SplashNet – A Hydraulic Sneakernet

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In this era of electronic surveillance and cyber warfare – fibers can be tapped, radios can be monitored, and satellites can be spoofed. This project - SplashNet is a hydraulic SneakerNet that uses the water networks present around you to stealthily deliver data. It solves the problem of systems hacks by making communication offline and untraceable. The proposed network in SnearkerNet use spherical capsules containing data and transporting them within a water network. Nodes are used for insertions and removal of the capsule, and motorized valves are used to control the direction of the flow. Pathfinding algorithms (like Dijkstra's algorithm) are employed to find the path a capsule would take between two nodes, following that the necessary valves are opened to connect that path and flow of the water does the rest. If employed, this technology could bring us into a new age of communication that is hard to detect and even harder to disable, with no scoop for remote hacking.

COMPONENTS

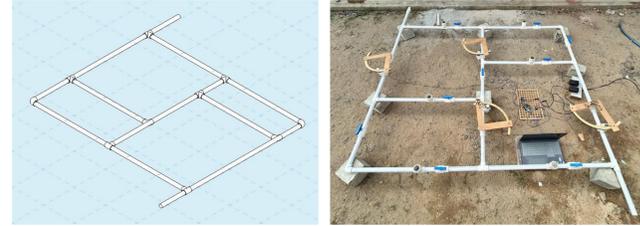**1 Pipe Network** – Provides the closed hydraulic loop

Figure 1. 3D Model of the Network (left) and the Prototype model (right).

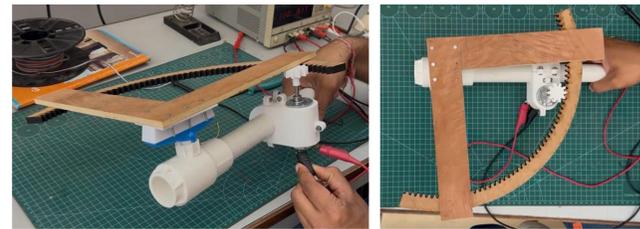**2 Solenoid Valves** – Control flow direction within the network

Figure 2. Prototype of the Solenoid Valve.

3 Exchange Nodes – Capsule insertion and removal points

Figure 3. Prototype of the Capsule Insertion and Removal Device.

4 Capsules – Sealed, spherical containers for data

Figure 4. Prototype of the Capsule with different densities and infills. 100% density would be equal to 1.27g/cm^3. In the picture (left), a capsule of density less than that of water is seen floating.

WORKING

1. INPUT START AND END NODE
2. FIND THE SHORTEST PATH
3. OPERATE THE VALVES
4. INSERT THE CAPSULE
5. START THE FLOW OF WATER
6. STOP THE FLOW OF WATER
7. REMOVE THE CAPSULE

SCAN TO WATCH STEP-BY-STEP WORKING OF THE MODEL

SCALABILITY

Human Scale
A hydraulic loop-based transport system in which sealed pods carrying passengers are propelled through a network of tubes by the controlled flow of water. Each passenger pod would be neutrally buoyant, minimizing friction and energy losses while ensuring smooth, stable motion.

Need?
The concept is technically intriguing but practically problematic for mainstream passenger transport when better and cheaper alternatives like trains, and metros exist. Though it's worth exploring for niche applications like underwater habitats, controlled amusement ride, or sealed transfer of people in a research facility.

Warehouse Scale
A closed-loop hydraulic transport system for efficient and automated intra-warehouse package movement. Sealed capsules containing parcels are propelled through PVC pipes by the continuous circulation of fluid, eliminating the need for conveyor belts.

Need?
A feasible idea but falls short of the existing mature technologies conveyors, sorters, AMRs (autonomous mobile robot). Though it does have a few advantages such as gentle handling of fragile products as the water-borne capsules reduce shocks, the pipe can run above aisles which frees up floor space.

Sneaker Net
Transporting physical storage (hard drives / SSDs / encrypted media) through a building-wide hydraulic capsule network to create an automated high-security sneakernet.

