhaps we can help youth stop their tags and learn robotics, and in the process, find a way forwards for chemical free cultivator robots.



A 3d printer can create plastic prototypes, to be powered with spare 3D printer motors. A lot easier than an articulated arm to assemble, holding a magic marker dampened by a spring, you would own the world’s very first mini pen-plotter robot that is portable and fits in your backpack.

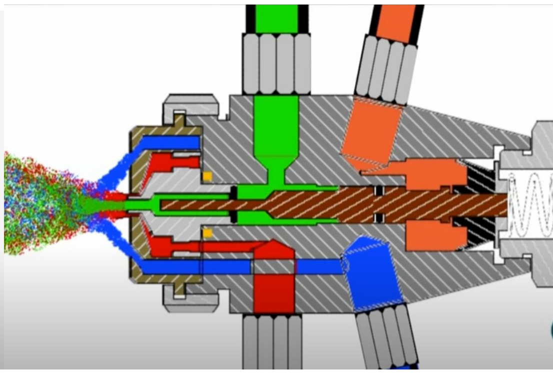


Stainless steel laser-cut designs would be very resistant and scalable.

A 50 cm arm with a reach of 120cm, would print wall art of 180 cm diameter.
A 100 cm arm with a reach of 200cm, would print wall art 400cm diameter.
Weighing 25 kilos, it could be affixed to a roof rack, the car jacked with a wood block, as a

source of revenue tending companies and cities that want vibrant wall art and publicity.
A theoretical 2 mm precision for a 200 cm artwork is 1000 pixels of diameter, not bad.
That sounds very difficult from telescopic rails, is it possible? It will have the same wobble and deceleration issues of the RepRap project.
Pointillism and Roy Lichtenstein artwork can be achieved with a sponge paint deposition system, one or multiple sponges that are supplied with drips of paint.

Complex color systems require mixed paint, RGB+Black adaptive nozzles that can be fed by small motors. The paint jet doesn’t have to be powerful, just 1-10 cm distance, so it can be 3D printed, and powered with a compressed air bottle, or a 3D printed compressor.


www.coatingsystems.co.uk equipment available from coating systems international, and plastic atomizer.

A curtain over the front end of the arm should keep it free of paint airborn paint, and adaptable shields will also work fine.
A CMOS to set markers on the wall for drawing pictures of 200cm and 1000cm in multiple steps could be good too.

We need your help!

If you are a good communicator, consider joining the project to host the arm design competition.

I will try to find a $500-$1000 prize for a telescopic robot arms challenge.

Please share the project with friends, channels from YT, Twitter, Reddit and the news.

Please support this project on Patreon,
call to chat about communications, funding and project progress.

Thanks a lot for reading!

Contact me inveginuity@gmail.com

FUN SILLY READING:

Vineyard motivation

In Côtes-du-Rhône wine valleys, 80% of hirondeau birds have gone following pesticide excess (pyrethrins, quinalphos, quizalofop-p-tefuryl, rotenone, spiroxamine, in covert misty drifts). Birds are literally falling in mid flight in an avalanche of beaks and wings. Eco-warriors are outraged. The local fruit trees are treated frequently, especially apples at 30 times a year (TFI Treatment Frequency Index). Thousands of farmers and millions of birds perish every year. The risk of French pedestrians ending their stroll with a goose collision is very high.

There was a time when hirondeaux were merrily nesting in the roofs of our French home. They slowly vanished completely. The nests, gloomy and dilapidated, have clung to their wood struts, crumbling without baby bird twitters and bird families to upkeep them. Grand-père would be concerned considering the rafters, bereft of the many swifts that pirouette and twirl in the deep blue sky. Grand-mamie was mystified by this chemical pandemic birdpocalypse. The sparrows also disappeared from bird influenza. The ornithologists are sad.

95% of disoriented bumblebees that stumble confusedly down the road and reside in makeshift leaf-tents on local patios, are confused from pesticides, not from fentanyl-honey, and swimming in cola. Prof Tolkien was a fan of the Alps, he would be dismayed by the valleys of doom and beepocalypse, having breathed the fumes of the WW1 trenches.

We are spraying Xylylcarb WMDs at all the insects and plants, having banned chlorine bombs just to invent 866 other fumigants for the creatures and rivers that we'd be wise to protect. We use 3 million tons of pesticide to compete with global food prices and reduced labor for maximum profit. Bees are locally extinct in 1/5 regions. 20% of butterfly species are gone in Holland. Adopt the bees;)

AI can let us equip the farmers with AI enhanced machines that use a tool-turret instead of a robot arm. Please come out of isolation and help the inveginuity to hit the ground running. Help in Cote-du-Rhone.

DARPA robotics challenge awards $3 million in annual prizes to the winners of biped robots to intervene in Fukushima type accidents. Fukushima caused 2332 deaths, however pesticides claim 50k people and 50 million birds every year. Hunters have less birds to shoot and the healthcare toll is over $1 billion. More birds, less dizzy bees, less war, it's a lofty aim. Can the E.U. put up a prize like DARPA for garden bots? Who will win?

Food is the purchase of 8 billion people; it generates 50% of household waste, it is the seed for every road and town. it's mechanization has augmented towns into huge cities of chaos.

So hey! Forget Bulletproof EVs, Quantum Computers, Graphene Radiators, Lucid Dream Caps, AI Datacenters... Where are we going to drive in the Bulletproof EVs? Through square fields and eerily quiet valleys, rivers with leached chemicals, to the nearest pine tree plantation that is harvested for cardboard? Okay I'm not an eco-warrior, I am just trying to be a good salesman for the idea ;) With photovoltaics now localizing expensive energy, what about food bots? They are financially advantageous

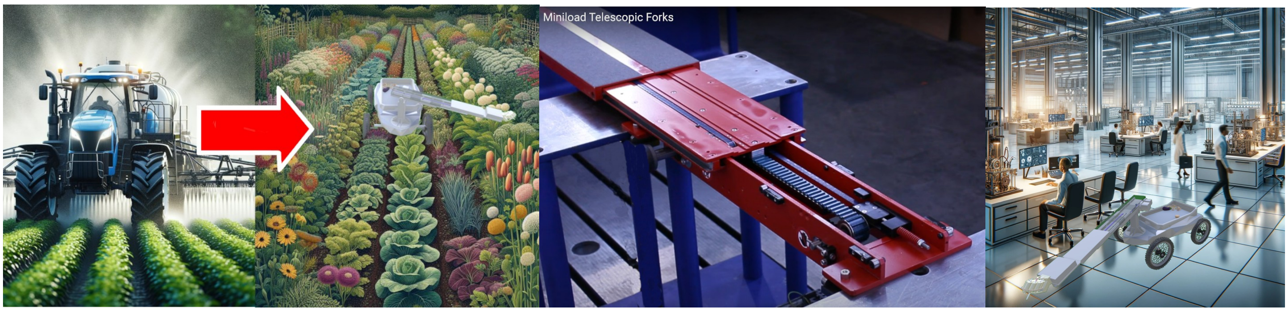
When you become an AI movie designer, music composer and artist, will you jog in a hamster wheel made of TV screens? Is there still a market for the real-life-world with physical butterflies, flowers, foxes in landscapes reflecting iridescent refractive effects on an atomic level?

This is the new era of 2 nanometer chips and AI. Surely, I am not unreasonable to research in the recesses of robotics research for a paradigm-change technology that may be right beneath our feet, right at this moment, like an Atlantis technology hidden in the flotsam of the quantum tsunami?

Food insecurity fuels migration and war. Farms employ over a billion people. An entire room of a western home. The birdpocalypse and beemageddon are global. London, Paris, New York, Berlin, Tokyo, Beijing, Cairo. If you travel to these cities, which were created by food, most of the green space in every direction is intensive food production systems. 70% more food is required by 2050. Is it not time for AI food bots? This is rational research!

Farmers struggle with 3 percent on a loaf of bread. In food futures markets, a bull market exists when global futures are rallying. A bear market occurs when futures are in decline. 80% of the global grain trade is controlled by just four companies, that hold up deliveries and raise prices in times of food insecurity. This is a food security bot. Weather, conflict, legislation and trade relationships drive food futures markets. Eco-freindly hypermarkets lobby for the enlargement of monoculture chemical systems to reduce prices further. Just like music label monopolies in the 1980's and the inefficient typerwriter, soon, local streamlined technology will take over.

Cultivator-mechanoids are coming soon, using 2023 technologies. We'll see them in our lifteime... as soon as folk realize their potential is like photovoltaics. If you want other futurology info, post a request! Including investment in straightforward D.S.P. synergies for AI markets.



pallet mechanism thanks to Eurofork Italy (125 cm, 110 kg)

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End of Book