Need?
It is useful where strong air-tight security, regulatory chain-of-custody, or very large bulk-data transfer is required (e.g., classified labs, financial institutions, etc.) It competes poorly with normal networks for everyday data transfers but wins when it comes to regulating data transfers through a secure network.

INSPIRATION

Pneumatic Tube System – are networks of pipes that transport sealed capsules using compressed air or vacuum pressure. Capsules are pushed or pulled through the tubes at high speeds (typically 5–25 m/s) carrying small items like documents, money, samples, or medicines. The New York City postal pneumatic network (1870s–1950s) was one of the largest—spanning miles under Manhattan for postal delivery.

Working Principle:
- A compressor or vacuum pump creates pressure differences in the tubes.
- The capsule fits snugly inside the tube with small gaps for airflow.
- Directional valves or diverters route the capsule to the correct station.
- At each station, an operator can insert or retrieve capsules.

Where were they used and why did they stop:
Hospitals: transporting blood samples, lab specimens, and medicines between wards and labs.
- they were discontinued as the impacted the integrity of the samples, they caused hemolysis(the breakdown of red blood cells).

Banks & retail: secure cash transfer between counters and safes.
- with the rise in online banking, they became redundant.

Industrial facilities: sending documents, small parts, or samples.
-Digital messaging and scanning have replaced the need for physical documents and messages in many cases.

Aspect	Pneumatic Delivery System	Water Delivery System
Propulsion Medium	Compressed air / vacuum	Flowing water in a closed loop
Primary Force	Pressure differential (push/pull)	Bulk flow momentum (advection)
Power Source	Air compressors / vacuum pumps	Water circulation pump
Operating Speed	very fast	gentler, slower
Energy Use	Pulsed, high instantaneous power	Continuous moderate power

MAKING AND FUNCTIONING

PIPE NETWORK
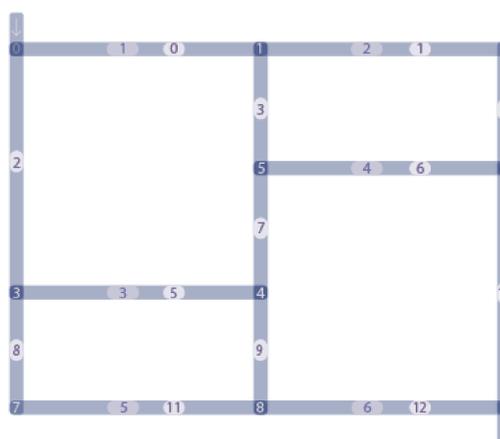
For the prototype, a network with 13 pipes was made, with 6 Exchange Nodes. Each pipe had a solenoid valve placed on it to direct the flow. Every junction at which the pipes intersected was given a number, which was then used in the algorithm to find the direction of flow in each pipe, by determining the order of the junctions passed.

- Pipe
- Exchange Nodes
- Solenoid Valves

PATHFINDING

```
// ---- Define Network ----
Edge edges[] =
{
  {0, 1, 1, 1, false, 0},
  {1, 2, 1, 2, false, 0},
  {0, 3, 1, -1, false, 0},
  {1, 5, 0.5, -1, false, 0},
  {2, 6, 0.5, -1, false, 0},
  {3, 4, 1, 3, false, 0},
  {5, 6, 1, 4, false, 0},
  {5, 4, 0.5, -1, false, 0},
  {3, 7, 0.5, -1, false, 0},
  {4, 8, 0.5, -1, false, 0},
  {6, 9, 1, -1, false, 0},
  {7, 8, 1, 5, false, 0},
  {8, 9, 1, 6, false, 0},
};

const int edgeCount = sizeof(edges) / sizeof(edges[0]);
const int nodeCount = 10;
```

```
=== Find Path ===
Enter START exchange node number:4
Enter END exchange node number:5

=== Shortest Path Result ===
Edge 0->1 | Exchanger 1 | Valve: OPEN | Direction: Backward
Edge 1->2 | Exchanger 2 | Valve: OPEN | Direction: Backward
Edge 0->3 | Exchanger: | Valve: CLOSED | Direction: None
Edge 1->5 | Exchanger: | Valve: CLOSED | Direction: None
Edge 2->6 | Exchanger: | Valve: OPEN | Direction: Backward
Edge 3->4 | Exchanger 3 | Valve: OPEN | Direction: Forward
Edge 5->6 | Exchanger: 4 | Valve: OPEN | Direction: Forward
Edge 5->4 | Exchanger: | Valve: OPEN | Direction: Backward
Edge 3->7 | Exchanger: | Valve: OPEN | Direction: Backward
Edge 4->8 | Exchanger: | Valve: CLOSED | Direction: None
Edge 6->9 | Exchanger: | Valve: CLOSED | Direction: None
Edge 7->8 | Exchanger 5 | Valve: OPEN | Direction: Backward
Edge 8->9 | Exchanger 6 | Valve: OPEN | Direction: Backward

Edges with OPEN valves (IDs):
0, 1, 4, 5, 6, 7, 8, 11, 12
```

Figure 5. The network defined in the code (left) and the output received after running the network with the inputs being the address of the Start Exchange Node and the End Exchange Node (right).

1. START
2. INITIALIZE
   Start node distance = 0
   Others = ∞
   Mark all unvisited
3. PICK UNVISITED NODE WITH THE SMALLEST DISTANCE   Set it as Current Node
4. CHECK NEIGHBOURING NODES
   Compute new distance
   If new < stored → update neighbour
5. MARK CURRENT NODE AS VISITED
   (its distance becomes final)
6. ANY UNVISITED NODES WITH FINITE DISTANCE
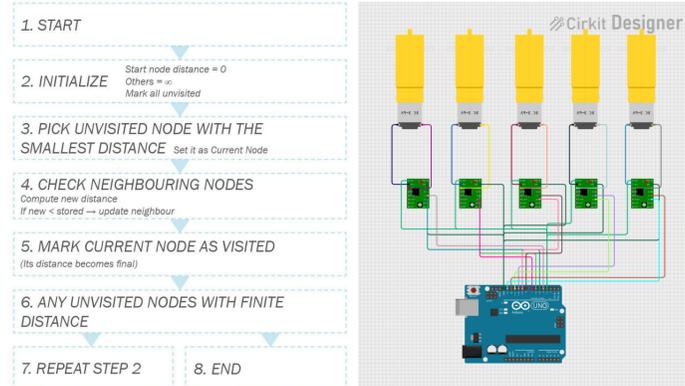7. REPEAT STEP 2   8. END

Figure 6. The algorithm of the code used to find the path (left), and the supporting electronics which receives the signal and opens the necessary valves as per the output (right).
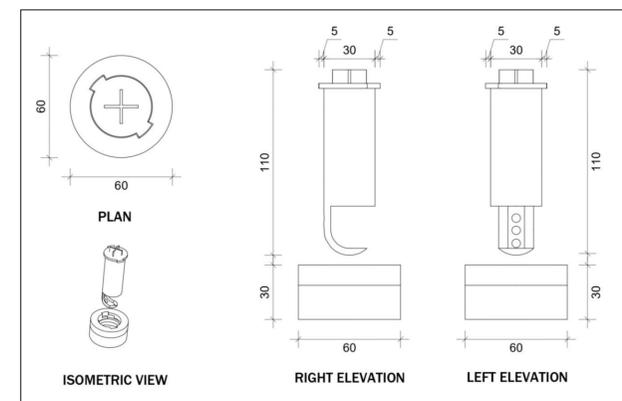
EXCHANGE NODES

Figure 7. Design and dimensions of the Exchange node used to insert and retrieve the capsule.
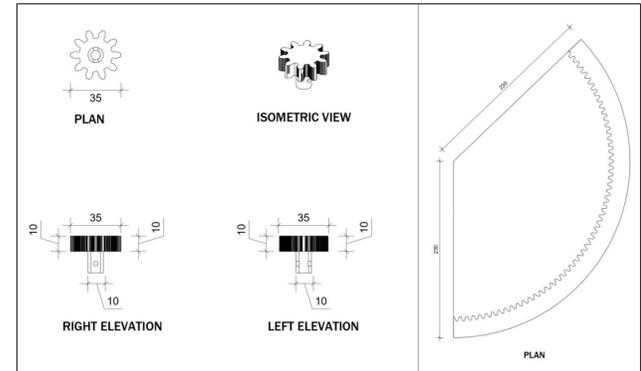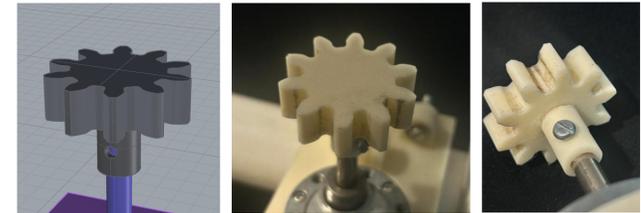
SOLENOID VALVE

Gears

Figure 8. Images and Drawings of the gear system. The small gear was attached to the motor using a screw.
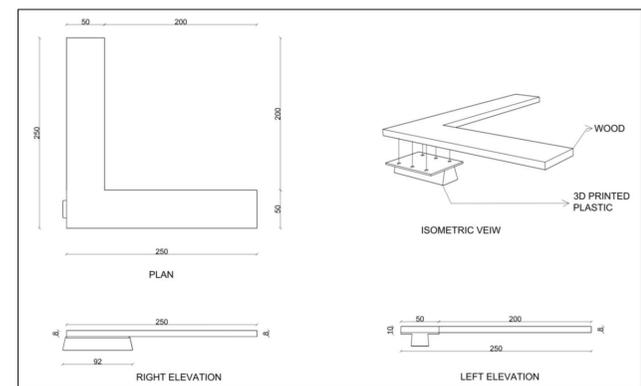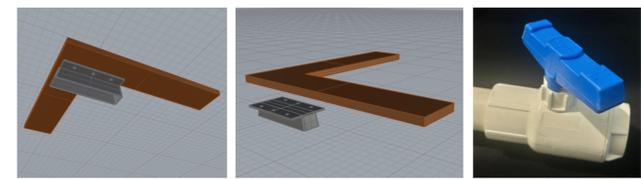
Mechanical Arm

Figure 9. Images and Drawings of the Mechanical Arm and the attachment used to connect it to the valve shown.
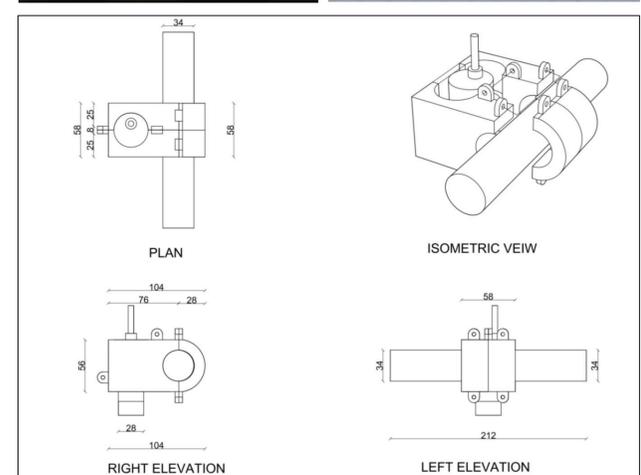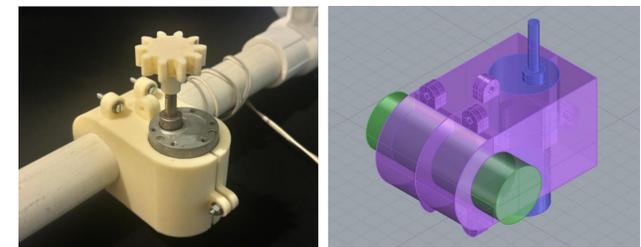
Motor Holder

Figure 10. Images and Drawings of the Mechanical Arm and the attachment used to connect it to the valve shown.

Figure 11. Progress and Model photo.